

COURSE OF INSTRUCTION HANDBOOK

This Handbook Contains General Information Concerning
Graduation Requirements, Academic Registration
Procedures, Course Offerings, and Academic Programs
Effective Fall 2024 at the United States Air Force Academy.

As directed in United States Air Force (USAF) Academy Instruction 36-3526, the Dean of the Faculty publishes this handbook annually. Procedures for initiating changes to this handbook are contained in USAF Academy Instruction 36-3526. The Course of Instruction Handbook documents the curriculum of the USAF Academy, as approved by the Academy Board.

This handbook contains information relating to the academic year 2024-2025. Every effort has been made to ensure its accuracy, but USAF Academy reserves the right to make corrections and changes to any information contained in this and subsequent issues of the Course of Instruction (COI) Handbook or in any of its other publications. Courses of instruction, programs, degree requirements, and any other matters are subject to change.

Information concerning this handbook and additional copies may be obtained from the Curriculum and Academic Affairs Division, Office of Student Academic Affairs and the Academy Registrar (DFVR), 2354 Fairchild Drive, Ste 2G13, USAF Academy, Colorado, 80840. This handbook is available under the Academics and Registrar tab at <http://www.usafa.edu>. This handbook was edited by the Curriculum and Academic Affairs Division (DFVRC, 719-333-2452).

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CHAPTER 1 OVERVIEW

SECTION 1-1 INTRODUCTION

1-1.1. PURPOSE OF THE COURSE OF INSTRUCTION HANDBOOK

The Office of Student Academic Affairs (DFVR), Curriculum and Academic Affairs Division (DFVRC), publishes the Course of Instruction Handbook at the beginning of each academic year. Together with the USAF Academy Catalog, published by the Office of Admissions (RR), it documents the curriculum of the USAF Academy as approved by the Academy Board. The Course of Instruction Handbook contains general information concerning graduation requirements, academic registration procedures, course offerings, academic programs and majors, and academic probation. If you have questions, contact DFVRC in Fairchild Hall, Room 2G13, (719) 333-2452.

1-1.2. HANDBOOK CONTENTS

This handbook is organized into three main topic areas. Sections 1-1 – 2-5 contain information concerning academic registration procedures, grades, scheduling, academic deficiencies, and special programs. Sections 2-6 – 2-8 address the core requirements, academic programs, and majors and minors; Section 2-9 is a description of the Bachelor of Science Program. The appendices contain USAF Academy Institutional Outcome white papers, course descriptions, and definitions.

1-1.3. COURSE OF INSTRUCTION CHANGE PROPOSALS

The USAF Academy has established procedures for updating and revising the USAF Academy curriculum. These procedures are explained in detail in USAF Academy Instruction 36-3526, USAF Academy Course of Instruction & Change Control.

1-1.4. OBJECTIVES OF THE USAF ACADEMY CURRICULUM

a. USAF Academy Institutional Outcomes

(1) The USAF Academy develops a diverse pool of professional Air and Space Force officers who:

- (a) Lead with Character and Respect by demonstrating *skilled leadership, teamwork, and organizational management*, while *living ethically with unwavering respect for human dignity*;
- (b) Integrate Knowledge about Human Cultures and the Natural World by valuing *the human condition, cultures, and societies*, employing *the principles of science and scientific reasoning*, and harnessing *the fundamentals of engineering*;
- (c) Address complex and uncertain problems with agile intellectual skills sustained by *effective communication and critical thinking*;
- (d) Defend our nation in air, space, and cyberspace by maintaining the *national security of the American Republic*, with dedication to the *warrior ethos as airmen and guardians*.

(2) The USAF Academy Institutional Outcome white papers are included in Appendix 1. The USAF Academy Institutional Outcomes are:

- (a) Leadership, Teamwork, and Organizational Management – to apply character-based leadership principles at the personal, interpersonal, team, and organizational levels.
- (b) Ethics and Respect for Human Dignity – to recognize ethical alternatives among the options available, use ethical judgment to select the best alternative, and act consistently to respect the dignity of all affected persons.
- (c) The Human Condition, Cultures, and Societies – to comprehend what it means to be human, the individual situated in a culture and society, and the interactions of people from different socio-cultural milieus.
- (d) Scientific Reasoning and the Principles of Science – to apply scientific habits of mind, including proficiency in the nature of science, scientific reasoning, and the principles of science.
- (e) Application of Engineering Problem-Solving Methods – to understand the opportunities, requirements, and constraints imposed by the scientific and mathematical workings of the universe, supported by knowledge of the current and projected state of technology.
- (f) Clear Communication – to express ideas in written or oral formats with the intent to enhance knowledge, foster understanding, or stimulate new thinking.
- (g) Critical Thinking – to apply self-aware, informed, and reflective reasoning for problem solving and decision making in the absence of ideal information.
- (h) National Security of the American Republic in a Complex Global Environment – to possess the knowledge necessary to protect the fundamental values and core interests of the United States, and recognize the broader political context in which military force must be employed.
- (i) Warrior Ethos as Airmen and Guardians – to persevere despite physical and mental hardships, embrace the oath of office and the profession of arms, adopt the core values, and value all Airmen and Guardians.

b. Academic Program

(1) Provides cadets with general courses in the basic sciences, engineering, social sciences, and humanities to form a Liberal Arts foundation for their development as future Air and Space Force officers. The broad core curriculum at the USAF Academy continues to hold true to the belief of its founders, that national leaders require multidisciplinary perspectives and skills to solve the nation's complex problems.

- (2) Offers elective courses to meet cadets' needs and desires.
- (3) Motivates cadets toward advanced education through enrichment courses (e.g., advanced placement, audit, special topics, and independent study).
- (4) Prepares cadets to fulfill their intellectual responsibilities as citizens and dedicated public servants in the Air and Space Forces.

c. Military Training

- (1) Provides cadets with the education, training, and experiences necessary to commission as an officer in the United States Air and Space Forces.
- (2) Offers a multi-dimensional developmental approach across 47 months to prepare cadets to lead with character as officers in the United States Air and Space Forces.
- (3) Educates cadets in their roles and responsibilities as members of the profession of arms.

d. Physical Education and Athletics

- (1) Further develops desirable traits of character essential to leadership, including persistence, desire to win, aggressiveness, and esprit de corps.
- (2) Teaches skills needed to perform physical tasks.
- (3) Encourages a positive attitude toward physical fitness.

e. Airmanship

- (1) Airmanship programs include soaring, parachuting, powered flight, Unmanned Aerial Systems/Remotely Piloted Aircraft operations, and all associated competition teams. Per USAF Academy Mission Directive Six, USAF Academy/A3 is the Office of Primary Responsibility (OPR).
- (2) USAF Academy is authorized to utilize unique airmanship programs in support of the cadet development mission (AFI 36-3501, *USAF Academy Operations*). The overall goal is to foster "Airmindedness:" a global, strategic mind-set providing perspective through which the battlespace is not constrained by geography, distance, location, or time. This goal is achieved through three program objectives:
 - (a) Educate all cadets on the concept of airpower, as defined in Air Force Doctrine Volume I as the ability to project military power or influence through the control and exploitation of air, space, and cyberspace to achieve strategic, operational, or tactical objectives. Cadets should understand the intellectual foundations behind airpower,

articulate its proper applications, and understand Air Force aviation's history, traditions, demands, and emerging capabilities.

(b) Inspire cadets and provide motivational, character-building experiences that contribute to informed career decisions and allow the USAF Academy to meet its Rated Training Allocation requirements.

(c) Train cadets to ensure graduates awarded rated assignments possess the attitude, aptitude, skills and confidence necessary to excel in Undergraduate Pilot Training.

f. Character and Leadership Development

(1) Guided by USAFA Manual 36-3526, *Developing Leaders of Character at USAFA* ([USAFAMAN36-3526](#)), which outlines a framework for developing leaders of character and provides guidance for how USAFA personnel can foster a personal commitment to leadership development in their day-to-day roles, and help them grow as leader-developers. The Leader of Character Framework is depicted in Figure 1.

(2) Prepares cadets to fulfill their responsibilities as leaders of character who live honorably, lift others, and elevate performance.

(3) Takes place across academic, military, athletic, and airmanship education, training, and experiences throughout the 47-month experience.

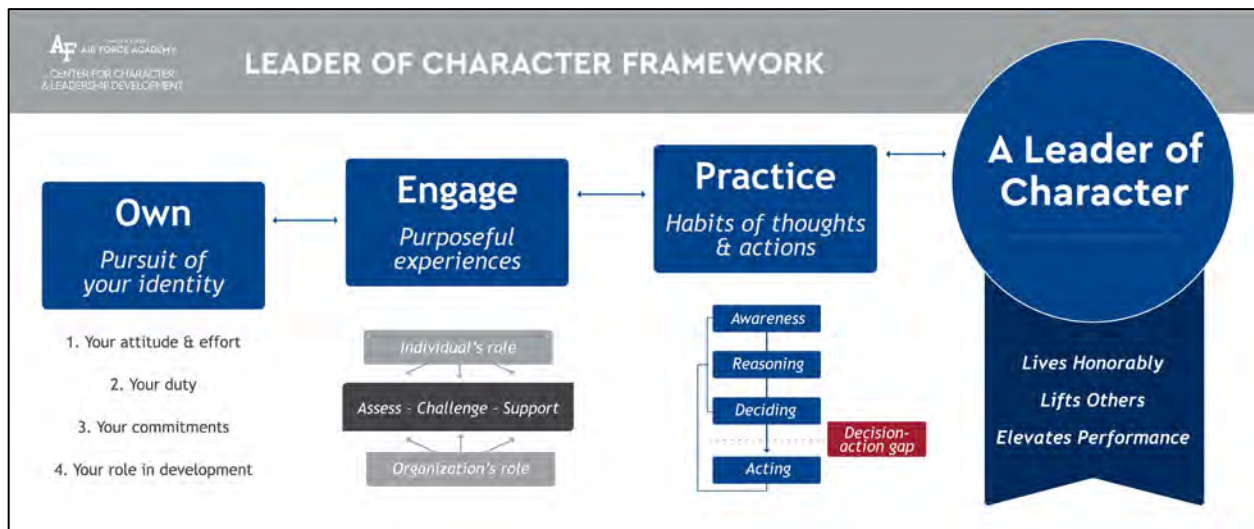


Figure 1. The Leader of Character Framework (USAFAMAN 36-3526)

1-1.5. GRADUATION AND RESIDENCY REQUIREMENTS

To graduate from the USAF Academy, a cadet must demonstrate an aptitude for commissioned service and leadership, display acceptable conduct, maintain proficiency in physical education and the commissioning education program, and meet all requirements for an academic major unless approved for the Bachelor of Science Program.

- a. To fulfill academic requirements, cadets must satisfactorily complete the core curriculum with a minimum 2.0 core grade point average (GPA). Cadets must also meet the minimum standard of a 2.0 cumulative GPA. All cadets must declare a major, unless approved for the Bachelor of Science Program, and earn a minimum 2.0 GPA in that major.
- b. A cadet must complete at least eight semesters in residence at USAF Academy. A semester spent in a USAF Academy-sponsored exchange program/semester abroad, not to exceed one, counts as a semester in residence. A cadet must take at least 125 semester hours at USAF Academy (including those completed in USAF Academy-sponsored exchange programs, not to exceed 24 semester hours) to satisfy residency requirements, regardless of semester hours transferred and validated. Courses which do not fulfill residency requirements include those validated or transferred, courses carrying no semester hour credit, and failed courses.
- c. A cadet's commissioning education includes a course of study in professional military education and the leadership laboratory experience provided by being part of the Cadet Wing. Each cadet is evaluated on military performance each semester and must maintain a minimum 2.0 cumulative military performance appraisal (MPA) level of performance for graduation. Before graduation, each cadet must successfully complete each of the Core Military Training programs as a student. Each cadet must successfully complete two leadership programs, one of which must be a Military Leadership program. Each cadet must successfully pass Basic Cadet Training (BCT), Combat Survival Training (CST), and participate in Ops Air Force as summer programs required for graduation. Leadership credit can be obtained during the school year if key leadership positions within the Cadet Wing are held for the entire semester.
- d. To fulfill the Physical Education requirements, cadets take 5.0 semester hours (ten 0.5 semester hour courses) of Phy Ed credit over their four academic years. Participation in intramurals, clubs, or intercollegiate athletics is required in each of their eight academic semesters. Proficiency is also required in both the physical fitness test (PFT) and aerobic fitness test (AFT). Athletic proficiency for graduation is demonstrated by meeting the minimum standard of a 2.0 cumulative physical education average (PEA) and passing the USAF Physical Fitness Assessment during the first-class year. PEA is a weighted 4.0 grading scale (50% PFT + 35% Phy Ed courses + 15% AFT).

1-1.6. INTERNATIONAL CADETS

Students that are citizens of foreign countries are designated International Cadets. International Cadets for whom English is a second language are awarded validation credit for their native language. They must fulfill all other USAF Academy graduation requirements to earn a Bachelor of Science degree; those International Cadets who do not fulfill all requirements before graduation are awarded a certificate of completion stating they attended the USAF Academy for four years. For details, refer to COI 2-5.7 *English as a Second Language*. International cadets are not authorized to participate in RPA Airmanship courses.

CHAPTER 2 ACADEMICS

SECTION 2-1 REGISTRATION

2-1.1. RESPONSIBILITY FOR REGISTRATION

a. Cadet Responsibilities. The primary responsibility for completion of graduation requirements rests with the cadet. Each cadet is expected to plan a course of study and maintain satisfactory standards of scholarship and conduct. The faculty stands ready to help when called upon, but the initiative rests with the cadet. Cadets must meet with their academic advisors or Associate Air Officers Commanding for Academics (AAOCA) at least once each semester prior to the registration deadline for the following semester. In addition, cadets will take the following steps:

- (1) Deliver all annotated Academic Program Summaries (APSs) with course changes for the following semester to DFVRC if after the registration deadline.
- (2) Verify the accuracy of each document returned from the Office of Student Academic Affairs following the processing of course change requests.
- (3) Ensure the latest copy of the APS reflects plans for meeting graduation requirements.
- (4) Coordinate with their AAOCAs prior to declaring an academic major(s). Cadets must declare a major no later than a week prior to the registration deadline during their third semester (fall of third-class year). However, some majors – e.g. Computer Science, Chemistry, and Biology (particularly those interested in pursuing medical school) – should be declared before the end of the fourth-class year due to course sequencing requirements.
- (5) Submit a USAF Academy Form O-498, Request for Permission to Enroll in an Independent Study Course, when necessary (see Para 2-1.10).
- (6) Comply with all registration change, academic major declaration, and academic major change procedures and deadlines described in this handbook.

b. Advisor-in-Charge (AIC), Academic Advisor, and AAOCA responsibilities.

- (1) Hold cadets accountable for meeting deadlines established in this handbook. To ensure accomplishment of all necessary administrative requirements, advisors and AAOCAs must meet with their advisees at least once each semester prior to the registration deadline for the following semester.
- (2) Be available for cadet appointments concerning registration changes, academic program declarations, and academic program changes.
- (3) Coordinate all advisee registration changes, academic program declarations, and academic program changes by completing the online registration process.

- (4) Verify each advisee's program meets course prerequisite requirements and that waivers and department approvals have been obtained and processed as required.
- (5) Be responsible for accomplishing counseling, registration changes, or academic program changes with advisees as directed by the Academic Review Committee (ARC).
- (6) Initiate, at the beginning of the semester, an annotated APS to drop all overload courses for cadets who do not meet minimum GPA criteria for overloads.
- (7) Make sure each advisee's academic program includes all requirements for graduation.
- (8) Ensure cadets on academic probation are counseled at each progress report.
- (9) Assist and counsel advisees preparing for ARC interviews.
- (10) Provide mentoring and guidance towards achievement of the cadets' personal and professional goals.

2-1.2. ACADEMIC COUNSELING AND ADVISING

The Dean of the Faculty has delegated to DFVR responsibility for administering the academic advising and counseling program. DFVRC trains and educates the AAOCA's and AIC's for each academic program the USAF Academy offers. Academic advising is an integral part of the USAF Academy learning experience. Academic advising includes assisting cadets with course and program selection and registration, helping cadets develop realistic self-perceptions, and successfully transitioning cadets to the USAF Academy environment.

- a. AAOCA. Each AAOCA provides general advice and counsel on academic programs to cadets of their squadron. AAOCA's mentor cadets in selecting an academic program that mirrors the cadets' life goals and is supported by the cadets' abilities. AAOCA's keep records on all advisees.
- b. AIC. Each AIC is responsible for the advising of all cadets within the applicable academic program. The AIC may have a number of assistants (advisors) to help counsel cadets interested in that discipline; however, it is the AIC that makes all final decisions in administering the program. The AIC, in general, oversees the proper completion and timely submission of all inputs to the registration system. In this regard, the AIC serves as the single point of control for all paperwork and procedures concerning the program; DFVRC will honor only the AIC's signature or that of a designated alternate.
- c. Air and Space Force Specialty Codes (AFSCs and SFSCs). When advising cadets on alignment between USAF Academy majors and future AFSCs and SFSCs, advisors and cadets should review the Air Force Officer Classification Directory (AFOCD), Appendix A, CIP Education Matrix, to ensure that the selected USAF Academy major is required, desired, or permitted for the AFSC/SFSC the cadet is pursuing. For entry into the AFSC/SFSC, it is mandatory that an officer accession meet at least one of the tiers listed in the CIP matrix for the AFSC/SFSC in which they are to be accessed. Each AFSC/SFSC will work to fill the first

Tier prior to filling the other Tiers. Each career field has a different set of requirements and tier structure. If an officer doesn't meet any of the tier requirements in the matrix, they are not qualified to enter the AFSC/SFSC. Target Accession Rates are defined in the CIP Education Matrix. Tier 1 target accession rates are generally the largest because the desired population for each AFSC/SFSC should be a Tier 1 officer. Tier 2 and Tier 3 target accession rates follow suit. There are some AFSCs/SFSCs which have only one Tier due to the strict educational entry requirements. For example, 61CXN and 61DXN have only one Tier defined with target accession rates for these AFSCs being 100%. When distributing officer accessions across the education needs of all AFSCs/SFSCs, Tier 1 requirements are considered first until the pool of available accessions with matching education has been exhausted.

d. Maintenance of Cadet Academic Records. The AIC, advisor, or AAOCA keeps a current copy of cadets' APSs and other academic-related documents to include waivers, graduation checks, Cadet Academic Deficiency Evaluation and Probation Action Plans (USAF Academy Form 68) and special information concerning cadets' academic programs. Cadets should keep copies of all information related to their academic programs. Cadets' official transcripts may be requested from DFVRR. The most current APSs are available from COMPASS. Records should be maintained for six months following the cadet's graduation or departure.

2-1.3. PROGRAM PLANNING

During their first semester at the USAF Academy, fourth-class cadets should begin planning their academic program. As an aid to cadets and their AAOCA, DFVRR will pre-register each cadet in all common core courses the cadet must complete at the USAF Academy based upon predetermined semester-load balances negotiated with academic departments. Cadets and AAOCA must check APSs for omissions, sequencing errors, and ensure third semesters include prerequisites required by the envisioned academic major. Cadets may make changes to this initial schedule, provided they satisfy core sequencing policies.

a. Course Offerings. Course offerings are published semi-annually in the Curriculum Handbook Supplement and annually in this handbook.

b. Contact Hours. The two-day USAF Academy scheduling cycle limits the available number of periods (contact hours) to 13. Because some academic courses meet every day or require a double period for laboratory or seminar meetings, cadets should be careful to keep their programs within the 13-period limit each semester. Cadets should pay particular attention to flying programs that require additional periods. The number of contact hours for each course is shown in the course description section of this handbook beside the course identifier. For example, an entry "3(2)" indicates that a course has three semester hours value and meets two contact hours over the two-day scheduling cycle.

c. Semester Hour Computation. Only courses, programs, or experiences that fulfill requirements for the Bachelor of Science degree are considered for semester hour credit. A semester hour is awarded on the expectation of roughly 40 hours of cadet work over the course of the semester, either in direct interaction with a qualified faculty member or completing out-of-class work associated with the course or program. Most academic courses at USAF Academy are 3.0 semester hours, meaning that they will require 120 hours of cadet work over the course of the semester. This is typically accomplished by meeting for 40 one-hour periods

of classroom instruction (minus the institutionally-allotted transit time between classes) and requiring typical cadets to perform roughly 80 hours of out-of-class work over the course of the semester.

- (1) Qualified faculty will possess a Master's degree or higher with 18 credit hours at the graduate level in the academic discipline being taught, or in a related academic discipline. For exceptional circumstances or where documented and tested experience warrant an exception, consult with USAFAs Accreditation Liaison Officer.
- (2) All courses / experiences awarding academic credit shall maintain learning objectives appropriate for undergraduate education. Additionally, the courses should be part of a routine programmatic or course review.
- (3) Variants of the typical 3.0 semester hour configuration are possible. For example, a 3.0 semester hour course could also meet for roughly 80 hours (e.g., in 40 two-hour periods), but only require typical cadets to perform 40 hours of out-of-class work over the course of the semester.
- (4) It is also possible for courses to deviate from the 3.0 semester hour standard. For example, a 1.0 semester hour course (requiring 40 total hours of cadet work) could meet for 40 one-hour lessons but expect no out-of-class work or meet for 20 one-hour sessions with the expectation of roughly 20 hours of out-of-class work. Any department offering a course or program with a semester hour designation that deviates from the 3.0 standard is expected to explain how semester hours are computed as part of a Course of Instruction Change Proposal (CCP).
- (5) USAF Academy Physical Education (Phy Ed) courses are one notable exception to the 3.0 semester hour standard. All Phy Ed courses are worth 0.5 semester hours. They consist of eight lessons, 75 minutes in duration, equating to 10 classroom contact hours. Cadets are expected to allocate roughly 75 minutes per lesson to outside class study, practice, preparation, and extra-instruction (EI). This results in 20 total hours per .5 semester hours Phy Ed course (150 minutes x 8 lessons) and is therefore proportionate to the 120 hours required for a 3.0 semester hour academic course.

d. Course Load. When planning course loads, cadets should attempt to balance their schedules as much as possible. The waiver authority for maximum course loading is DFVR. The waiver authority for minimum course loading is the Vice Dean of Academics. The waiver process is described in paragraph 2-1.9.

- (1) For the fourth-class fall semester, the maximum semester hour load is 17.5 semester hours; the minimum semester hour load is 13.5 semester hours. Cadets determined to be academically at-risk will take 4 academic courses their first semester plus Lrn Strt 101; the course loads for their first two semesters are determined upon entry into the USAF Academy.
- (2) For the fourth-class spring semester, the maximum semester hour load is 21.25 semester hours; the minimum semester hour load is 14.5 semester hours. The semester hour range for academically at-risk fourth-class cadets in the spring semester is 14.5 – 17.5 semester hours. In addition, academically at-risk cadets will normally be granted an academics-plus-summer break slot in the summer prior to their third-class year. If an academically at-risk cadet earns a 2.80 semester GPA or higher at the end of the fall

semester, is academically proficient, and passes all coursework in the fall semester, the cadet can opt out of the academics-plus-summer break slot, opening the opportunity for other summer programs, such as Airmanship, Cyber, Space, and RPA courses.

(3) For third-class, second-class, and first-class cadets, the maximum semester hour load is 22.0 semester hours; the minimum semester hour load is 14.5 semester hours. Cadets in good standing may exceed 22.0 semester hours if they have a minimum 3.25 cumulative or previous semester GPA.

(4) The minimum semester hour load for the Wing Commander, Vice Wing Commander, the four Group Commanders, the Wing Director of Character and Honor, the Wing Honor Remediation Officer and Wing Character and Honor Development Officer, and the eight Group Director of Character and Honor and Group Honor Chairperson is 12.5 semester hours.

(5) The NCAA requires intercollegiate student athletes to be enrolled in a minimum semester hour load of 12.0 hours to maintain eligibility for athletic competition.

(6) Any cadet placed on academic probation may be ARC-directed to drop a course or courses.

e. Normal Course Load Progression for Graduation:

Table 1. Semester Hour Requirements

CLASS	SEMESTER	SEMESTER HOURS
Fourth	1	13.5 – 17.5
	2	14.5 – 21.25
Third	3	14.5 – 22.0
	4	14.5 – 22.0
Second	5	14.5 – 22.0
	6	14.5 – 22.0
First	7	14.5 – 22.0
	8	14.5 – 22.0
Total Semester Hours:		134.0 – 149.0

2-1.4. CADET OPERATIONS MANAGEMENT PLANNING & ADMISSIONS SUPPORT SYSTEM (COMPASS)

COMPASS is the computer database USAF Academy personnel use to record cadets' academic programs. The Office of Student Academic Affairs staff produces and distributes COMPASS products that cadets and advisors use for registration and monitoring progress toward graduation. Samples of the APS and the Academic Graduation Check are provided in *Figure 2* and *Figure 3*, respectively.

a. Academic Program Summary. Information found on the APS (*Figure 2*) includes transfer and validation credit, athletic squads, clubs, intramurals, total semester hours for each

semester, total cumulative semester hours at the end of each semester, semester and cumulative GPA at the end of each semester, turn back status, academic probation information, and courses taken and planned. The following areas warrant further explanation:

- (1) "Academic Probation" indicates academic probation for mid-semester (Prog), end-of-semester (End), or end-of-summer term (End) and is a permanent entry for that semester or term.
- (2) The semester hour total listed below each semester's courses reflects all completed graded courses, completed pass/fail courses, and transfer and validation semester hours' credit.

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Core GPA: 3.817 CUM GPA: 3.902 OPA: 3.451 Major 1 GPA: 4.000 Major 2 GPA: 0.000 Major 3 GPA: 0.000	Major(s): Aeronautical Engineering Minor(s): Advisor: Program Status: Active in Program Total Semester Hr (units): 126.25	State/Country: KY/USA MIA Position: AFSC: - Academy Scholar: N Intercollegiate Sport:																																																																																																																																																																																																									
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Figure 2. Academic Program Summary

b. Academic Graduation Check. The three major sections of the grad check (Figure 3) are Core Requirements, Major Requirements, and Other Courses Taken. Columns represent the following:

- (1) The "Requirement" column lists the Master Course File number and the course title.
- (2) The "Course" column lists the course filling the requirement.


(3) The “GPA” column lists each GPA (i.e. core (C), 1st major (M1), and/or 2nd major (M2)) toward which that course counts. Courses may be included in more than one GPA.

(4) The “Wvr” column indicates if that course was waived (Y) into that requirement.

(5) The “Sem” column lists the semester in which the course was taken or is planned.

(6) The "Grd" column lists the final grade, the mid-term grade, or no grade for a course not yet taken (*) or scheduled (--). A ‘T’ indicates transfer credit; a ‘V’ indicates validation credit.

(7) The “Hrs” column lists the semester hours for the course filling that requirement, rounded to the nearest tenth.



Grad Check Report

The information herein is FOR OFFICIAL USE ONLY (FOUO) information which must be protected under the freedom of information Act (5 U.S.C 552) and/or the Privacy Act of 1974 (5 U.S.C. 552a). Unauthorized disclosure or misuse of this PERSONAL INFORMATION may result in disciplinary action, criminal and/or civil penalties.

Report Run: 12-JUL-2023 01:55

Name: CLYR: 2024
Core GPA: 3.817
CUM GPA: 3.902
OPA: 3.451
Major 1 GPA: 4.000
Major 2 GPA: 0.000
Major 3 GPA: 0.000

EMPLID: CLYR: 2024
Major(s): Aeronautical Engineering
Minor(s):
Advisor:
Program Status: Active in Program
Total Semester Hr (units): 126.25

SQ: Gender: **ESL:** **CMPAC:** 3255
State/Country: KY/USA
Mil Position:
AFSC: -
Academy Scholar: N Intercollegiate Sport:

Requirement

Course	GPA	Wvr	Term	Grd	Units
Math 141			2205	V	3.0
Math 142			2205	V	3.0
Math 177			2208	A	3.0
Chemistry I			2208	A	4.0
Physics I			2208	A	4.0
Physics II			2205	V	3.0
Physics III			2211	A	4.0
Physics IV			2218	A	3.0
ASTROENG 310			2241	*	3.0
COMPSCI 110			2231	A	3.0
ECCE 315			2241	*	3.0
MECHENG 320			2218	A	3.0
RFPHSC 110			2205	V	3.0
LRSHIP 100E			2211	A	0.8
LRSHIP 200E			2221	A	0.8
LRSHIP 300G			2231	A	0.8
LRSHIP 400X			2238	*	0.8
ECEN 201			2218	A	3.5
LAW 220			2221	A	3.0
MSS 251			2221	A-	4.5
POLSCI 211			2218	A	3.0
SOCSCI 311			2238	*	3.0
ENGLISH 111			2208	A	3.0
ENGLISH 212			2221	A-	3.0
HISTORY 100			2211	B-	3.0
HISTORY 300			2238	*	3.0
PHILOS 310			2238	*	3.0
RUSSIAN 132			2211	A	3.0
RUSSIAN 131			2208	A-	3.0
MATH 525			2208	A	3.0
MGT 400			2241	*	3.0
MATH 345			2211	A	3.0
PHYED 100			2205	P	0.6
PHYED 110F			2211	B	0.5
PHYED 111A			2218	B	0.5
PHYED 112B			2208	A-	0.5
PHYED 223B			2218	A	0.5
PHYED 215A			2228	B	0.5
PHYED 315C			2228	B	0.5
PHYED 346C			2221	B-	0.5
PHYED 481B			2230	F	0.5
PHYED 330E			2231	B-	0.5
PHYED 348E			2241	*	0.5
MULTNG 100			2205	P	0.0
MULTNG 390G			2215	P	0.0
MULTNG 411			2225	P	0.0

Requirement

Course	GPA	Wvr	Term	Grd	Units
Math 346			2218	A	3.0
MECHENG 330			2221	A	3.0
MECHENG 350			2228	A	3.0
AFROENG 341			2221	A	3.0
AFROENG 341			2228	A	3.0
AFROENG 342			2231	A	3.0
AFROENG 351			2228	A	3.0
AFROENG 352			2231	A	3.0
AFROENG 361			2231	A	3.0
AFROENG 436			2228	*	3.0
AFROENG 442			2238	*	3.0
AFROENG 471			2231	A	3.0
AFROENG 481			2228	*	3.0
COMPSCI 311			2218	A-	4.0
AFROENG 482			2241	*	3.0
AFROENG 456			2241	*	3.0

Other Courses Taken

Course	GPA	Term	Grd	Units
AFROENG 156L		2241	*	1.0
MULTNG 402		2235		0.0
MULTNG 481		2235		0.0
MULTNG 481		2235		0.0
CE 300		2231	P	0.0
MATH 543		2238	W	5.0
MULTNG 400		2235	P	0.0
CE 300		2221	P	0.0
MATH 465		2221	A	3.0
CE 100		2211	P	0.0
SPACE 251C		2211	P	0.0
SPACE 252H		2211	P	0.0

Resident Units Required for Graduation: 120

--- = Missing Requirement

* = Planner Course

GPA: C = Core; M1 = 1st Major; M2 = 2nd Major
M3 = 3rd Major; N1 = 1st Minor; N2 = 2nd Minor; N3 = 3rd Minor

Term: 2 = Century YY = Academic Year; 1 = Spring; 5 = Summer; 8 = Fall

Figure 3. Academic Grad Check

c. Verification of Graduation Requirements.

(1) It is the cadet's responsibility to review their Grad Check to verify if they are on track to graduate with the assistance of the Air Officer Commanding (AOC), and the Academic Advisor.

(2) Academic Requirements: During the fall semester, DFVR audits the core curriculum portion of each first-class cadet's graduation check to ensure all core requirements have been or will be met.

(3) Verification of Military Graduation Requirements and Athletic Graduation Requirements: Commandant of Cadets personnel will audit and verify the military training curriculum portion of cadets' graduation check to ensure all military training requirements have been or will be met. ADP will audit and verify the physical education curriculum portion of each cadet's graduation check to ensure their physical education course requirements and their Physical Education Average (PEA) status fulfills graduation requirements.

d. Semester Titles. Semester and term titles in COMPASS APS are as follows:

Table 2. Semester Titles

Semester/Term	COMPASS Term Titles
Summer Term 2024	2245
Fall Semester 2024	2248
Spring Semester 2025	2251
Summer Term 2025	2255

2-1.5. REGISTRATION PERIODS

Four types of registration periods occur:

a. Special Semester Registration: Changes authorized anytime. Coordination by all affected departments is required. Changes authorized:

- (1) Drop courses per course drop timetable (*Table 4*)
- (2) First-class only: correct grad check discrepancies (department coordination required)
- (3) Department-approved changes to lower/higher-level courses
- (4) Academic Review Committee-directed changes
- (5) Change of advisor and/or major

b. Late Registration: Registration changes for the next semester requested after that semester's registration deadline (e.g., changes to spring requested in December). Obtain approval to add or drop classes from each affected Department Head or representative in the form of a signature on the APS.

c. Future Semester On-Line Registration: Registration changes for future fall and spring semesters are accepted anytime in COMPASS by the cadet's assigned advisor. If past the registration deadline for that semester, late registration procedures apply (see para 2-1.5b). Department coordination is required during on-line registration for future semesters if the change violates course prerequisites or the course requires department approval as directed by the course description (Appendix 2).

d. Summer Registration: Summer academic course registration occurs in the spring semester preceding the summer term. Details will be advertised by DFVR to cadets and advisors.

2-1.6. CHANGES AFFECTING FUTURE SEMESTERS

Schedule changes to future semesters can be made any time before the registration deadline for that semester as advertised by DFV. The registration deadline for the spring semester occurs in the October preceding it. The registration deadline for the fall semester occurs in the April preceding it. Advisors/AAOCAs can enter registration changes for future semesters through COMPASS's On-Line Registration System. Moving a core course in excess of +/- one year outside its designated year requires an academic waiver approved by the Associate Dean for Student Academic Affairs (DFVR).

a. Registration - Options:

- (1) Add Course to Schedule (add course to future semester)
- (2) Move Selected Course to... (move future course to a different semester)
- (3) Swap Terms for Selected Courses (change semesters for two future courses)
- (4) Replace Selected Course with... (replace future course with a new course)
- (5) Delete Selected Course (delete course from future semester)

b. Registration – Rules of Engagement:

- (1) Only academic courses can be changed with COMPASS (i.e. no Phy Ed and no Armnshp).
- (2) Advisors can only change advisees' courses.
- (3) AICs can make changes to cadets within their major.
- (4) Schedules for the current semester must be changed by DFVRC after coordination with affected departments per registration guidance. After the registration deadline for the upcoming semester, advisors will not be able to make on-line changes for that semester.
- (5) AICs must validate registration changes (e.g. manually check course prerequisites).

- (6) Advisors verify changes were made (i.e. view new APS next day).
- (7) Only offered courses can be added in associated semesters.
- (8) Advisors should verify changes are consistent with course load minimums and maximums (see para 2-1.3d).
- (9) Advisors should ensure registered courses do not exceed 13 hours contact time maximum.
- (10) Advisors should ensure cadets meet all graduation requirements (core and major).

c. Registration changes after the registration deadline must be submitted IAW paragraph 2-1.5b.

2-1.7. CHANGES AFFECTING CURRENT SEMESTER

We classify any changes affecting the present semester as current semester changes. Cadets must attend the courses printed on their academic schedules until they receive a new schedule via the COMPASS webpage. Instructors are required to mark as absent any cadet who does not attend class and is still on their roster. The cadet will drop from the instructor roster at the effective time that their schedules are changed. An instructor may allow a cadet to attend a class a cadet is attempting to add during the cadet's free period until the cadet receives the schedule change.

a. Checklist for Changes to Current Semester. All changes attempted after the normal registration period requires appropriate Department Head (or designated representative) coordination; course drops must meet the deadlines listed in the course drop timeline (*Table 4*).

- (1) Cadet and advisor/AAOCA work out desired changes, performing the following:
 - (a) Course offering check (are courses taught in semesters desired?)
 - (b) Core course sequencing check
 - (c) Academic program course check (are all required courses scheduled?)
 - (d) Prerequisite check
 - (e) Underload/overload check
 - (f) Contact hour check (are 13 or fewer contact hours scheduled per semester?)
 - (g) Duplicate course check (are any courses scheduled more than once?)
- (2) Cadet and advisor/AAOCA annotate a current APS with desired changes.
- (3) For current semester changes, the APS must be coordinated by the following:

- (a) Cadet, advisor/AAOCA, and AIC (if the cadet has declared an academic major)
- (b) Department Head or designated representative for each course that is added or dropped
- (c) Coordination with the following agencies, if affected by changes:

Table 3. Course Coordination

Course	Req'd Coordination
Armnsnp Courses	A3O
Aviation Courses	A3O
Cyber Courses	DFCS
Phy Ed Courses	ADP
Space Courses	DFAS

b. Directed Changes.

(1) DFVRR may change a cadet's schedule to correct errors or to balance course load.

(2) DFVR may make changes to implement decisions resulting from the Academic Review Committee process. If any of these changes requires a cadet to drop or add a course, DFVRC will sign the annotated APS as the initiating authority or may ask the advisor/AAOCA to sign the change request as the initiating authority.

(3) Cadets will drop necessary courses or initiate a waiver during Lesson 1 to comply with the overload policy for cadets whose grade point averages at the beginning of a semester are insufficient to carry their desired enrollment (see overload policy, para 2-1.3d, and Definition of Terms).

c. Adding a Course. To add a course in the current semester, the cadet and Advisor/AAOCA must coordinate with DFVR and submit an APS signed by the Department Head (or designated representative) of the class being added. After Lesson 3, no courses can be added without Department Head coordination and Vice Dean for Academics approval, coordinated through DFVR.

d. Dropping a Course. A cadet may drop an academic program, elective, or core course during the semester with DFVR approval if not dropping below minimum semester hour requirements outlined in para 2-1.3d. To drop or make changes to an Airmanship, Aviation, or RPA/UAS course, cadets must coordinate with the A3O Registrar (av.am.scheduling@afacademy.af.edu). Approval to drop a course is subject to the timeline shown in Table 5 and dependent upon ability to retake the course within proper sequencing guidelines.

2-1.8. CHANGING AN ACADEMIC PROGRAM SUMMARY

Make changes to a cadet's program either in COMPASS or by annotating required changes in RED INK on a current copy of the cadet's APS.

- a. Ensure you use the most current APS available.
- b. To drop courses, circle them (don't line out courses; this indicates no change to DFVR personnel). If the course is circled in error, line through the circle and the class will not be dropped.
- c. To add courses, write them in under the appropriate semester.
- d. To declare or change an academic program, annotate above the advisor's name.
- e. Changes made to the 7th or 8th semester of a first-class cadet must include the graduation check to allow DFVRC to verify graduation requirements will be met.
- f. If any APS changes are initiated by a person or group other than the cadet and the cadet's academic advisor, both the cadet and advisor will be notified by that entity within 24 hours of the change.

Table 4. Course Drop Timeline

LESSON	ACTION
M1 - T8	Course will not appear in mid-semester progress report or on official transcript. Cadets must have AAOCA/Advisor and AIC (if applicable) coordination for their intended drops along with approval by all affected departments. (Coordination will be via signature on current APS submitted for change; approval authority is DFVR.)
M9 - T20	Drops which are in the best interest of USAF Academy and the cadet will be allowed in select circumstances. Cadets must have Advisor, AIC, and Course Director coordination with final approval by the major's Department Head. Coordination will be via signature on current APS submitted for change. Undeclared cadets require AAOCA and Course Director coordination with approval by DFVR. Coordination will be via signed APS and USAF Academy Form 69 (see <i>Figure 3</i>). If drop is approved, a "W" will appear on the official transcript.
M21-T30	A grade will appear on the mid-semester progress report. Cadets academically deficient as a result of this grade will be placed on academic probation and will not be eligible to come off until the end of the semester. Drop requests must be submitted via an APS coordinated through the Course Director, AAOCA/Advisor, and AIC (for declared cadets). If drop is approved, a "WP" or "WF" will appear on the official transcript. DFVR is the final approval authority.
M31-Finals	No drops will be allowed except in extraordinary circumstances (extended hospitalization, extended emergency leave, or extenuating occurrences approved by DFV). Extraordinary circumstances do not include a cadet's academically deficient performance in a course and do not apply to cadets changing their academic programs, even if the course they wish to drop is not required in the cadet's new program. These drops will not be approved solely to remove a deficient grade in the course and must have waiver approval via USAF Academy Form 69 (see <i>Figure 3</i>) approved by DFV. Drops approved in this time period will be reflected on official transcripts as "WP" or "WF."

NOTES:

1. The annotated APS should be delivered electronically to DFVRR by submitting it to dfvr.mail@afacademy.af.edu. The academic advisor or AAOCA keeps one copy of the annotated APS.

2. If the requested change does not create a graduation check failure, the requesting cadet receives a new schedule via the COMPASS webpage. If the change creates a graduation check failure or if other errors are detected, DFVRC will contact the cadet's advisor for review, clarification, or further adjustments. Cadets must attend all courses until receipt of a new schedule via the COMPASS webpage.
3. Some offerings of Calculus II, Calculus III, Differential Equations, and Chemistry II vary from this schedule due to grade protection.

2-1.9. WAIVERS

Use USAF Academy Form 69, Request for Academic Waiver (see *Figure 4*).

- a. When cadets request substitute courses for core or academic program requirements, their advisors must specify the requirements as listed on the cadets' Grad Checks. Advisors must also list the term in which the substitutes will be or have been taken.
- b. When a cadet requests a change to the approved core sequencing found in Section 2-8, the cadet must obtain the signature of the department head of the course delayed.
- c. An APS and Grad Check must be submitted with the USAF Academy Form 69.
- d. The advisor completes the appropriate portions of the form and signs it. The AIC initials approval of the form and submits it to the appropriate department head for signature. The form is delivered electronically to DFVR, via dfvr.mail@afacademy.af.edu, who ensures the form has been completed correctly and processes the form through the final approval authority. DFVR notifies advisors of the final disposition of the waiver request.
- e. Final approval authorities for most waivers are as follows:

Table 5. Final Waiver Approval Authority

Type of Waiver	Approval Authority
<i>Core Courses</i>	
<ul style="list-style-type: none"> • Substitute • Final exam or final report • Prerequisites • Delay of core course • Waiver of foreign language requirement 	Academy Board Vice Dean for Academics Appropriate Department Head Appropriate Department Head DFLLC Department Head
<i>Non-core courses</i>	
<ul style="list-style-type: none"> • Prerequisite • Final exam or final report 	Appropriate Department Head Vice Dean for Academics
<i>Academic Load</i>	
<ul style="list-style-type: none"> • Minimum course load • ARC-directed load • 7 courses while on academic probation • Course drop timeline () • Substitutes for major's requirements • Minimum graduation requirements 	Dean of the Faculty Academic Review Committee Academic Review Committee DFVR or DFW Appropriate Department Head Academy Board

ACADEMIC WAIVER REQUEST			
<i>(Reference USAFAI 36-3526 and the Course of Instruction)</i>			
<small>AUTHORITY: Title 10 U.S.C., Sections 8013 and 133; E.O. 9397 PRINCIPAL PURPOSE: Academic Waiver Request. ROUTINE USE: None. DISCLOSURE IS VOLUNTARY: However, if information is not provided, waiver may not be processed.</small>			
To: DFVRR thru DFVR, DFVRC, Academic Advisor			
CADET NAME (Last, First, Middle)	EMPLID - 3000	DATE	
MAJOR	CLASS YEAR 2025	SQUADRON	
1. REASON FOR ACADEMIC WAIVER			
<input type="checkbox"/> Substitute	taken in semester for in major.		
<input type="checkbox"/> Delay	until semester of class year.		
<input type="checkbox"/> Underload to	course units.		
<input type="checkbox"/> OTHER (Specify)			
2. ACADEMIC ADVISOR'S JUSTIFICATION - MUST ATTACH A GRAD CHECK AND APS			
PRINT	SIGNATURE	DEPT	DATE
3. COMMENTS/COORDINATION <i>(Reference Course of Instruction)</i>			
DEPARTMENT HEAD (Signature Block)		<input type="checkbox"/> APPROVE <input type="checkbox"/> DISAPPROVE	
SIGNATURE	DEPT	DATE	
DFVRR (Signature Block)		<input type="checkbox"/> APPROVE <input type="checkbox"/> DISAPPROVE	
SIGNATURE	DEPT	DATE	
ACADEMIC REVIEW COMMITTEE CHAIRMAN (Signature Block)		<input type="checkbox"/> APPROVE <input type="checkbox"/> DISAPPROVE	
SIGNATURE	DEPT	DATE	
DEAN/VICE OF FACULTY (Signature Block)		<input type="checkbox"/> APPROVE <input type="checkbox"/> DISAPPROVE	
SIGNATURE	DEPT	DATE	
ACADEMY BOARD (Signature Block)		<input type="checkbox"/> APPROVE <input type="checkbox"/> DISAPPROVE	
SIGNATURE	DEPT	DATE	
<small>USAFA FORM 69, 20231208 Prescribed by USAFAI36-3526</small>			
<small>PREVIOUS EDITION IS OBSOLETE</small>			
<small>DISTRIBUTION: Original - DFVRR Copy - Academic Advisor</small>			

Figure 4. Academic Waiver Request, USAF Academy Form 69

2-1.10. INDEPENDENT STUDY COURSES

Cadets can be enrolled in independent study courses for future semesters on-line through COMPASS. A USAF Academy Form O-498, Request for Permission to Enroll in an Independent Study Course (*Figure 5*), should be submitted to DFVRR by lesson 3 of the semester with the independent study. Fourth-class cadets will not be allowed to enroll in an independent study course. Third-class cadets can enroll in an independent study course with Department Head approval. Independent Study courses are numbered as follows: 499 is a 3.0 semester hour course; 499A is a 2.0 semester hour course; 499B is a 1.5 semester hour course; and 499C is a 1.0 semester hour course. The independent study syllabus, appropriately tailored for the student and subject, will outline the course goals, policies, and expectations. Independent Study courses are unscheduled; DFW is the waiver authority for any special independent study scheduling requests.

- a. Title of Independent Study Courses. The title of an independent study course, submitted on the USAF Academy Form O-498, should be short and succinct. Limit the title to 30 characters, since the title or its abbreviation will appear on the cadet's official transcript. Except in special circumstances, which the requestor should explain, the title should be different from any assigned to other cadets. No cadet may take an independent study course during the summer term without permission of DFV, coordinated through DFVR.
- b. Limit of Independent Study Courses Taken. You may apply up to six semester hours of independent study to academic graduation requirements without Department Head approval. A cadet may take only three semester hours of independent study in any semester.

CUI (When Filled in)																																											
REQUEST FOR PERMISSION TO ENROLL IN AN INDEPENDENT STUDY COURSE																																											
AUTHORITY: Title 10 U.S.C. 9331. PRINCIPAL PURPOSE: To obtain permission of instructor, advisor, and department head for enrollment in an independent study course. ROUTINE USE: None. DISCLOSURE: However, if information is not provided, individual may not enroll in independent study course.																																											
EMPLID 3000	CADET NAME (Full legal name not preferred name)	CLASS YEAR	SQUADRON																																								
<div></div>	<div></div>	<div></div>	<div></div>																																								
DISCIPLINE OF REQUESTED INDEPENDENT STUDY COURSE		ACADEMIC SEMESTER (E.G., FALL 2023, TERM 2238)																																									
<div></div>		<div></div>																																									
LIST COURSES COMPLETED/PRESENTLY ENTOLLED IN THAT RELATED TO PROPOSED TOPIC																																											
<div></div>																																											
I have checked the <i>Course of Instruction Handbook</i> to confirm that there is such a course offering and that I have met all prerequisites.																																											
CADET SIGNATURE			DATE																																								
<div></div>			<div></div>																																								
Submit the USAFA Form O-498 to USAFA/DFVR (dfvr@afacademy.af.edu) NO sooner than 1 week prior to M1 and No later than Lesson T3 of the current semester. DFVR will ONLY accept O-498s for the current semester. The title should be succinct and fit into no more than 30 spaces. This title is what will appear on the cadet's official USAFA transcript. It must be typed or clearly printed. Except in special circumstances, which should be briefly explained, the title should be different from any assigned to other cadets.																																											
INDEPENDENT STUDY TITLE (30 characters max to include spaces)		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </table>																																									
In accordance with the USAFA COI Handbook, <div></div> will be awarded upon successful completion of this course.																																											
MATERIAL AND/OR EQUIPMENT REQUIRED TO ADMINISTER THIS COURSE (If non, please indicate.)																																											
<div></div>																																											
Instructor: Please sign electronically or print your name in addition to the signature.																																											
INSTRUCTOR SIGNATURE <i>I agree to instruct this cadet in this independent study course.</i>		DEPARTMENT	PHONE NUMBER																																								
<div></div>		<div></div>	<div></div>																																								
ADVISOR SIGNATURE <i>I concur.</i>		DEPARTMENT	PHONE NUMBER																																								
<div></div>		<div></div>	<div></div>																																								
DEPARTMENT HEAD SIGN <i>(Department offering course) Permission granted.</i>		DEPARTMENT	PHONE NUMBER																																								
<div></div>		<div></div>	<div></div>																																								
Controlled by: HQ USAFA/DF CUI Category: PRVCY Distribution/Dissemination Controls: FEDCON POC: Lt Col Brian D. Contreras/333-2452 USAFA Office Form 498, 20240408																																											
PREVIOUS EDITION IS OBSOLETE CUI (When Filled in)																																											

Figure 5. Request for Permission to Enroll in an Independent Study, USAF Academy Form O-498

2-1.11. SPECIAL TOPICS COURSES

Special Topics Courses (495s) must be identified at least one semester in advance to DFVR. Notification should include a course description, section size, enrollment restrictions, prerequisites/co-requisites, and a list of students to enroll if already selected. Unless otherwise approved, special topics courses are worth three semester hours and require one contact hour. Special topics courses will be listed in the COI Handbook Supplement published the semester before the course is taught. Each academic discipline can offer one 495 special topics course each semester. In addition, Department Heads should clearly indicate if third-class cadets will be allowed to enroll in the course. Fourth-class cadets cannot enroll in special topics courses without DFW approval, coordinated through DFVR. Deviations from this standard may be approved by the Vice Dean for Academics for scenarios that support improvement of department's curriculum without risk to current offerings.

2-1.12. AUDITING

- a. Upper-class cadets may audit a non-core course if they have at least a 2.60 cumulative GPA. An audited course will not count toward minimum course load requirements, but does factor into maximum course load requirements. Cadets must fulfill the 3.25 GPA requirement if they exceed their maximum course loads by adding a course for audit.
- b. A cadet must have the approval of the appropriate Department Head to audit a course. The Department Head or the instructor has the option of refusing an audit request.
- c. A cadet may not take a course for credit at any time after receiving formal approval to audit the class and after attending one period in an audit status.
- d. Class attendance will be optional for an audited course.
- e. The auditor need only do minimum preparation for the audited course. An auditor will not participate in graded exercises or assignments. If an instructor feels an auditing cadet is detracting from the instructor's effectiveness, the instructor may direct the cadet to withdraw from the course.
- f. Cadets may only request permission to audit a course after receiving their class schedules. A cadet's class schedule will not be rearranged to allow the cadet to audit a course.
- g. Cadets will submit an audit request letter IAW *Figure 6*. Upon completing the request letter, cadets return it to DFVRR for processing and filing. The audited course will not appear on the cadet's transcript.



DEPARTMENT OF THE AIR FORCE
United States Air Force Academy
Cadet Squadron {XX}

{DATE}

MEMORANDUM FOR USAFA/DFVR

FROM: {Cadet Rank and Name}

SUBJECT: Request to Audit an Academic Course

1. Request I be permitted to audit {course} in {section} of the {fall/spring 20XX} semester.
2. My cumulative GPA is {gpa} is and my latest semester gpa was {gpa}. My graded academic course load is {hours} semester hours.
3. I have a free period at the time I desire to audit the course; no schedule changes are necessary to accommodate this request.
4. This course is NOT a core or major's requirement.
5. I have not previously audited nor taken this course for credit, and I understand that I will not be permitted to take this course for credit at any time after I have attended one period in an audit status, though I may drop the audited course later during the semester.

CADET SIGNATURE BLOCK & SIGNATURE

{NAME, Rank}, USAF
Advisor, {Dept}

{NAME, Rank}, USAF
AIC, {Major}

{NAME, Rank}, USAF
Instructor of {Course}

{NAME, Rank}, USAF
Permanent Professor and Head, {Dept}

Figure 6. Request to Audit an Academic Course

SECTION 2-2 SCHEDULING

2-2.1. THE ACADEMIC WEEK

The academic week in the fall and spring semesters generally consists of five days with seven 53-minute periods each. For scheduling purposes, we designate alternate weekdays as "M" and "T" days during each semester. Each two-day block (one "M" day and one "T" day) is a complete lesson.

2-2.2. ACADEMIC COURSE SCHEDULING

DFVRR prepares the Schedule of Classes for each semester using course offering data, department inputs (via the Preferred Course Offering Information (PCOI) process), and cadet registration information. Each department scheduling coordinator will provide updated course file data (e.g., type of sectioning, whether or not course will be giving final exams) to DFVRR upon request.

2-2.3. CADET EXCUSAL FROM ACADEMIC TIME

Department Heads may excuse cadets from a class taught by their departments to visit specific places or agencies in the cadet duty area to perform academic research or work related to specific academic courses. When the department desires to sponsor an event which will use other than the departmentally scheduled academic time or will require cadets to depart the cadet area, the department must submit an electronic Scheduling Committee Action (SCA) request in COMPASS through their department representative at least two weeks prior to the event. You can find additional information concerning excusal and compensatory time in USAF Academy Instruction 36-3536.

2-2.4. FINAL EXAMINATIONS

The Academy Board specifies the end-of-semester final examination period. DFVRR schedules end-of-semester final examination times and places for all courses that indicate a final examination requirement, as shown in this handbook and in the COMPASS course catalog. Final examination periods will not be used for cadets to brief findings on course projects. Final examination periods must be used solely for written final examinations. A portion of Foreign Language final exams may include an oral proficiency evaluation. A final examination must be at least two hours in length and account for at least 25% of the course grade. Requests for changes to an individual cadet's final examination schedule must be submitted to DFVRR for approval before the published deadline advertised each semester. DFVRR coordinates with chapel personnel to accommodate specific religious worship times during final exam scheduling. English-as-a-Second Language (ESL) cadets eligible for extra time in final examinations must coordinate with individual instructors. If the extra time given requires rearranging other finals, the cadet must contact DFVRR for rescheduling.

2-2.5. THE SUMMER

During the fall semester, DFVRC will publish a list of the upcoming summer academic course offerings. These courses can be found on the DFVR website. Summer Programs (para 2-5.13) provides further information regarding summer programs.

2-2.6. ACADEMIC DAY SCHEDULE OF CALLS

A cadet's academic schedule reflects M-day and T-day information. The academic periods are (from the USAF Academy Cadet Wing Schedule of Calls):

0700-0753 DF/CW COMMON USE PERIOD

0800-0853 1ST PERIOD ACADEMICS

0815-0930 PHY ED PERIOD

0900-0953 2ND PERIOD ACADEMICS

1000-1053 3RD PERIOD ACADEMICS

1015-1130 PHY ED PERIOD

1100-1153 4TH PERIOD ACADEMICS

1200-1253 NOON MEAL

1300-1353 5TH PERIOD ACADEMICS

1330-1445 PHY ED PERIOD

1400-1453 6TH PERIOD ACADEMICS

A cadet's academic schedule reflects the day (M or T) and period(s) (e.g. M1-M2, T4) during which each course on the schedule is assigned. The cadet schedule also provides semester hours awarded for course, the location, and the instructor. All 10-lesson courses will begin on lessons 1 (A/E blocks), 11 (B/F blocks), 21 (C/G blocks) or 31 (D/H blocks). All 20-lesson courses will begin on lesson 1 or lesson 21 (the latter denoted with the 'X' suffix in the course identifier, e.g. Leadership 400X). Phy Ed classes are taught across 8 lessons within the confines of the designated block. USAF Academy/AD will publish the start and end dates of each PE 'go' prior to the start of each semester. All other classes begin on lesson 1. Additional suffixes that may appear on a schedule, but that do not affect the start date of the class, include 'H' for honors sections, 'Z' for experimental sections, 'FR' for fourth-class cadet only sections of upper-level classes, and 'S' for sections that count toward the Martinson Honors Program Academy Scholar designation.

2-2.7. COURSES WITH UNUSUAL SCHEDULES

a. Airmanship, Aviation, Leadership, and Space. During the fall and spring semesters, various Airmanship, Aviation, Leadership, and Space courses are taught in ten- or twenty-lesson blocks with two or more consecutive contact hours. Many of these are overscheduled with one another or with Phy Ed Courses.

b. Pseudo Courses. Phy Ed 8xx and 9xx are pseudo courses scheduled for 1st, 2nd, 5th, and/or 6th period. Intercollegiate athletes are enrolled in these courses to block out Phy Ed time. Ext Prog 7XX is a pseudo course that blocks out one or more academic periods for scheduling purposes.

c. Eight/Ten Lesson Block Courses. Courses that meet for 8- or 10-lesson blocks (Phy Ed, Armnshp and Leadership) are identified with the following suffix (see *Table 6* below).

Table 6. Block Schedules

Fall		Spring	
Block	Lessons	Block	Lessons
A	M1 – T10	E	M1 – T10
B	M11 – T20	F	M11 – T20
C	M21 – T30	G	M21 – T30
D	M31 – T40	H	M31 – T40

d. Twenty Lesson Block Courses. Various classes (e.g. Comm Strt 101/101X, Armnshp 302/302X) meet for 20 lessons. Courses with no suffix indicate the cadet will attend lessons 1 through 20; courses with the X suffix will attend lessons 21 through 40.

Table 7. Scheduling Considerations

PHY ED	FITNESS TESTING (PFT/AFT)	10-LESSON COURSES (e.g. Jump)	20-LESSON COURSES (e.g. Lrn Strt)
8 lessons within each block, per published AD calendar	As scheduled by AD	A/E: 1-10 B/F: 11-20 C/G: 21-30 D/H: 31-40	No suffix: 1-20 X suffix: 21-40

Table 8. Courses with Special Schedules

10-LESSON COURSES	20-LESSON COURSES
Armnshp 201	Aero Engr 206
Aviation 100	Armnshp 251
Aviation 300	Armnshp 302
CE 100	Aviation 400
CE 200	Cyber 355X
CE 300	Cyber 455X
CE 400	Econ 201*
Ldrshp 100	Ldrshp 400
Ldrshp 200	Lrn Strt 102
Ldrshp 300	Comm Strt 101
Space 251	Read Strt 104
Space 252	Read Strt 201
Space 472	

* Econ 201 is a 30-lesson course

e. Experimental Courses. Experimental courses are courses testing new instructional material. They are identified on the cadet's schedule by a "Z" suffix.

f. Learning Strategies 101 (Learning Strategies for Academic and Career Success). A course administered by the Academic Success Center (DFVRL) in the fall for fourth-class cadets identified as "academically at-risk." Other cadets are welcome to take this course.

g. Learning Strategies 102: A condensed version of the Learning Strategies 101 course. It is offered once in the spring and once in the fall after mid-semester grades are released.

h. Communication Strategies 101/101X. Introduction to Communication. A half-semester reading, oral communication, and writing skills course. When registering for this course, please specify preference for taking course during first-half (i.e., Comm Strt 101) or second-half of semester (i.e., Comm Strt 101X).

i. Reading Strategies 201/201X: Reading Enhancement. A half-semester reading skills course. When registering for this course, specify preference for taking course during first-half (i.e., Read Strt 201) or second-half of semester (i.e., Read Strt 201X). If you received credit for Comm Strt 101, you may NOT enroll in Read Strt 201/201X.

j. Double-Period Courses. Only valid laboratory or other approved courses may be double-period courses. Valid double-period academic core courses with three semester hours of credit may include up to 10 syllabus-specified laboratory periods in a given semester. Other lessons must end at 53 minutes. 100-level foreign language courses are exempt from this policy and therefore may include up to 40 laboratory periods per semester. Non-core double-period courses are not affected by this policy and may include up to 40 laboratory periods per semester.

k. Excusal Codes. Intercollegiate excusal codes help schedulers block out time in cadets' schedules for participation in the appropriate athletic activities. The most common codes are intercollegiate practice time M afternoon (Phy Ed 816 or Phy Ed 916) or T afternoon (Phy Ed 826 or Phy Ed 926). Other excusal codes are used to block out time during the academic day for designated cadet senior leadership to accomplish their job duties.

2-2.8. MINIMUM ENROLLMENT SIZE FOR MAJORS AND CLASSES

At least 12 graduates per major are expected to graduate yearly. If the number of graduates in a major falls below 12 yearly for two successive years, the major is placed on a warning list. After three more successive years with an average of less than 12 graduates in the major, the major will be eliminated from the curriculum unless the Dean of the Faculty approves an academic waiver. Minimum enrollment for any course, excluding independent study courses, is six cadets. No course will be taught with fewer than six cadets without a waiver from the Vice Dean for Academics.

SECTION 2-3 GRADING

2-3.1. GRADES AND QUALITY POINTS

A cadet's performance in any graded course of instruction is officially reported to Student Academic Affairs at mid-semester and end-of-semester or summer term as one of the following grades: A, A-, B+, B, B-, C+, C, C-, D, F, WP, WF, and I (discussed in special grades, para 2.3-6). Deficient grades include C-, D and F. Following is a list of grades, their quality points (QP), and course quality points.

Table 9. Grades and Quality Points

GRADE	QUALITY POINTS	COURSE QPs (4.5 Sem Hrs)	COURSE QPs (4 Sem Hrs)	COURSE QPs (3.5 Sem Hrs)	COURSE QPs (3 Sem Hrs)	COURSE QPs (0.75 Sem Hrs)	COURSE QPs (0.5 Sem Hrs)
A	4.0	18.0	16.0	14.0	12.0	3.0	2.0
A-	3.7	16.65	14.8	12.95	11.1	2.775	1.85
B+	3.3	14.85	13.2	11.55	9.9	2.475	1.65
B	3.0	13.5	12.0	10.5	9.0	2.25	1.50
B-	2.7	12.15	10.8	9.45	8.1	2.025	1.35
C+	2.3	10.35	9.2	8.05	6.9	1.725	1.15
C	2.0	9.0	8.0	7.0	6.0	1.5	1.0
C-	1.7	7.65	6.8	5.95	5.1	1.275	0.85
D	1.0	4.5	4.0	3.5	3.0	0.75	0.5
F	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2-3.2. GRADES

Final grades are awarded at the end of the semester and are reflected on each cadet's official transcript. Mid-term grades are awarded after lesson T20 but are not recorded on a transcript. Departments must ensure mid-term grades are worth 25% or more of courses' final grades. During summer academics and summer training programs, final grades are awarded one week after the course concludes. During all final grading cycles, semester and cumulative Grade Point Averages (GPA), Military Performance Averages (MPA), and Physical Education Averages (PEA) are recomputed and appear on each cadet's personal grade report.

2-3.3. DEPARTED CADET GRADE ASSIGNMENTS

Periodically, between final grading cycles, cadets permanently depart the USAF Academy. Upon their departure, the Office for Student Academic Affairs requests final grade assignments from each department in which the cadet was enrolled.

2-3.4. GRADE CHANGES

Grade changes should be sent to DFVRR as expeditiously as possible so that products can be updated. All grade changes are accomplished IAW USAF Academy Instruction 36-3542, Assigning and Processing Formal Grades, and should be signed by the appropriate Department Head as depicted in *Figure 7*.



DEPARTMENT OF THE AIR FORCE
United States Air Force Academy
{Department of }

{DATE}

MEMORANDUM FOR USAFA/DFVR

FROM: USAFA/DF{XX}

SUBJECT: Request for Grade Change

1. IAW USAFAI 36-3542, the following information is provided to facilitate designation of grade change:

- a. Department: {}
- b. Course: {}
- c. Semester/Term: {}
- d. Final or Prog: {}
- e. Cadet: {}
- f. Class Year: {}
- g. Squadron: {}
- h. Change Grade from {} to {}
- i. Rationale: {}

2. If you have any questions, please contact the instructor, {} via phone at {} or email at {}.

DEPARTMENT HEAD SIGNATURE BLOCK

Figure 7. Grade Change Request Letter

2-3.5. ACADEMIC APPELLATE PROCEDURE

A cadet may appeal a grade or other academic issue directly to the instructor and course director. If the matter is not resolved satisfactorily to the cadet, the cadet may appeal in writing to the Department Head concerned, stating specific objections. Under USAF Academy Instruction 36-3542, Assigning and Processing Formal Grades, Department Heads maintain ultimate responsibility for assignment of and changes to letter grades. Normally, the Department Head's decision is final. In appropriate cases, the Dean of the Faculty may request the appropriate Division Chair review the appeal case for overall fairness, consistency, and appropriateness, and make recommendations to the Dean of the Faculty for final resolution.

2-3.6. SPECIAL GRADES

The cadet's official transcript, mid-semester grade report, or the end-of-semester grade report may contain the following notations: P (passing), W (withdrawn), WP (withdrawn passing), WF (withdrawn failing), IC (incomplete controllable—a grade indicating questionable status in a

course), and IU (incomplete uncontrollable). These grades carry no quality points and are not used in computing any GPA.

a. A "P" grade is awarded when a cadet is satisfactorily performing or has satisfactorily completed a Pass/Fail course.

b. A "W" grade is awarded when a cadet withdraws from a course between Lesson M9 and Lesson T20. If a cadet drops a full-semester course after T20, the department concerned awards the cadet a "WP" or "WF" grade, as appropriate. The academic department has three working days from the time of notification that the cadet has withdrawn from the course to forward the awarded grade to DFVRR. If the cadet completed the course requirements before the end of the semester (e.g., a course that has no final exam), the department will submit a final grade to DFVRR.

c. An "IC" or "IU" grade is a temporary grade given at the end of the semester, or a penalty grade given at a progress report. "IC" or "IU" grades indicate a cadet's questionable status in a course. "IC" or "IU" grades may be awarded in graded courses as well as in pass/fail courses. They may be "controllable" or "uncontrollable" incomplete grades. It is the cadet's responsibility to coordinate with instructor(s) to resolve any "IU" or "IC" grades prior to the next grading cycle. For instance, incomplete grades awarded at the end of the fall semester should be resolved by spring mid-semester grade submission. Incomplete grades awarded at the end of the spring should be resolved by end of summer grade submission. The waiver authority to approve additional time to resolve incomplete grades is the Department Head for the course with the incomplete grade, to include notification to the Office of the Registrar. If a cadet does not complete the coursework within the allotted time or receive an extension for additional time, the department awards a final grade, as appropriate, based on the completed and unfinished work in the course. When "IC" or "IU" grades are cleared and all course work is completed, a permanent grade will be assigned. DFVRR must be notified immediately of the grade change so that all products associated with a grade change (i.e., transcripts, APSs, GPAs, Honor Lists) can be updated. If a cadet is out processing, "IC" or "IU" grades must be resolved prior to departure.

(1) Uncontrollable incomplete "IU" grades indicate that work has not been completed for causes outside the control of the cadet, such as medical incapacity or emergency.

(a) Mid-semester: Uncontrollable incomplete work for full-semester courses at the mid-semester report will be awarded an "IU" grade.

(b) End-of-Semester: Uncontrollable incomplete work will be monitored by the department awarding the "IU" grade and will be completed at the earliest opportunity. The cadet is not placed on restriction or academic probation solely for this "IU" grade. An uncontrollable incomplete grade, pending an extension by the Department Head, should be resolved by the next grading cycle, but must be resolved before graduation.

(2) Controllable incomplete "IC" grades indicate the cadet was responsible for failure to complete an assignment. Controllable causes include cadet's failure to complete an assignment considered to be important for evaluating course work.

(a) Mid-semester: Controllable incomplete "IC" grade indicates that for reasons within the control of the cadet, work has not been completed. Cadets in this situation will be placed on academic probation for the next grading period.

(b) End-of-Semester: Cadets earning controllable incomplete grades will be restricted to USAF Academy through finals (affects cadets earning "IC" grades in courses with no final exam). If incomplete work is completed by the end of finals, a grade will be awarded and the cadet will not be placed on academic probation solely due to the "IC" grade. If incomplete work is not completed by the end of finals, the department issuing the "IC" may assign a final letter grade IAW USAF Academy Instruction 36-3542, Assigning and Processing Formal Grades, or allow the cadet to carry the incomplete into the next semester. It is highly encouraged that departments issue a final fall semester grade for all first-class cadets before lesson 3 of the spring semester. First-class cadets may need to add or retake a course to meet graduation requirements. Any cadet with an outstanding controllable incomplete grade at the end of a semester will be placed on academic probation and will be subject to academic disenrollment. A controllable incomplete grade, pending an extension by the Department Head, should be resolved by the next grading cycle, but must be resolved before graduation.

d. Grade assignments for 10- or 20-lesson block pass/fail courses. The following provides guidelines for assignment of grades to cadets who are disenrolled from Airmanship or other 10- or 20-lesson block pass/fail courses. If the cadet withdraws from a course before the completion of all course requirements, the following criteria will be used in assignment of pass/fail grades:

- (1) If the cadet completed 5 or fewer of the 10 or 20 required lessons, assign a "W."
- (2) If the cadet completed at least 6 lessons but less than the entire course, assign either a "WP" or a "WF."
- (3) If the cadet completed the entire 10- or 20-lesson course, assign either a passing "P" or failing "F" grade.

2-3.7. TRANSFER AND VALIDATION CREDIT

No quality points are awarded for transfer or validation credit. All transfer and validation credits may be applied toward graduation requirements, providing that the cadet completes a minimum of 125 semester hours in residence. DFVR enters transfer/validation credit into a cadet's record after being informed, in writing, by the academic department/agency responsible for the applicable course, following the format depicted in *Figure 8*.

a. Transfer/validation credit. Cadets who attended another college or university or who validate courses may earn validation or transfer credit that is included in the total semester hour count. The appropriate department, dependent on the subject matter or discipline, will review materials (e.g., transcript, syllabus, textbook, etc.) to determine whether USAF Academy transfer credit is appropriate for the coursework completed at another college or university. The Office of Student Academic Affairs & Academy Registrar will maintain the

transcript in the cadet's record for any coursework approved for transfer credit. If cadets leave the USAF Academy prior to Lesson 9 of their first semester, transfer/validation credit will not appear on their USAF Academy transcripts.

- (1) A cadet who is readmitted following disenrollment or resignation may be given transfer or validation credit for courses taken while away from USAF Academy. If the transfer or validation credit is for a course previously taken and failed at USAF Academy and subsequently repeated at another college or university, the transfer/validation credit should fill the course requirement on the grad check and the 'F' grade will be listed under "Other Courses Taken" for active cadets; the 'F' grade continues to count in the cumulative GPA.
- (2) Credit (grades and corresponding quality points) will be accepted for courses completed with a proficient grade at USAF Academy by USAF Academy Preparatory School cadets upon entering USAF Academy. If a Cadet Candidate from USAF Academy Preparatory School is receiving a deficient grade, the cadet will be withdrawn from the course.
- (3) Phy Ed courses can be transferred from other universities, particularly for cadets on semester exchange to foreign military academies and sister service academies. Regardless of the total number of Phy Ed courses transferred, a minimum of eight USAF Academy Phy Ed courses must be taken and counted toward graduation requirements.
- (4) Chemistry Initial Placement and Major Declaration. Transfer credit, validation credit, and placement into Chem 100 or Chem 200 in the fall or spring will be based on college transcripts and AP scores, as well as a survey of incoming cadets. Cadets completing Chem 100 in the 4^o fall and interested in declaring chemistry, biology, or pursuing a Pre-Med track should be placed into Chem 200 in the 4^o spring. Cadets with a strong interest in chemistry are encouraged to declare early (NLT spring 4^o year). Depending upon validation and transfer credit, cadets interested in chemistry should be placed in Chemistry 233 (Organic Chemistry I) in the fall of their 3^o year.
- (5) Validation credit based on AP (College Board) and IB (International Baccalaureate) testing is in accordance with the table below:

Table 10. AP/IB Credit

AP/IB Subject	AP Test Code	AP Score for Credit	IB Score for Credit	Course Validated	Comments
Biology	20	4/5	5/6/7 ^(HL) 6/7 ^(SL)	Biology 215	
Chemistry	25	4/5		Chem 100	
Econ-Mac	35	4/5		Econ 355	
Econ-Mic	34	4/5	6/7	Econ 201	
Eng Lang/Comp	36	5		English 111	
Eng Lit/Comp	37	5	6/7	English 111	
Calculus (AB/BC)	See Note 3	See Note 3	See Note 3	Math 141, Math 142	See Note 3
Physics C-Mech	80	4/5		Physics 110	
Physics C-Elec/Mag	82	4/5		Physics 215	
Psychology	85	5	5/6/7 ^(SL & HL)	Beh Sci 110	
World History	93	5	6/7	History 300	
European History	43	5	6/7	History 230	
U.S. History	7	5	6/7	History 210 or History 220	See Note 1
Human Geography	53	4/5		Geo 250	
Chinese Lang/Culture	28	3/4/5		Chinese	See Note 2
French Language	48	3/4/5		French	See Note 2
German Language	55	3/4/5		German	See Note 2
Japanese Lang/Culture	64	3/4/5		Japanese	See Note 2
Spanish Language	87	3/4/5		Spanish	See Note 2

Note 1: coordinate with the Department of History for appropriate credit.

Note 2: coordinate with the Department of Foreign Languages for appropriate credit; Chinese, French, German, Japanese, and Spanish validation credit is based upon AP scores and USAF Academy foreign language placement scores.

Note 3: Math validation and placement is based on a combination of placement scores (Pearson) taken before in-processing in addition to AP/IB scores and previous college coursework, if applicable.



DEPARTMENT OF THE AIR FORCE

(appropriate department title)
USAF ACADEMY, COLORADO

DATE

MEMORANDUM FOR USAFA/DFVR

FROM: USAFA/(DEPARTMENT OFFICE SYMBOL)

SUBJECT: Award of Course Transfer or Validation Credit

1. In accordance with the USAFA Course of Instruction Handbook (Chapter 1, Section 4), I request that DFVR enter transfer (a class from another college) or a validation (AP/IB/Test scores) credit into the following cadet's record for the applicable course as reflected below.

- a. Non-USAFA course being transferred (School, Semester, Course) or basis for validation credit:
- b. Transfer / Validation (choose one) credit for USAFA Course:
- c. Cadet:
- d. Class Year:
- e. Squadron:
- f. Additional Information (if applicable):

2. If there are questions please contact: (Course Director/Department Representative, e-mail and phone)

SIGNATURE BLOCK
(Course Director/Department Representative)

Figure 8. Award of Course Transfer or Validation Credit Request Letter

2-3.8. GRADE POINT AVERAGE

A cadet's semester and cumulative GPAs are determined by dividing the total quality points earned in all graded courses by the total semester hours attempted. DFVRR publishes semester and cumulative GPAs to the nearest .01 for each mid-semester and end-of-semester grade report. When a cadet repeats a course, the GPA is recomputed as follows:

- a. The cumulative GPA is adjusted with the previous grade being replaced by the most recent grade. Up to 13 semester hours may be replaced in the cumulative GPA in this manner, but

all grades will remain on the transcript. If a cadet repeats more than 13 semester hours of courses, the grades for all additional courses repeated will not replace the previous grades but will be calculated into the cumulative GPA along with the previous grade. Courses that can be used to replace a grade also include core substitutes (e.g., Math 300 replacing Math 356), 100-level foreign language courses (e.g., Portuguese 132 replacing Arabic 132), and intermediate core science basket courses (e.g., Biology 215 replacing Physics 215). Cadets and academic advisors should verify that courses used for grade replacement also fulfill graduation check requirements for the current/new academic major/program.

b. If a course is repeated in the same semester (i.e. a Phy Ed or Leadership course), grade replacement will reflect in the semester GPA computations. For cadets who repeat a failed spring course in the summer, the repeated grade will replace the original grade in the combined Spring/Summer semester GPA and for all other end-of-summer GPA computations. The cadet will remain on academic probation if the combined Spring/Summer semester GPA is below a 2.0 or for any other unresolved issues which contribute to academic probation.

c. Students must have a passing grade to replace an "F" grade in the cumulative GPA. If a repeat "F" grade is earned, both "F" grades will count in the GPAs. When a cadet takes a course for a third time and receives a passing grade, the newest grade will replace only the grade from the second attempt; the grade from the first attempt will remain factored into the cumulative GPA.

d. The semester GPA will include the grades of courses taken that semester, regardless of whether or not the course was taken previously or was subsequently repeated.

e. When considering whether or not to repeat a passed course, a cadet must note that it is the most recent grade, not necessarily the best grade that is computed in the GPA.

2-3.9. MAJOR'S and CORE GPA

The major's GPA includes grades for courses designated by the Department Head responsible for that major, regardless of whether or not the course is being used to satisfy a major's requirement. Courses which count toward the major's GPA are annotated by an 'M1' ('M2' for a second major) on the academic graduation check. The core GPA includes grades for any course which has been approved to fill a core requirement per the curriculum for that class year, regardless of whether or not the course is being used to satisfy a core requirement.

2-3.10. OVERALL PERFORMANCE AVERAGE (OPA)

The graduation class standing is based on cadet cumulative Overall Performance Average (OPA). To earn Distinguished Graduate designation, a cadet must be in the top 10% of OPA and also be in the top 50% of cumulative Grade Point Average (CGPA), cumulative Military Performance Average (CMPA), and cumulative Physical Education Average (CPEA) for their class year. The Academy Board can extend, at its discretion, below the top 10% of cadets by OPA to identify the top 10% of cadets who meet the criteria of being in the top 50% of CGPA, CMPA, and CPEAs as Distinguished Graduates.

OPA is calculated using the following algorithm. First, CGPA, CMPA, and CPEA are individually standardized to create GPA*, MPA*, and PEA*. Second, OPA* is calculated as the weighted combination of GPA*, MPA*, and PEA*.

$$\text{OPA}^* = 50\% \text{ GPA}^* + 40\% \text{ MPA}^* + 10\% \text{ PEA}^*$$

For the calculation of OPA, Phy Ed grades are removed from CGPA since they are included in CPEA. Finally, OPA is calculated by normalizing OPA* with a mean of 3 and a standard deviation of 0.33.

This algorithm can result in OPA being higher or lower than CGPA, CMPA, and/or CPEA.

2-3.11. GRADUATION RECOGNITION

The following recognitions are determined by the Academy Board prior to graduation.

Table 11. Graduation Honors

RECOGNITION	GRADUATING CLASS	BASED ON
Distinguished Graduate	Up to top 10%	(OPA)
With "Academic Distinction"	Top 10%	(GPA)
With "Military Distinction"	Top 10%	(MPA)
With "Athletic Distinction"	Top 10%	(PEA)
Academy Scholar	Meet Martinson Honors Program requirements	

2-3.12. HONOR LIST REQUIREMENTS

Any probation or honor rehabilitation precludes placement on an honor list.

a. Dean's List. Cadets who earn a semester GPA of at least 3.0 in academic courses will be on the Dean's list. These cadets are authorized to wear the Dean's pin on their uniform for the next semester. Physical Education grades are not included in Dean's list calculations. It is possible for a cadet to have a semester GPA over 3.0 and still not be on the Dean's list if the Phy Ed grades pulled the GPA over 3.0. Likewise, it is possible for a cadet to have a semester GPA slightly less than 3.0 and be on the Dean's list if the Phy Ed grades were low. Also note that only the semester GPA determines the Dean's list. Therefore, cadets cannot be placed on the Dean's list based on Prog (mid-semester) grades or Cum GPA. However, cadets may be removed from the Dean's list at Prog if their mid-semester grades put them on academic probation. Summer grades are not included in Dean's list calculations.

b. Athletic Director's List. Cadets who earn a semester Physical Education Average (PEA) of at least 3.0 will be on the Athletic Director's list. These cadets are authorized to wear the Athletic Director's pin on their uniform for the next semester. PEA is a weighted 4.0 grading scale (50% Physical Fitness Test + 35% Phy Ed course grades + 15% Aerobic Fitness Test).

c. Commandant's List. Cadets in the top third of their class year by semester MPA will be on the Commandant's list. These cadets are authorized to wear the Commandant's pin on their uniform for the next semester.

- d. Superintendent's List. Cadets who earn semester performance averages (GPA, PEA, and MPA) to merit placement on the Dean's, Athletic Director's, and Commandant's lists will be on the Superintendent's list. These cadets are authorized to wear the Superintendent's pin on their uniform for the next semester.

2-3.13. EXCHANGE PROGRAM GRADES

For USAF Academy cadets participating in study abroad and exchange programs, the following guidelines apply for the awarding of course credit and grades from their semester away from USAF Academy.

- a. Service Academy Exchange Program (SAEP): cadets receive the letter grades awarded on their sister service academy transcript, consistent with our grading scale.
- b. AFROTC Exchange, Cadet Semester Exchange Abroad Program (CSEAP), and Cadet Semester Study Abroad Program (CSSAP): cadets receive Pass/Fail grades from their semester away from USAF Academy, consistent with the grade earned at the supporting institution.

For any of these cadets on an exchange or study abroad program, USAF Academy coursework completed while away from USAF Academy, with a USAF Academy faculty member, can be awarded as a Pass/Fail grade or as a letter grade at the discretion of the academic department.

SECTION 2-4 ACADEMIC DEFICIENCY AND PROBATION

2-4.1. ACADEMIC DEFICIENCY

a. A cadet is deficient in studies at the mid-semester progress report or the end of a semester/summer term under the following conditions:

(1) A grade of "F" or a controllable incomplete "IC" grade in one or more courses, whether graded or pass/fail. A grade of "F" in a Phy Ed course, by itself, does not place a cadet on academic probation. In addition, a previous grade of "F" or "IC" in a core academic course which has not been repeated with a passing grade, either at mid-semester progress or end of a term, results in academic probation.

(2) Semester, core, and/or cumulative GPAs less than 2.0. Semester, core, and cumulative GPAs include all graded courses. Deficiencies in core GPA will not be tracked for academic probation (ACPRO) status until a cadet's 4th semester.

(3) First-class cadets are deficient and will be placed on academic probation if their majors' GPAs are less than 2.0.

b. Academic Review Committees (ARCs) review cadets in the following categories:

(1) Cadets whose academic records meet any one of the following criteria are considered to be seriously deficient in academics. The ARCs review those cadets' records to determine if the cadets should be recommended for disenrollment or if any other appropriate action is necessary.

(a) Multiple Failures. More than one "F" grade in one semester.

(b) Very Low GPA. A GPA considered being seriously deficient and warranting special consideration by the ARC. Very Low GPAs may be either semester or cumulative and vary by semester as shown below.

Table 12. Academic Deficiency - "Very Low GPA"

SEMESTER	SEM GPA LESS THAN	CUM GPA LESS THAN	CUM CORE GPA LESS THAN
1	1.50	1.50	
2	1.50	1.70	
3	1.50	1.80	
4	1.50	1.90	2.00
5	1.50	1.95	2.00
6	1.60	2.00	2.00
7	1.70	2.00	2.00
8 or later	1.80	2.00	2.00

- (c) Repeat Failure. Repeat failure ("F" grade) in the same course, whether core or elective and regardless of the number of semester hours.
 - (d) Two sequential semesters of either low or very low semester and/or cumulative GPA. Low, vice very low, GPAs are defined in paragraph 2-4.1b(2).
 - (e) Failure to achieve a 2.0 semester or cumulative GPA in 3 sequential semesters.
 - (f) Multiple deficient semesters. Third-class cadets that were deficient three of their first four semesters.
 - (g) Multiple Probations. Deficient in academics and aptitude, conduct, honor, and/or athletic performance.
- (2) Low GPA Review. Any cadet whose academic record meets any of the following criteria is considered to be deficient in academics:
- (a) Semester, core, and/or cumulative GPA less than 2.0 but greater than the GPA defined in paragraph 2-4.1b(1)(b).
 - (b) For first-class cadets, a major's GPA less than 2.0.
 - (c) Single "F" grade. One "F" grade in an academic major, core, or elective course. "WF" (withdrawn failing) grades do not result in academic probation.
 - (d) Controllable incomplete "IC" grade. Willful incompleteness of a course requirement.

2-4.2. PLACEMENT ON ACADEMIC PROBATION

The guiding directive for academic probation is USAF Academy Instruction 36-3523, Review and Disposition of Deficient Cadets.

- a. All academically deficient cadets will be placed on academic probation at mid-semester, end-of-semester, or at the end of the third summer term if they attended summer academics. Cadets are effectively on academic probation from the date of publication of a progress report on which they are deficient as described in paragraph 2-4.1.
- b. AOCs are responsible for pulling their cadet squadron's probation report from COMPASS immediately after mid-semester grades are released and at the beginning of each semester.

2-4.3. ACADEMIC PROBATION POLICIES

The following are roles, responsibilities, and expectations of cadets, advisors, and AOCs to fulfill the requirements of academic probation.

- a. Cadets placed on academic probation must submit by email a fully coordinated USAF Academy Form 68 to their AOC, Academic Advisor, Cadet Academic Officer (CADO), and

ARC Coordinator within 10 days of being placed on probation at mid-semester, within 10 days of the beginning of a new semester, or as directed by the Academic Review Committee.

b. Probationary cadets are expected to work with their cadet chain of command, CADO, Academic Advisor, and AOC to complete the Form 68. The purpose of the USAF Academy Form 68 is to identify precisely why a cadet is failing to perform academically, develop a plan of action to counteract the reasons identified, to determine if the cadet is motivated to make the necessary changes, and to capture the commitment of the cadet's support structure. Probationary cadets are expected to take responsibility for their academic deficiency, seek counsel, and to work hard towards academic **EXCELLENCE**, not simply towards becoming marginally proficient. Probationary cadets are failing academically and failing to internalize Air Force Core Values.

c. Probationary cadets are primarily responsible for proactively completing the USAF Academy Form 68 on time and for seeking academic help. All cadets should check their grades as soon as they are released by the Academy Registrar. Cadets are expected to know if they are on probation by reviewing their grades in relation to the deficiency standards in paragraph 2-4.1. Deficient cadets are on probation and will be reviewed by the Academic Review Committee. Deficient cadets do not need to wait for a probation list to know that they are on probation. Probationary cadets should begin the Form 68 process immediately after grades are released. USAF Academy provides countless resources designed to aid cadets in achieving success. Probationary cadets will work with their element, flight, academic cadet staffs, their Academic Advisors, and their AOCs to design a personalized academic Action Plan that, if followed, ensures the cadet will be on the path towards achieving academic excellence.

d. Cadet Squadron AOCs are responsible for knowing which of their assigned cadets are deficient academically, the key factors causing probationary cadets to fail, and how probationary cadets are going to change to achieve academic excellence. AOCs are responsible for pulling a list of probationary cadets from COMPASS and providing a list of cadets on academic probation to the cadet squadron Academic Officer immediately after grades are released by the Academy Registrar. Any delay in providing the AcPro list to the CADO could jeopardize the intended timeline for completing the USAF Academy Form 68.

e. AOCs are expected to meet with academically deficient cadets before the Form 68 can be final. The AOC may direct revisions to the probationary cadet's evaluation, statement, and action plan. AOCs are expected to provide routine oversight of academically deficient cadets and help ensure probationary cadets are following through with their action plans.

f. AOCs will work closely with squadron academic officers in developing a squadron academic policy that enables all cadets to achieve academic excellence and to ensure its proper implementation.

g. Academic Advisors are expected to meet with their probationary advisees shortly after grades are released to provide guidance in identifying factors for academic failure, to discuss the personal change that is required to achieve academic excellence, and to refer the cadet to the appropriate support offered by USAF Academy. Academic Advisors are primarily

responsible for documenting consultations using the USAF Academy Form 68 in a way that will most benefit the probationary cadet in their pursuit of academic excellence.

h. Squadron Cadet Academic Officer (CADO) responsibilities.

- (1) The AOC will provide the CADO a list of academically deficient cadets assigned to their squadron on lessons M1 and M22.
- (2) CADOs will meet with all academically deficient cadets individually and help the cadet initiate the Form 68 no later than lessons M2 and M23.
- (3) CADOs provide primary oversight for the completion of the USAF Academy Form 68 within the directed timelines. Probationary cadets appealing a disenrollment vote by the ARC Records Review may only have 5 days to complete the entire USAF Academy Form 68 process and will require priority over other probationary cadets.
- (4) CADOs provide a statement in field 3 of every USAF Academy Form 68 and are required to assign and validate Weekend Academic Call to Quarters (WACQs) as part of every probationary cadet's action plan. (See additional WACQ guidance in Appendix 3.)
- (5) CADOs are required to develop squadron academic policies that ensure all cadets can achieve excellence in academics and employ all the resources offered by USAF Academy to include the Writing Center, Quantitative Reasoning Center, and library.
- (6) CADOs are responsible for ensuring military training and other squadron functions do not interfere with a cadet's ability to achieve academic excellence, to attend Consultations directed in section 5a of the USAF Academy Form 68, or to attend professional tutoring services.
- (7) CADOs are responsible for ensuring Academic Call to Quarters is a quiet and studious environment where cadets can achieve academic excellence.
- (8) CADOs are responsible for compiling a list of in-squadron academic tutors and for establishing a squadron tutoring plan. The tutoring plan should be made available to all squadron members (especially 4 degrees), provide incentives for tutors to participate, and ensure all cadets benefit from the tutoring offered. Peer tutoring should not take the place of seeking EI, completing Writing Center tutorials, or attending the Quantitative Reasoning Center. The Squadron Tutoring Plan should be developed to complement the resources USAF Academy professionally offers.
- (9) CADOs are responsible for developing a WACQ monitoring program and an incentive policy in coordination with the cadet squadron staff and the AOC. The incentive policy should encourage probationary cadets to become proactive learners and to seek resources beyond what is prescribed in their USAF Academy Form 68 Action Plans. The monitoring program should require probationary cadets to proactively

manage the requirements of and track the progress in their courses on a daily/weekly basis.

(10) Example probationary policy MFR: Academic Probation Policy Template

(a.) The purpose of this memorandum is to detail the process by which cadets on academic probation may sign out on weekends after completing the below requirements.

(b.) The intent of this policy is to replace a blanket restriction with a goal-oriented program that will reward academic efforts on a weekly basis and encourage good academic habits for those on academic probation. Ideally, this system will encourage lifelong habits, organization, and study skills that will help probationary cadets for the remainder of their cadet and professional careers. This policy should give academically deficient cadets reasonable and attainable goals while providing opportunities to earn sign-out privileges on a weekly basis. If the probationary cadet uses the program as intended, they will get in a cycle of being ahead academically and be able to use their weekends to recharge for the next week's challenges. If at any point the cadet is not meeting the intentions of this program, they may return to normal probation restricted status and will not be allowed to sign-out on the weekends.

(c.) Cadets on academic probation will maintain an academic folder or binder. It must contain the following information: the cadet's academic schedule for the current semester, an up-to-date grade tracker for all classes in which the cadet is currently enrolled, an assignment calendar with timelines for GRs, projects, papers, quizzes, and any other assignments that will have an impact on the cadet's current grades, a record of all counseling documents related to academic probation, and a completed academic action plan (USAF Academy Form 68).

2-4.4. REMOVAL FROM ACADEMIC PROBATION

Cadets will be removed from all conditions of academic probation when their semester, core and cumulative (and major's GPA for first-class cadets) performance meet the minimum GPA of 2.0 with no "F" or controllable incomplete "IC" grades at mid-semester, end-of-semester, or end-of-summer term report.

a. Cadets having not yet repeated and not currently repeating a previously failed core course will remain on academic probation.

b. Cadets on academic probation at the end of spring semester remain on academic probation through the summer, until the fall mid-semester progress report, unless conditions for probation are corrected by summer academic performance. Upon completion of summer course work, summer grades will be combined (for determining academic probation status only) with spring semester course work to determine the combined "spring-summer" semester GPAs. If cumulative and spring-summer combined "semester" GPAs are 2.0 or greater and all failed courses have been repeated and passed, the cadet will be removed from academic probation.

c. Cadets with outstanding controllable incomplete "IC" grades will remain on academic probation until the grading cycle after the "IC" grade is removed. Also, cadets will remain on academic probation until they are passing a failed core course.

d. Cadets will not be removed from academic probation at any time other than indicated above unless they were placed on academic probation through administrative error. Cadets who drop a course after the mid-semester progress report are not removed from academic probation solely because the deletion of a deficient course "raises" their core, semester or cum GPA. These cadets remain on academic probation until the end-of-semester progress report.

2-4.5. ACADEMIC REVIEW COMMITTEE RESPONSIBILITIES

a. Mid-semester ARC. Each ARC Chair and coordinator will review the records of deficient cadets and may make recommendations or directives to cadets. No retention/disenrollment voting occurs at mid-semester meetings.

b. End-of-Semester/Summer ARC. Full voting membership ARC meetings are held at the end of each semester and at the end of the summer term. Reviews include all academically deficient cadets.

(1) The ARC recommends cadets for disenrollment, nine semesters, conditional turn back, late graduation, and the Bachelor of Science Program. The committees will recommend that cadets deficient in studies be disenrolled unless it is determined that both overall performance and probability of successful academic program completion justify retention.

(2) Decisions by the ARC to retain cadets are final. Should the committee decide that a cadet's overall performance and probability of successfully completing an academic program justify retention, it will recommend or direct one or more of the following:

(a) Continue with class.

(b) Seek assistance from appropriate agency.

(c) Underload or drop to a normal load during the current or future semester (See Section 2-1.3).

(d) Remove from advance placement course to lower-level course (coordinate with sponsoring Department Head).

(e) Repeat a course or complete an incomplete grade (See Section 2-3.6).

(f) Recommend/direct change or drop of major.

(g) Recommend/direct withdrawal from or limit participation in intercollegiate athletics, with coordination through the appropriate eligibility committee and AD.

- (h) Withdraw from or limit participation in extracurricular activities.
- (i) Recommend/direct withdrawal from or limit participation in military duties, with coordination through the Commandant of Cadets representative.
- (j) Be automatically reviewed at a future progress report.
- (k) Direct enrollment in summer academics in lieu of summer break.
- (l) Any other recommended/directed action appropriate to an individual cadet's case.

2-4.6. ACADEMIC REVIEW COMMITTEE PREPARATION

a. Committee Coordinator Responsibilities:

- (1) Ensure committee members are trained in responsibilities and procedures.
- (2) Distribute cadet deficiency reports at each progress report.
- (3) Prepare and distribute records review/interview schedules, agendas, and APSs as soon as possible to ARC members and academic departments prior to end-of-semester/summer ARC meetings.
- (4) Prepare deficient cadet records and brief them during committee review.

b. Group and Squadron Air Officer Commanding (AOC) Responsibility: Squadron AOCs will forward end-of-semester/summer evaluations to the ARC Chair through Group AOCs. These evaluations will include any data the AOC believes to be significant for ARC decision-making (e.g., suitability for commissioning, Weekend Academic Calls to Quarters (WACQs) assigned/served, probationary status, and personal and medical information).

c. Academic Advisor/AAOCA Responsibility: Under the procedures of USAF Instruction 36-3523, advisors have a significant role. They function as extensions of the Academic Review Committees.

- (1) The ARC requires advisors to oversee cadets in all categories of academic probation in completing the USAF Academy Form 68, Cadet Academic Deficiency Evaluation and Probation Action Plan. If ARC directives require a scheduling change, an APS must be coordinated as soon as possible. All cadets on academic probation must be counseled within 10 duty days after the beginning of the following semester and publication of grades. The USAF Academy Form 68 is the advisor's written statement to the ARC.
- (2) Advisors are primary sources of information to the ARC. Advisors must therefore serve as detectives or diagnosticians and attempt to discover the real causes of poor academic performance.
- (3) The following suggestions are useful while preparing a USAF Academy Form 68.

- (a) Understand the ARC will look unfavorably on any cadet who has needed Extra Instruction (EI) and can't document that quality EI was sought.
- (b) Communicate any directives clearly to the cadet.
- (c) Diagnose the problem and assist in developing a specific course of action.
- (d) Don't assume that the cadet's view of his or her level of effort or standing in the course is an objective/realistic one.
- (e) When you direct the cadet to see you at specified intervals, make them frequent enough to serve an effective oversight function. Once a month is too infrequent.
- (f) The USAF Academy Form 68 should reflect an individualized plan, since each cadet's situation is unique and requires personalized attention to ensure academic success.
- (g) If the advisor will not be available for the cadet's appeal interview, they must submit a written comment card, memo for record, or be very clear on the USAF Academy Form 68 as to their retain or disenrollment recommendation and supporting bullets. In addition, the advisor must ensure another advisor from the same academic department can advise the cadet through the appeal process and during the appeal interview.

d. Academically Deficient Cadet Responsibilities: Deficient cadets will complete a USAF Academy Form 68 according to the instructions and submit it to their academic advisor/AAOCA within 10 duty days after the publication of progress reports. Exception: Cadets recommended for disenrollment must complete a USAF Academy Form 68 with their appeal package if they intend to appeal the recommendation. If cadets fail to complete a USAF Academy Form 68 and deliver it to their academic advisor/AAOCA by the established deadline date, the academic advisor/AAOCA will initiate coordination with the squadron AOC and squadron cadet academic officer.

e. Instructor Responsibilities:

- (1) Mid-semester. The ARC requires instructors to complete computerized comment cards for all cadets who earned C-, D, and F grades in their course.
- (2) End-of-Semester. The ARC requires instructors to complete computerized comment cards for all cadets who earned C-, D, and F grades in their courses and for all cadets listed on ARC comment card rosters.
- (3) End-of-Semester ARC Interviews. Instructors may complete a letter of recommendation for cadets who elect to appeal an ARC disenrollment recommendation. Granting a cadet's request for a letter is an instructor prerogative, not a requirement.

(4) End-of-Summer Term. The ARC requires all academic instructors to complete a comment card on cadets who have earned a final C-, D, or F grade in their courses and for any additional cadets, as requested by the ARC. Instructors must submit comment cards to the Summer Academics Program coordinator in DFVRC no later than two days after the last day of summer term classes.

f. Medical Staff Responsibilities. The medical representative will review the medical records of cadets appealing a disenroll recommendation. The medical representative need not be present at committee meetings, but if there is significant medical information, either written or verbal comments need to be prepared for the committee. A negative reply to the coordinator prior to committee meetings is required.

g. Athletic Representative Responsibilities. The athletic representative will review the athletic and physical education records of all reviewed cadets.

2-4.7. ACADEMIC REVIEW COMMITTEE PROCEDURES

a. Although ARCs review records and issue directives at mid-semester, they may review cadets for retention/disenrollment only at end-of-semester/summer progress reports.

b. During the review, ARCs consider all pertinent information. A profile or character sketch of the cadet is composed using information from the instructor comment cards, formal records of counseling, military performance appraisals, athletic ratings, and medical history. Cadets, advisors/AOCAs, and AOCs do not attend records reviews.

c. ARC coordinators send notification letters, listing ARC actions and recommendations, to AOCs, with copies to Advisors. AOCs are responsible for delivering the letters to cadets.

d. Cadets recommended for disenrollment after a records review receive a letter via COMPASS through their AOC notifying them of a mandatory formation to receive information about the ARC appeal process. At this meeting, the ARC coordinators distribute official disenrollment recommendation notification letters and brief cadets on the appeal process. After receiving this documentation, cadets have 72 hours to choose one of the following two options:

(1) Personal Interview. Cadets directly address the ARC. Appealing cadets may submit written statements for consideration at the personal interview. Written appeal packages are due to the ARC coordinator no later than five days after receipt of the official notification letter. The ARC interview is the only time cadets are permitted to present their cases verbally and/or in writing. To exercise this right, a cadet must appear in person on the date, time, and location the cadet is scheduled. Cadets will not be allowed to call witnesses to testify in person before the ARC, although the advisor/AOCA and AOC are required to attend. When preparing for an ARC interview, a cadet should do the following:

(a) Give mature consideration to the situation.

(b) Be prepared to be open and frank with the committee and, while not making excuses, discuss personal matters, if any, which affected academics.

(c) Before the committee interview, meet with the academic advisor/AAOCA to complete the USAF Academy Form 68 and to design an academic program that provides the best opportunity for academic success.

(d) Come into the ARC interview with a plan and be prepared to take responsibility for the current situation. The plan should be a realistic assessment of ability and potential. Set attainable goals; discontinue habits that netted the current poor results.

(e) Consult with current course instructors to establish a "get well" plan of action IAW the USAF Academy Form 68, Cadet Academic Deficiency Evaluation and Probation Action Plan.

(2) Waiver of personal interview and written statements.

e. The ARCs interview cadets who elect option (1) above no earlier than the day after appeal packages are due. After the interview, the ARC re-votes to retain or recommend disenrollment of the appealing cadet.

(1) Cadets appealing a recommendation for disenrollment in the spring semester will not be enrolled in a summer academics course.

(2) Student Academic Affairs sends notification letters containing ARC actions, via AOCs and Academic Advisors, to cadets retained after the ARC interviews.

(3) ARCs forward disenrollment recommendations to the Dean of the Faculty. The Dean of the Faculty can retain the cadet or forward the ARC's disenroll recommendation to the Superintendent for final disposition. If the Superintendent's decision is to disenroll the cadet, the Staff Judge Advocate (JA) sends notification letters to cadets.

2-4.8. DISENROLLMENT PROCEDURES

a. Disenrollment of Cadets. Deficient cadets are processed for discharge or disenrollment in accordance with the provisions of USAF Academy Instruction 36-3504, *Disenrollment of United States Air Force Academy Cadets*.

b. Notification Procedures. JA notifies cadets of final disenrollment decisions. Disenrolled first- and second-class cadets will also be notified about decisions concerning their active duty commitments. JA counsels all disenrollees of their rights and options.

c. Legal Reexamination. Title 10, U.S.C. 9351. Any disenrolled cadet who is deficient because of failure to pass a required examination or course equivalent in any one subject is entitled to a reexamination of equal scope and difficulty in that subject, provided both the cadet's semester and cumulative GPAs are greater than or equal to 2.0 for all courses exclusive

of the one failed. The cadet must apply in writing to Student Academic Affairs, Curriculum and Academic Affairs Division (DFVRC).

(1) Notification. Student Academic Affairs notifies eligible cadets in writing. The notification letters include all pertinent information regarding the entitlement to reexamination.

(2) Cadet Acknowledgment. Cadets entitled to a reexamination must be counseled by the ARC coordinator concerning their Title 10 rights. Cadets will designate in writing their intent to take the reexamination. The written notification is due no later than ten days after receipt of the official written notification of disenrollment. Cadets electing reexamination will not out-process, but will be removed from the Cadet Wing until the results of the reexaminations are known. The department offering the failed course prepares, administers, and grades the reexamination within five duty days of their notification of the request. The five duty days do not include weekend days, federal holidays, periods of authorized emergency leave, or days the cadet is admitted as an inpatient in a hospital. Cadets awaiting reexamination will not be sent TDY. The re-exam will be of comparable scope and difficulty to the final examination in the failed course. Departments notify DFVRC in writing of the cadet's grade for placement in the cadet's official records.

(3) The department administering the reexamination endorses the cadet acknowledgment letter, annotating the date, time, and location of the reexamination.

(4) Cadets prepare for reexamination primarily through individual study. They will not be allowed to attend regularly scheduled classes in the course in which they are retesting.

(5) When cadets are disenrolled at the end of the fall semester or at the end of the summer term, they will attend all academic and military formations while awaiting reexamination.

(6) When cadets are disenrolled at the end of spring semester, they retest in lieu of summer break.

(7) A cadet who successfully passes a reexamination is formally readmitted to the Cadet Wing. The failed course must be repeated the following offering term. (See USAF Academy Instruction 36-3523.)

(8) A cadet who fails a reexamination is not authorized a second reexamination. The case will be forwarded for final disposition in accordance with USAFAI 36-3504.

d. Readmission of Former Cadets Program (USAF Academy Instruction 36-2005). Cadets disenrolled academically must attend another four-year accredited university to qualify for readmission. If they improve their grades and take courses that may transfer to USAF Academy, they may be eligible to apply for readmission under the Readmission of Former Cadets Program. The program requires interested students to again secure a USAF Academy appointment and again complete the entire application process.

2-4.9. CLASS ATTENDANCE BY CADETS RECOMMENDED FOR DISENROLLMENT

a. Class Attendance by Cadets Recommended for Disenrollment. Cadets recommended for disenrollment after the fall or summer semester will be placed into classes in a provisional status. Cadets recommended for disenrollment after the spring semester will be removed from first period summer academics, military training, and summer break and be placed in Operations Group Admin Squadron. Cadets will remain in this status until their cases have been resolved.

(1) A disenrolled cadet is immediately withdrawn from classes and begins out-processing.

(2) A retained cadet is removed from provisional status and readmitted to the Cadet Wing.

b. Resigning Cadets. Cadets who plan to resign at the end of a semester and elect to take final examinations will receive letter grades and may be disenrolled for academic deficiency in lieu of voluntary resignation if they are deficient in studies at the final grade report. To avoid the possibility of academic disenrollment, a cadet must resign and be officially removed from all classes prior to the start of finals. The Director of Cadet Personnel and Administration (A1A) and DFVRC will agree upon and publish the latest date a cadet may resign and still be excused from final examinations. Cadets resigning after Lesson T20, but before final examinations, will receive grades of WP or WF, as appropriate.

2-4.10. WHY SHOULD CADETS WORRY ABOUT ACADEMIC DISENROLLMENT?

a. First- and second-class cadets disenrolled from USAF Academy have an active duty service obligation. It is rare for this obligation to be waived.

b. Academic disenrollment seriously affects a student's chances of enrolling in another university, even on a probationary status. Many universities require a petition for entry and allow only one semester to correct deficiencies.

c. Academically disenrolled cadets desiring readmission into USAF Academy must go through the same admission procedure as new appointees and again secure an appointment. Readmission is not assured.

2-4.11. WHAT CAN A CADET DO TO PREVENT ACADEMIC PROBLEMS?

a. Take responsibility for her/his academic program.

b. Create a long-term plan for academic success by setting realistic, attainable goals.

c. Take advantage of all the help that is available, including EI, the Academic Success Center (the Writing Center, the Academic Success and Reading Enhancement programs, and the intercollegiate study hall), and the Cadet Counseling and Leadership Development Center.

d. Consult their squadron academic officer, advisor, AIC, course instructors, and DFVRC Academic Review Committee Coordinators.

- e. Approach their scholarship to USAF Academy with an understanding that academic, athletic, and military performance are of equal importance to one's success at USAF Academy.
- f. Strive for **EXCELLENCE** in academics. It is a core value that applies to all mission areas.

SECTION 2-5 SPECIAL PROGRAMS

2-5.1. CADET SEMESTER EXCHANGE ABROAD PROGRAM (CSEAP)

The USAF Academy offers semester-long, reciprocal exchange programs with several international military academies. Exchange agreements are approved by the USAF Academy Superintendent and Secretary of the Air Force for International Affairs (SAF/IA), and their equivalent foreign counterparts. Current exchanges exist with Canada, Chile, France, Germany, Japan, Singapore and Spain. These exchanges occur during the fall and/or spring semester of the first- or second-class year. International semester exchange cadets at USAF Academy are not required to take final exams. This program is grounded in Air Force Instruction (AFI) 16-109 (*International Affairs Specialist Program*) requirements, established by AFI 16-111 (*The USAF Academy Cadet Semester Exchange Abroad Program*), and administered at USAF Academy in accordance with USAF Academy Instruction 16-101 (*International Education Programs*). In accordance with USAF Academy Instruction 16-101, the International Programs Council oversees all USAF Academy international programs, and DFLC/DFLCP administers them. The strategic purpose of the program is to strengthen USAF Academy cadets' foreign language skills and bolster cross-cultural understanding and interoperability between US and allied air forces to meet DoD and AF objectives.

2-5.2. CADET SEMESTER STUDY ABROAD PROGRAM (CSSAP)

The USAF Academy has semester-long study abroad programs at foreign civilian universities for cadets studying several of the eight languages taught by DFLC: Arabic, Chinese, Japanese, Portuguese, Russian, and Spanish. This program was established in accordance with the Office of the Secretary of Defense's 2005 Defense Language Transformation Roadmap to "exploit study abroad opportunities to facilitate language acquisition" (required actions 1.Q.). Its purpose is to strengthen USAF Academy cadets' foreign language skills, increase cultural awareness and enhance their ability to operate effectively in cross-cultural environments. CSSAP is administered at USAF Academy in accordance with USAF Academy Instruction 16-101. Though this program was originally designed for Foreign Area Studies majors, cadets from other disciplines are encouraged to participate, provided that their advisors, working in concert with other departments and DFLC/DFLCP prior to departure, can establish a plan for meeting all graduation requirements.

2-5.3. CSEAP/CSSAP SELECTION, PREPARATION, AND ACADEMICS

- a. Candidate Selection. Cadets interested in semester exchange or study abroad are encouraged to work with academic advisors as early as their first year at USAF Academy. Cadets should plan their coursework to accommodate a semester to study at a foreign institution. Second- and third-class cadets with a minimum 2.6 cumulative GPA, who will have completed the appropriate For Lang 322, or equivalent, by the time of departure are eligible to apply. Cumulative MPA and PEA scores of 2.6 or better are also expected. Waivers to these criteria may be granted by CWV or ADP. Program participants may not be on any probationary status at the time of travel. A cadet who is on probation at the time when applications are submitted may only apply with squadron AOC approval. Eligible cadets should apply through the Office of International Programs (DFLCP) in the fall of the second-class year or earlier as denoted by a specific exchange program. DFLCP will ensure notification to the Cadet Wing of the application period.

b. Preparation. Cadets selected as primary or alternate candidates for semester overseas programs must be available all three summer periods prior to their study abroad semester and could be required to take an academic course or depart on exchange without leave. Cadets must complete academic coursework as necessary to satisfy all graduation requirements. Cadets must coordinate with their academic advisors and ADP to develop a plan specifying which classes they expect to receive credit for while studying abroad. DFLCP will provide course catalogs or equivalent for each program. However, due to the structure and curricula of our partner academies, course information is not readily available for all locations. The cadet will need to work closely with the academic advisor, DFLCP, and any departments involved in the cadet's credit transfer plan to ensure all major, elective, and core requirements will be satisfied before graduation.

c. Transfer Credit. Course credit transfer may be awarded to meet major's requirements, Foreign Area Studies electives (for non-FAS majors), and core equivalents. USAF Academy cadets will receive pass/fail grades for their foreign coursework. Cadets considering participation in CSEAP or CSSAP should work with their advisor, ADP, and DFLCP to carefully plan and manage their academic program before, during and after their intended semester of participation. Within the spirit of the program's purpose, this planning should maximize opportunities for foreign coursework to transfer toward their academic major's requirements and FAS courses. The following process should be used by all cadets and advisors planning to participate in CSEAP/CSSAP:

(1) As soon as possible, but no later than lesson 15 of the semester prior to CSEAP/CSSAP participation, the cadet and advisor shall establish an academic plan that maximizes the opportunities for foreign coursework to transfer toward their academic major's requirements and electives. Each academic major is encouraged to be as flexible as possible in determining how each of these courses may fit into their academic major's requirements and therefore maximize the cadet's ability to receive transfer credit for their time abroad. In addition to major's classes, any cadet participating in a semester program overseas in a foreign language environment may receive experiential credit for For Lang 402 and For Ar Stu 495. A cadet may typically earn credit for a maximum of 6 courses while abroad, and may request authorization from the Director, DFLCP to receive credit for additional courses. The Director will coordinate with the AIC of the cadets' departments in cases for which an exceptional course load pursued overseas justifies additional credit.

(2) Credit toward academic courses that meet graduation requirements will be the primary objective within the maximum course load, including course equivalents for major's, elective, and core courses. Approval for credit to fulfill requirements for USAF Academy core courses is possible using core substitutes (*Table 13*) and constrained by considerations (a) through (g) below:

Table 13. Exchange/Abroad Program Transfer Credits

Cadet can receive transfer credit for the following <u>core substitute</u>	Fulfilling the requirement for one of the following <u>core courses</u>	If the course taken abroad/on exchange contains roughly the following <u>course objectives/content</u>
Bas Sci 401	- Biology 215 (Bas Sci 401BI)	- any course using the content of biology to teach critical thinking and the principles of science and the scientific method
	- Math 300/356/377 (Bas Sci 401MA)	- introductory statistics, probability, hypothesis testing, probability distributions, correlation or regression
Engr 401	- Astr Engr 310 (Engr 401AS)	- history, principles, challenges of space, orbits, spacecraft systems, launch vehicles, re-entry or mission management
	- Aero Engr 315 (Engr 401AE)	- introductory aircraft design, fluid mechanics, airfoil/wing aerodynamics, aircraft performance, or stability & control
	- ECE 315 (Engr 401EC)	- introductory electrical or computer engineering principles, signal analysis, electronic system design or evaluation
Soc Sci 401	- Mgt 400 (Soc Sci 401MG)	- successful techniques in allowing people to understand & influence their environment, models & processes, interrelationships of power, or techniques contributing to decision making in complex, uncertain situations
Hum 401	- English 411 (Hum 401EN)	- moral & intellectual aspects of war as expressed in literature, written and oral communications skills, or major canonical works of fiction, memoir and oratory addressing complexities & ethical issues of war/leadership
	- Philos 210 (Hum 401PH)	- study of major moral theories, application to moral problems, ethical action, understanding of civic, cultural & international contexts or influential normative theories of ethics, devotes substantial in-class treatment to the just-war tradition with associated reading assignments and homework

(a) Equivalency is defined as a suitable substitute for the corresponding USAF Academy offering within the spirit of the program's overarching purpose; course syllabus and associated learning outcomes need not correspond on a direct one-for-one basis in order to receive credit for a course. If a department believes the substance of a particular core equivalent is not met by the CSEAP/CSSAP course offering, departments and advisors are encouraged to work with cadets to develop acceptable alternatives aligned with the desired outcome. For instance, a department may work with the cadet and an instructor to create a 499 course with independent coursework, and/or deliverable materials that may be completed during the CSSAP semester and either submitted or presented upon the cadet's return (or via networked means while abroad). Additional requirements should be the exception, not the rule.

- (b) Cadets and their advisors are responsible for working with departments to coordinate approval for credit within the major or minor discipline. DFLC/DFLCP, working with DFVR, will coordinate with departments to effect transfer credit for core courses. Approval for equivalency credit is granted by the Department Head or the department's designated official.
- (c) Within one week of beginning academic coursework at the foreign military academy or civilian institution, each cadet must contact DFLCP to update and/or refine their academic plan for the semester. Offered courses frequently change. DFLCP will work with the advisor and the cadet to adjust the plan based on circumstances. Potential transfer credit from any additional departments will be coordinated within two weeks of notification.
- (d) DFLCP will maintain records of foreign coursework to include country, location, institution, course titles and descriptions.
- (e) Upon receiving proper coordination/approval for transfer credit for USAF Academy courses and successfully completing equivalent foreign coursework, major's courses, FAS courses, core course, or *core substitute* will appear on the cadet's transcript indicating pass/fail credit.
- (f) Due to curriculum changes and internal scheduling processes at foreign institutions, course availability cannot be guaranteed until after cadets report to their respective overseas programs. Cadets and advisors will refer to DFLCP resources during planning to confirm expected course offerings.
- (g) In cases of unresolved conflict between departments and advisors regarding equivalent credit, the circumstances will be presented to Director, DFLCP who will, if necessary, present it to the appropriate Division Chair for a final decision on divisional core substitute credit.

2-5.4. SERVICE ACADEMY EXCHANGE PROGRAM

(USAF Academy Instruction 36-2001, *Cadet Service Academy Exchange Program*). USAF Academy has a semester-long exchange program with the U.S. Military Academy at West Point, the U.S. Naval Academy at Annapolis, and the U.S. Coast Guard Academy at New London. Cadets selected for this program during their fourth semester attend the sister academy during the fall of their second-class year. Academic grades received at sister service academies transfer to USAF Academy and are included in the cumulative GPA. If end-of-semester grades would result in academic probation status at USAF Academy, the cadet is placed on academic probation upon return. Interested cadets apply through their Air Officer Commanding (AOC). Students and advisors should work with AICs and departments to ensure maximum flexibility for students participating in this program; courses taken at sister service academies should generally meet the intent of similar classes offered at USAF Academy, recognizing these courses will not provide an exact one-to-one match of course objectives and topics.

2-5.5. RESERVE OFFICER TRAINING CORPS EXCHANGE PROGRAM

Similar to the Service Academy Exchange Program, USAF Academy also has agreements with several civilian institutions that allow cadets the opportunity to attend those universities during the fall of their second-class year. Interested cadets apply through their AOC. As with CSEAP and CSSAP, students selected for this program will be awarded transfer credit for courses taken at the civilian institution that meet major's and core requirements. USAF Academy cadets will receive pass/fail grades for their ROTC exchange coursework. Cadets considering participation in the ROTC exchange program should work with their advisor and ADP to carefully plan and manage their academic program before, during and after their intended semester of participation. Within the spirit of the program's purpose, this planning should maximize opportunities for relevant coursework to transfer toward their academic major's requirements. As with other exchange program, maximum flexibility in offering course transfer credit is encouraged; cadets should work with both the civilian university and USAF Academy's academic departments in advance to find course options that will fill cadet graduation requirements.

2-5.6. ACADEMIC SUCCESS CENTER (ASC)

The Academic Success Center is a centralized learning center designed to enhance cadet performance and is comprised of four key educational units: Quantitative Reasoning Center, Communication Strategies Center, Strategies for Academic Success, and Graduate Studies and Scholarships. The Quantitative Reasoning Center offers instructional support in Calculus, Physics, Chemistry, and Mechanical Engineering. The Communication Strategies Center offers Reading Enhancement classes, a Writing Center to help with papers and reports for all classes, and a Public Speaking Lab to assist cadets with their speaking presentations. The Strategies for Academic Success program offers classes and individualized assistance to assist cadets with learning strategies for general as well as subject specific content, as well as extra instruction and support for ESL and international cadets. The Graduate Studies and Scholarship program assists high-achieving cadets who seek scholarships and who aspire to attend graduate school. The vision of the Academic Success Center is to support and encourage academic excellence in all cadets through faculty-led, personalized instruction that advances study strategies, critical thinking, STEM, and communication literacy. The ASC works to inspire cadets to pursue graduate education and become life-long learners.

a. Quantitative Reasoning Center (QRC). The QRC provides evening extra instruction (EI) for STEM subjects. Supplemental instruction in select core quantitative disciplines is provided in individual, small group, and workshop settings. Subjects include Calculus, Physics, Chemistry, and Engineering Mechanics. The QRC is open in the evenings, Monday through Thursday, from 1730 – 2130. Appointments are recommended and some drop-in hours may be available. Students should first seek EI from their primary course instructors, but the QRC is an excellent source of supplemental instruction. To learn more about the Center's services visit our Blackboard site at <https://aetc.blackboard.com> (log in and click the Academic Services tab at the top). To schedule extra instruction visit <https://usafa.mywconline.com/>.

b. Communication Strategies Center. The Communication Strategies Center offers classes and individualized support for reading, writing, and speaking enhancement to best prepare all cadets to be well-informed critical readers, writers, and speakers. For information, please contact the Director of the Communication Strategies Center, Dr. Elisa Cogbill-Seiders.

(1) Introduction to Communication. Comm Strt 101 and 101X. This 20-lesson course is designed to enhance a cadet's ability to skillfully and ethically respond to academic, professional, and intercultural communicative situations. The course introduces students to evidence-based communicative practices through a variety of critical reading tasks, with an emphasis on use of core academic texts. Please contact Dr. Gary Mills or your academic advisor to discuss enrolling in this class. Cadets can enroll in Comm Strt 101 (first 20 lessons of the semester) or Comm Strt 101X (second 20 lessons of the semester).

(2) Writing Center. The Writing Center is open in the evenings, Monday through Thursday, from 1730 – 2115 for appointments or walk-ins. Individual appointments can also be scheduled during the day through MyWCOnline (<https://usafa.mywconline.com/>). For more information, please contact Dr. Chris Gras.

(3) Public Speaking Lab. The Public Speaking Lab is USAF Academy's academic support center for any and all oral communication needs. Public speaking specialists help cadets refine and improve academic presentations in the classroom, leadership speeches in the cadet wing, and interview preparation for cadet jobs and graduate school programs. Individual appointments can be scheduled during the day and evening. For more information, please contact Dr. Daniel Johnson

c. Strategies for Academic Success. The Strategies for Academic Success program offers full semester (Lrn Strt 101) and half semester (Lrn Strt 102) courses which focus on the most effective learning strategies for academic achievement, time-task management, prioritization, note-taking, and reading skills. Discussions about mindset and grit are also included in the classes. Cadets should contact Mr. Spencer Thomas or stop by the Academic Success Center to discuss an individualized program or enrollment in a Lrn Strt course. Select fourth-class cadets will be enrolled in fall or spring Learning Strategies courses based on entering academic composite numbers or performance during a grading cycle.

(1) ESL/International Cadet Support. For English as a Second Language (ESL) and international cadet assistance, please contact Prof. Connie Leonard

d. Graduate Studies and Scholarships. The Graduate Studies and Scholarships office assists academically high-achieving cadets pursue scholarship and graduate study opportunities. For additional information, contact Dr. Helen Meisenhelder, Director of the Graduate Studies and Scholarship program.

2-5.7. ENGLISH AS A SECOND LANGUAGE (ESL) PROGRAM.

Every summer during the in processing of basic cadets, DFVR will administer questions to international cadets regarding their English language proficiency. DFVR will use the responses to these questions to determine if an international cadet should be coded as an ESL student and placed in English For Academic Purposes (EAP) 109, Academic Communication for English as a Second Language Four-year Exchange Cadets or EAP 209, Academic Communication for English as a Second Language Semester-Exchange Cadets. If further information is required, the DFVR ESL Coordinator will conduct an interview with the cadets to determine ESL status and English course placement.

- a. Every summer, DFVR will ask every cadet two questions regarding ESL status. The first will establish if the cadet is ESL, and the second is to determine if the cadet would like to be referred to the ESL program. If enrolled in the program, the DFVR ESL Coordinator will notify the Registrar Customer Service and Scheduling Division (DFVRR) to update the SIS with a cadet's ESL status NLT lesson 2 of the Fall semester. A student's enrollment in the ESL program will be visible on the student's APS. Questions regarding the ESL designation of a cadet should be directed to DFVR.
- b. All cadets coded as ESL are authorized extra time to complete quizzes, graded review (GRs) and final examinations. Instructors are responsible for recognizing ESL cadets in their classes and in coordination with their department leadership are responsible for promulgating the guidance provided.
- c. Academic departments may grant up to double time on quizzes, graded reviews, and final examinations to ESL students as agreed upon by course director, instructor, and student. Academic departments may allow extra time on exams that require essay questions or that contain verbal reasoning problems but may deny requests for extra time on exams that are purely quantitative in nature. ESL students must be permitted to use an English or foreign language dictionary, but must coordinate with the instructor the specifics of what dictionary will be used and how and when it will be used. This guidance does not apply to DFLC foreign language classes. Suitable arrangements must be made between cadets and instructors to schedule quizzes, graded reviews, and final exams.
- d. Foreign language requirements are waived for international cadets. DFLC determines foreign language validation credit for U.S. ESL cadets. DFLC is responsible for submitting a list of cadets earning foreign language validation credit to DFVR.

2-5.8. ACADEMICALLY AT-RISK PROGRAM

This program is designed to provide academically "at-risk" cadets with a lighter academic load during their fourth-class year to increase their chances for successfully meeting graduation requirements. Cadets may not decline their placement into the program, nor can they volunteer for the program. Cadets may volunteer for the Learning Strategies 101 course.

- a. "At-risk" fourth-class cadets take four academic courses and Learning Strategies 101 during the fall semester. During the spring semester, at-risk cadets will take five academic courses. Cadets may be placed in the program based ACT or SAT scores, Prior Academic Record (PAR), Academic Composite, or other criteria as established by USAF Academy.
- b. Procedures
 - (1) Academically at-risk cadets are identified on the APS by enrollment in Lrn Strt 101 in the fourth-class fall (refer to Appendix 2, Course Descriptions, under Learning Strategies).
 - (2) An academically at-risk cadet who wishes to take more than five academic courses in the fourth-class spring semester may do so if the cadet qualifies for an overload (3.0 or greater fall GPA). At mid-semester, the ARC may direct any overloaded, deficient cadet to drop a course.
 - (3) An academically at-risk cadet who fails a course during the academic year may be directed to forfeit summer break and take an academic course in its place.

2-5.9. HOSPITAL INSTRUCTION (HI)

(USAF Academy Instruction 36-3509, *Extra Instruction for Cadets*). Hospital instruction helps cadets maintain their academic course work at a proficient level while hospitalized. While this program is primarily for cadets who experience an extended stay due to illness or injury, extra instruction services are available for all cadets.

2-5.10. EXTRA INSTRUCTION (EI)

(USAF Academy Instruction 36-3509, *Extra Instruction for Cadets*). Extra instruction provides an opportunity for students to meet one-on-one with their instructors to obtain additional, out-of-class assistance in academic areas. Extra instruction is the right of all cadets and is highly encouraged for cadets experiencing academic difficulty. All instructors are willing to help any cadet in need of additional academic assistance.

2-5.11. RETURN-TO-LEARN CONCUSSION PROTOCOL

Return-to-learn is a post-concussion academic recovery program. The goal is to provide a cadet with academic accommodations during the cadet's concussion recovery in order to give their brain the best chance to heal. After a concussion, the brain experiences a temporary energy crisis that may make it difficult to engage in cognitive activities. Return-to-learn exists to allow the brain to heal during this energy crisis by preventing a premature return to full academics.

Table 14. Return-to-Learn Stages

Stages	Accommodations
1 – Cognitive Rest	<ul style="list-style-type: none">• Cadet does not attend class• No homework
2 – Trial of Cognitive Activity	<ul style="list-style-type: none">• 20-30 min. of homework followed by 15 min. of rest• Increase homework by 15 min. increments• Move to Stage 3 when you can study for 60 min. and remain symptom free
3 – Return to Class (maximal modifications)	<ul style="list-style-type: none">• Attend some classes. Avoid classes/activities that provoke symptoms• Do not take quizzes or GRs• Begin to make up missed work (e.g., reading assignments)
4 – Return to Class (minimal modifications)	<ul style="list-style-type: none">• Attend all classes. However, may miss a particular class that provokes symptoms• Begin to make up missed quizzes/GRs
5 – Full Class Attendance	<ul style="list-style-type: none">• Fully participate in academics• Completes make up of any missed work

- a. I should expect a Return-to-Learn cadet to be:
 - ...in Stage 1 (Cognitive Rest) for 24-48 hours.
 - ...in Stage 2 (Trial of Cognitive Activity) within a few days from injury.
 - ...in Stage 3 (Return to Class (max. modifications)) within the first week from injury.
 - ...in Stage 4 (Return to Class (min. modifications)) within 10 days from injury.

...in Stage 5 (Full Class Attendance) at approximately 2 weeks from injury.

- b. I should be concerned if a Return-to-Learn cadet:
- ...is still in Stage 1 (Cognitive Rest) after 5 days from injury.
 - ...hasn't reached Stage 2 (Trial of Cognitive Activity) after first week from injury.
 - ...hasn't reached Stage 3 (Return to Class (max. modifications)) within 10 days from injury.
 - ...has not reached Stage 4 (Return to Class (min. modifications)) within 2 weeks from injury.
 - ...has not reached Stage 5 (Full Class Attendance) within 3 weeks from injury.
- c. This timeline should be used as a general rule of thumb – understanding that every concussion heals differently. If you notice that your cadet is falling into the concerning timeline, it would help to meet and/or teleconference with the cadet, academic advisor, instructor, and RTL liaison.
- d. It is important to watch for the following characteristics in a concussed cadet:
- Increased problems with attention and/or concentration
 - Difficulty with remembering or learning new information
 - Longer time needed to complete tasks
 - Inappropriate or impulsive behavior
 - Greater irritability and/or emotional liability
 - Decreased ability to cope with stress
 - Difficulty or distress in a stimulating environment
 - Physical symptoms such as: headache, nausea, dizziness, fatigue
- (These are all symptoms of a concussion and an increased intensity or onset of new symptoms may demonstrate a need for slower return-to-learn and additional medical attention. Presence of these symptoms for longer than three weeks without improvement signals a need for further medical attention. If you witness a cadet demonstrating these symptoms please verify that they have a clinic follow-up within the week. If you are concerned, escort them to the Cadet Clinic.)
- e. Protocol Management.
- (1) After the diagnosis of a concussion, the cadet's academic advisor and AOC will supervise the cadet's return-to-learn. These personnel will work with the cadet and their instructors, professors, as well as medical staff in order to develop a customized plan. As the cadet moves through the return-to-learn stages, the academic advisor and AOC will provide updates on the cadet's progress. Personnel in the Cadet Clinic will assign the return-to-learn stages and will maintain and disseminate an accurate Form-18. It is imperative that AOCs and academic advisors provide feedback to medical personnel on their concussed cadet's academic progress.
- (2) Returning to the classroom does not mean the cadet is symptom-free. The gradual return to full academics (i.e. caught up with syllabi in all classes) should be modified individually for each cadet based on symptoms and course content. Return-to-learn is completed in several stages and symptoms are monitored at each stage. Certain activities

may trigger new symptoms or worsen existing ones. In this case, the cadet may need to be re-evaluated by medical personnel. Cadets with a concussion are seen at least once per week in the Concussion Clinic.

(3) Concussion and mild traumatic brain injury are covered under the Americans with Disabilities Act Amendments Act (ADAAA). Any action taken in this process must remain compliant with the ADAAA law.

- f. Return-to-Learn Stages. The role of the AOC and academic advisor is to oversee their concussed cadet's academic recovery. Medical staff will assign the return-to-learn stages. In a minority of cases the AOC and academic advisor may need to communicate directly with the treating physician to ensure an effective Return-to-Learn protocol is in place. The duration of each stage should be specific to each individual cadet and is based on the symptoms experienced by the cadet. Regardless of stage, the AOC and academic advisor will jointly manage return-to-learn. During stages 1 and 2, the cadet will be on bed rest so these stages will be primarily managed by the AOC. When the cadet is ready to return to class (i.e., progresses to stage 3) the AOC will hand over primary management responsibilities to the cadet's academic advisor.

(1) Stage 1 - Cognitive Rest (typically same day of injury)

Avoid: classroom attendance, formation, briefings, homework, "screen time" (i.e. phone, computer, or video game use), reading, and loud noise and bright lights (e.g., meals should be provided in their dorm in order to avoid Mitchell Hall).

(In light of the energy crisis that occurs after a concussion, cognitive rest allows the brain to heal more quickly. If the cadet is still experiencing symptoms without stressors or activity, they should remain at the cognitive rest stage. When the cadet has no or minimal symptoms at rest, they will progress to the next stage.)

(2) Stage 2 - Trial of Cognitive Activity (return to homework)

Attempt cognitive activity such as homework or reading for 20-30 minutes, gradually increase time increments, allow for approximately 15 minutes of rest in between each activity, and if the cadet develops symptoms after participating in activities, they should rest until symptoms subside.

(Once the cadet can complete approximately an hour of cognitive activity without the onset of concussion symptoms, they will progress to the next stage.)

(3) Stage 3 - Return to Class (with maximum modifications)

Return to a partial day of classes. Avoid specific classes or activities that lead to the onset of symptoms (e.g., particularly challenging classes, labs, and intensive computer use). The cadet should not participate in physical education classes. The cadet should communicate to their academic advisor, professors, and instructors when they are experiencing symptoms and ask to leave class or modify classes in order to minimize the worsening of concussion symptoms. The cadet should not take quizzes or GRs, as a quiz or GR taken early in concussion recovery will not accurately represent their ability and knowledge. The cadet can begin to make up work (e.g., reading assignments) missed when they were not in class. The cadet can

begin to attend morning accountability formation, briefings, and meals in Mitchell Hall unless they provoke concussion symptoms.
(Once the cadet can complete a partial day of classes without the onset of concussion symptoms, they will progress to the next stage.)

(4) Stage 4 - Return to Class (with minimum modifications)

The cadet returns to a full day of classes but should take breaks when necessary. The cadet can begin to take quizzes and GRs, although they should be provided an opportunity to take an adapted form in order to prevent triggering symptoms (e.g., oral exam instead of written, paper instead of computer, longer time limit on a timed exam, etc.). Single class exceptions for a particular class that provokes symptoms may be necessary.

(Once a cadet can attend all classes without the onset of concussion symptoms, they will progress to the next stage.)

(5) Stage 5 - Full Class Attendance (no modifications)

The cadet returns to classes as usual, fully participating and taking all quizzes and GRs in the original format. The cadet will continue to work with professors and instructors in order to ensure that any missed work is made up and they are caught up to the syllabus. The expectation is that the cadet attends all formations and briefings.
(Continue to monitor for concussion symptoms, even after the cadet has reached stage 5. Any return of symptoms should be referred to a medical provider at the Cadet Concussion Clinic.)

- g. Symptoms Persisting Longer Than Three Weeks. For most cadets, concussion symptoms will resolve, and they will return to class with no modifications within three weeks. For those cadets who continue to experience symptoms past the three-week period, there are differing ways to make academic adjustments and accommodations. The cadet may need a change in schedule (e.g. drop a class); or special arrangements may be required to allow for extended absences, quizzes and GRs, term papers, and projects.

h. Potential Accommodations for Professors/Instructors to Consider

(1) General Academic Accommodations: modify or cancel an assignment(s), short in-class breaks, extended time on assignments or quizzes/GRs, quieter/dimmer exam room, ability to record lectures or provide note takers, alternative forms of quizzes and GRs (e.g., oral instead of written, paper instead of computer), excused absences, schedule change, and dropping a class that induces concussion symptoms.

(2) Symptom-Based Accommodations

Table 15. Concussion Symptoms and Accommodations

Symptom	Accommodation
Headaches	<ul style="list-style-type: none"> • Allow cadet to lay head down on desk • Allow frequent breaks • Identify triggers that cause headaches to worsen
Sensitivity to Noise	<ul style="list-style-type: none"> • No PE, band, or chorus • Avoid loud classes/labs • Permit earplug use • Avoid Mitchell Hall; eat in a quiet setting • Avoid attending athletic events (e.g., Falcon Stadium) • Allow cadet to leave/arrive from class early/late to avoid loud hallways • Limit cell phone, head phone/ear phone use
Sensitivity to Light	<ul style="list-style-type: none"> • Allow cadet to wear sunglasses indoors • Move cadet to area with low-lighting, dim lights • Avoid sitting in direct sunlight • Avoid bright projector/computer screen
Sleep Difficulties	<ul style="list-style-type: none"> • Allow late start to school (e.g. cadet may need to miss morning accountability formation) • Allow frequent rest breaks
Visual Problems	<ul style="list-style-type: none"> • Limit computer use • Reduce/shorten reading assignments • Record lectures or use auditory learning apps • Allow for more listening and discussion vs. reading • Increase font size on computer/projection screen • Limit texting/video games • Limit watching TV close up or from a distance • Sit cadet closer to center of the room (for blurry vision)
Concentration/ Memory Problems	<ul style="list-style-type: none"> • Place main focus on essential academic content/concepts • Postpone major GRs or participation in testing • Allow extra time for assignments, quizzes, GRs, projects • Modify class assignments and homework • Limit to one exam per day • Consider use of pre-printed notes, note taker, or reader for oral test taking
Dizziness/ Lightheadedness	<ul style="list-style-type: none"> • Allow cadet to leave class early to avoid crowded hallways • Provide an escort • Allow cadet to put head on desk

2-5.12. MARTINSON HONORS PROGRAM

The Martinson Honors Program, the honors program at USAF Academy, helps academically talented and intellectually curious cadets at USAF Academy reach their full scholastic potential. As a holistic program that blends an innovative, engaging, and integrative path through the core

curriculum with unique extracurricular experiences, the Honors Program serves as an exemplar of academic integrity and excellence. Upon graduation, Scholars are prepared for challenging, twenty-first century command positions and possess the intellectual curiosity and commitment to lifelong learning that will foster their growth as future officers, thinkers, and leaders. The curriculum consists primarily of smaller-sized, discussion-based core course sections that deepen and broaden Scholars' intellectual development, as a complement to existing academic, leadership, military training, and athletics programs.

a. Background. The Martinson Honors Program addresses several academic issues at USAF Academy, several trends in the Air and Space Forces, the global security environment, and higher education in the 21st century. USAF Academy's efforts to recruit the best qualified applicants, in addition to the competitiveness of our cadets for graduate scholarships, support a program focused on intellectual development across all four of USAF Academy's academic divisions.

b. Admission to the Martinson Honors Program. Shortly after the first progress report in the fall semester, eligible cadets in each new class (based on their fall prog GPA and faculty recommendations) will be offered the opportunity to apply for program entry. Cadets who wish to take Martinson Scholars courses, but who are not formally in the program, may do so on a space available basis with the approval of the Department Head in charge of the course and the Martinson Honors Program Director. A cadet will be considered for removal from the program if their GPA drops below 3.5. Additionally, any form of probation (honor, conduct, aptitude, athletic, or academic) may restrict a Scholar to course participation and from complementary opportunities.

Note: Cadets should not be enrolled into a Scholars course designated with an (S) suffix unless one or more of the following criteria are met: 1) the cadet is enrolled in the Martinson Honors Program or; 2) the cadet has a cumulative 3.5 GPA or above and the recommendation of the department head managing the course or; 3) the if the cadet has below a cumulative 3.5 GPA they must have the recommendation from the department head managing the course and concurrence from the Martinson Honors Program director for non-scholar participation in a scholars course.

c. Martinson Honors Program Curriculum. To graduate as an Academy Scholar, cadets must: 1) be formally accepted into the program; 2) complete the required capstone, Inter Dis 463S; 3) complete *at least* nine additional Scholars courses, *one* of which may be a capstone in the major or a 499; 4) graduate with a GPA of 3.5 or higher. Please note that courses not listed here may occasionally be offered, and courses listed here may not be offered; contact the Program Director for more information.

d. Recommended Sequence for Martinson Honors Program Courses:

Table 16. Martinson Honors Program Courses

Scholars Course	Core Course Equivalent	Year	Semester
English 211S OR English 200S	English 211	Fourth	Fall/Spring
History 100S	History 100	Fourth	Fall/Spring
Beh Sci 110S	Beh Sci 110	Fourth	Fall/Spring
Comp Sci 110S	Comp Sci 110	Fourth	Spring
Physics 110 S	Physics 110	Fourth	Spring
Pol Sci 211S	Pol Sci 211	Fourth	Spring
MSS 251S	MSS 251	Third	Fall/Spring
Econ 201S	Econ 201	Third	Fall
Physics 215S	Physics 215	Third	Fall
Law 220S	Law 220	Third	Fall/Spring
Mech Engr 220S	Mech Engr 220	Third	Spring
Biology 215S	Biology 215	Third/Second	Spring
ECE 215S	ECE 315	Third/Second	Fall/Spring
Soc Sci 311S	Soc Sci 311	Second	Fall/Spring
History 300S	History 300	Second	Fall/Spring
Philos 210S	Philos 210	Second	Fall
Math 300S	Math 300	Second	Spring
Astr Engr 310S	Astr Engr 310	Second	Fall/Spring
Aero Engr 210S	Aero Engr 315	Second	Fall/Spring
English 400S NB: Fills Adv Socio Option	English 411	First	Fall
Mgt 400S NB: Fills Adv Socio Option	Mgt 400	First	Spring
*Soc Sci 483S NB: Fills Adv Socio Option	Soc Sci 483	First	Spring
*DF 463S Capstone Seminar	N/A	First	Fall/Spring
*Required Scholars Course			

2-5.13. DF SUMMER PROGRAMS

Academic, airmanship/aviation, and military training core requirements are offered during the summer. The Commandant of Cadets summer scheduler coordinates scheduling procedures with DF, 306 FTG, AD, and SpDet. As the single point of contact for all summer program actions,

USAF Academy/CWTS also notifies cadets of all airmanship, athletic, DF-coordinated and military training summer program registration and changes.

- a. **Military Training.** All cadets will complete two programs per summer. Generally, for the two upper classes, one program will be a leadership program, a period of Summer Break and a Non-Cadre related program. For the rising third-class, one program will be Combat Survival Training (CST), a period of Summer Break and an airmanship program. Rising third-class cadets identified as "At-Risk" academically by DFVR will be assigned an academic class in lieu of airmanship. Certain summer military training programs must be completed to meet graduation requirements. Specific requirements will vary by cadet class. General graduation requirements are as follows:

- (1) Core military training requirements:

- (a) Basic Cadet Training (BCT) student (Basic Trainee) (Mil Tng 100)
- (b) Combat Survival Training (CST) student course (Mil Tng 220)
- (c) Operation Air Force (Ops AF) (Mil Tng 201) or equivalent:
 1. Air Education Training Command (AETC) Leadership Ops (Mil Tng 411)
 2. CE Ops/Civil Engineer Field Engineering Readiness Laboratory (CE-FERL) (Civ Engr 351)

- (2) DF Cadre Programs: All upper-class cadets will be required to complete one Cadre program per summer for manning purposes. Below is a list of programs that will meet the Cadre requirement:

- Wing Staff Cadre – Mil Tng 435
- BCT Group Staff/Cadre – Mil Tng 400/402/403
- Combat Survival Training (CST) – Mil Tng 320
- Ops Group Staff/Cadre – Mil Tng 407/413
- CE-FERL Leadership Cadre – Mil Tng 351
- CE SAME Camp – Mil Tng 352

- (3) The following DF programs are authorized by USAF Academy and considered non-cadre related. These programs can fulfill the second training program required each summer for upper-class cadets;

- Internships – Mil Tng 499
- Critical Language Scholarship (CLS) Program – Mil Tng 445
- Cultural Immersion Program (CIP) - Mil Tng 442
- Cadet Summer Research Program (CSRP) – Mil Tng 481
- Cadet Summer Language Immersion Program (CSLIP) – Mil Tng 441
- Summer Academics plus Summer Break Slots (limited) – SmrAcad 700
- Cadet Semester Study Abroad Program (CSSAP)
- Cadet Semester Exchange Abroad Program (CSEAP)

- (4) All cadets are normally assigned three weeks of summer break every summer. They may voluntarily choose to forego their summer break to accommodate additional time for CSRP and/or other non-cadre related programs or an academic class. In order for cadets to participate in two non-cadre related programs during the same summer, those cadets must forego their summer break.

NOTE 1: Summer Training Review Committee (STRC) – Directed Core Military Training. STRCs can direct core military training in lieu of summer break during the summer if deemed appropriate for completing graduation requirements based on circumstances surrounding incompleteness of core military training during prescribed summer term.

NOTE 2: All joint military training programs as well as all cadre for camps will have limited enrollment restricted by USAF Academy-based program manning.

NOTE 3: Physical Education Review Committee (PERC) – can direct summer RECONDO 3rd period (Mil Tng 234 Admin Squadron PRC) in lieu of summer break for any Physical Education deficiencies.

NOTE 4: “Leadership credit” can be earned in many ways with regards to select academic year positions and Cadet-in-Charge positions for various programs (e.g., CSLIP CIC). Although cadets may accumulate numerous “leadership credits,” that does not excuse a cadet from working a Cadre program identified in the Summer Cadre Programs list above. Summer Scheduling is not responsible for maintaining “leadership credit” and all upper-class cadets will be assigned at least one Cadre program each summer.

NOTE 5: Some Command Selected Board positions and cadets identified as qualified instructors may be required to work two periods during the summer for continuity and manning purposes.

NOTE 6: All cadets will be afforded the opportunity to provide their preference for some programs. By definition, “Preference is a choosing of or special liking for one person or thing rather than another.” Please note that a preference is not guaranteed but information collected to help schedule due to the extremely limited slots and availability of programs.

- b. Summer Academics. The purpose of summer academics is to enable cadets to correct a failed grade or deficiency and allow students to achieve personal goals such as completing a major, strengthening weak areas, or preparing for special academic programs. Each fall, the DFVRC Summer Academics Program Coordinator develops the next summer’s academic schedule. The goal of this program is to include as many core courses as possible. Most courses will be open to all interested cadets. Registration for summer academics is during the registration period held in the spring. After the established deadline date, changes to a cadet’s summer academic schedule will be reviewed on a case-by-case basis.

- (1) Academic Review Committee (ARC) – Directed Summer Academics. ARCs are Chaired by a Permanent Professor or Department Head (Colonel) from DF for each class and is the only approval authority which can direct summer academics and/or summer academics in lieu of summer break if deemed necessary for the cadet to maintain an achievable course load and graduate in 4 years.
 - (2) Summer Academics plus Summer Break. This program is designed to serve academically “at risk” third-class cadets or first-class cadets who either perform below average academically but continue to demonstrate the ability to benefit from a service academy education or, to a lesser degree, maintain above average academic performance while contributing extensive time to the USAF Academy community.
 - (3) Summer Academics in Lieu of Summer Break. A number of cadets choose to register for summer academics in lieu of summer break to ease future course loads or enrich their academic programs. Cadets who wish to drop or add a summer academic course must do so prior to the end of the registration period in the spring. After that date, the only additions or deletions will be ARC actions, CWT changes, or exceptions approved by DFVR.
- c. Cadet Summer Research Program (CSRP). (Mil Tng 481/486) CSRP provides opportunities for cadets to solve relevant problems, learn through real-world application of classroom principles, and build lasting collaborative relationships while participating in research at various military, government, and civilian facilities throughout the world. CSRP participants receive credit for a military summer training program, and this is considered a career broadening assignment. Cadets typically have the opportunity to participate in CSRP during the summer following their second-class year; however, in some cases cadets may participate on an unofficial basis in the summer following their third- or fourth-class years. Cadets interested in competing for a CSRP slot will coordinate directly with their department’s CSRP representative.

2-5.14. GRADUATE SCHOOL OPPORTUNITIES

Cadets may wish to attend graduate school or pursue careers in the biomedical, legal, or other professions after graduating from USAF Academy. Cadets may compete for the following programs:

- a. National Competitive Scholarship Program. Cadets may compete with students from other universities for scholarships and fellowships to study for advanced degrees in the United States and overseas. Among the major scholarships available to cadets are the following: Rhodes Scholarship, Marshall Scholarship, Gates Scholarship, Fulbright Scholarship, Fannie and John Hertz Foundation Fellowship, National Science Foundation Fellowship, John Stark Draper Fellowship at the Massachusetts Institute of Technology (MIT) and Rice University, Harvard University Scholarship at the John F. Kennedy School of Government, East-West Center Fellowship at the University of Hawaii, Program Research and Education in Space Technology (PREST) Fellowship at George Washington University,

University of Washington Engineering Fellowship, the University of Maryland Scholarship and the Pardee RAND Graduate School in Santa Monica, CA. Scholarship/Fellowship recipients will incur an active duty service commitment (ADSC). For additional scholarship opportunities, contact the Graduate Studies Programs Office (Room 1A84a, 719-333-4172).

- b. Graduate School Program (GSP). This program allows selected graduates of USAF Academy to attend a master's degree program immediately following graduation. GSP participants will incur an ADSC.

- (1) Number of slots available is determined by the Air Force Educational Resources Board (AFERB). The GSP slots will be used for departments to bring graduates back to teach. A number of slots are reserved for the Dean of the Faculty.

- (2) Candidates for this program must be willing to return to USAF Academy as academic instructors after gaining Air Force experience. Interested cadets should contact their Advisor-in-Charge or the GSP departmental representative to receive further details.

- c. Health Professions. Select cadets may be allowed to enter several health related professions after graduation.

- (1) Medicine. Cadets meeting USAF Academy's requirements may compete for scholarships to medical, dental, nursing, or physical therapy programs. USAF Academy can send up to 38 graduates per year to health profession degree and training programs. For medical training, graduates can attend any CONUS medical school, including the Uniformed Services University of the Health Sciences (Bethesda). Graduates attending medical schools are funded through the Health Profession Scholarship Program (HPSP). The HPSP pays for tuition, books and other required expenses, and provides a cost of living stipend. HPSP recipients incur additional commitments to the Air Force.

- (2) Health Profession Opportunities. Cadets interested in any health profession career field or healthcare-related opportunities should contact the Health Professions Advisor in the Department of Biology (DFBI). Medical schools do not accept AP or validation credits to fulfill the basic science course requirements. Cadets planning to attend medical or dental school must take one year each of inorganic chemistry, organic chemistry, physics and biology, with a laboratory component.

- d. Legal Training. USAF Academy graduates interested in attending law school may pursue such interest in the following ways:

- (1) USAF Academy Excess Leave Program (U-ELP). The Secretary of the Air Force may authorize annually that a graduate of USAF Academy be placed in unfunded excess leave as a student at an American Bar Association (ABA)-approved law school for a period not to exceed 36 months leading to a Juris Doctor and completion of legal licensing requirements necessary for service as an Air Force Judge Advocate. Eligibility is limited to USAF Academy cadets in their first-class year, in good

standing, who have either (a) a minimum 3.25 legal studies major GPA or (b) a minimum 3.5 majors GPA in another academic specialty accompanied by experience in the Cadet Mock Trial Program. The call for U-ELP applications occurs shortly after the start of the fall semester. Eligible first-class cadets must submit their application to the DFLA Department Head by 1 December of their first-class year at USAF Academy. Selection will be on a best-qualified basis, consistent with the needs of the Air Force. The selected applicant begins law school in the fall semester after graduation. Applicants are solely responsible for all application expenses, tuition, fees, associated educational expenses, bar review course fees, and bar examination fees. Applicants are authorized to accept tuition assistance such as scholarships and endowments.

- (2) **Funded Legal Education Program / Excess Leave Program (FLEP/ELP).** The Air Force sponsors two programs which allow officers on active duty to earn a law degree: the Funded Legal Education Program (FLEP) and the Excess Leave Program (ELP). The number of applicants accepted annually varies according to requirements for Judge Advocates, but in recent years it has been as many as eight and as few as one. Officers participating in FLEP receive their tuition, fees, and a book allowance from the Air Force while continuing to serve on active duty, thus also receiving full pay, allowances, and other benefits while attending law school. ELP allows active duty Air Force officers to attend law school using excess leave at the officers' own expense, and they do not receive pay or allowances while going to school; however, participants continue to accrue time for promotion and retirement purposes and remain eligible for other active duty benefits such as base exchange, commissary, and medical services. Officers who attend law school under either program practice law in the Air Force as a member of the Judge Advocate General's Corps upon graduation from law school and admission to any state bar. Officers are eligible to apply for FLEP between their second and sixth year of active duty and are eligible to apply for ELP between their second and tenth year. Applications must be submitted online by 10 January of the calendar year in which the applicant intends to enter law school.
- (3) Officers who complete these programs are normally designated as Judge Advocates and serve in various legal positions in the Air Force. For more information about these programs, contact the Law School Advisor (719-333-3680).

2-5.15. SCHOLARSHIP PREPARATION

Suggested courses for scholarship preparation are listed below. Cadets who are considering applying for scholarships or fellowships are encouraged to take the GRE during the spring semester of their second-class year. Cadets desiring additional graduate education information should contact the Graduate Studies Programs Office (719-333-4172).

a. **Suggested Courses for Non-technical Scholarship Preparation:**

- (1) **Core Courses:** Schedule before or during fall of first-class year.
- | | |
|--------------|---------------------------------|
| English 200S | Introduction to the Humanities |
| English 411 | War Stories |
| Philos 210 | Ethics |
| English 400S | Literature and the Fine Arts II |

(2) Electives (Strongly Recommended): Cadets should schedule for fall of first-class year to retain flexibility, should they decide not to compete for scholarships.

Engineering/Humanities/Social Science 400

Econ 374 Survey of International Economics Issues

English 303 Classical Literature

History 333 History of Military Thought and Strategy

History 340 America and the World

History 341 American Regional Identities

History 402 Global Dimensions of History: Capstone for FAS History

Majors

Hum 430 The Holocaust

Philos 391/2/3/4 Philosophy Option

Pol Sci 301 Political Theory

Pol Sci 302 Politics of National Security

Pol Sci 491 Capstone Seminar in Political Science: National Security and Political Analysis

(3) Electives (Good Preparation): Second-class year or fall of first-class year.

Beh Sci 352 Social Psychology

Beh Sci 360 Sociology

Econ 351 Comparative Economic Systems

Econ 473 Public Economics

Econ 480 Defense Economics

Creative Art 335 Music Seminar

History 321 STEM at War: History of Technology and Warfare

History 345 The American Way of War

History 346 Great Americans

Law 351 U.S. Constitutional Law

Law 363 International Law

Philos 391/2/3/4 Philosophy Option

Philos 401 Comparative Religion

Philos 402 Philosophy of Religion

Philos 495 Special Topics in Philosophy

Pol Sci 451 American Political Thought

Pol Sci 460 Civil-Military Relations

Pol Sci 495 Special Topics in Political Science

Soc Sci 483 Principles of Negotiation

b. Suggested Courses for Technical Scholarship Preparation:

Math 342 Numerical Analysis

Math 360 Linear Algebra

Math 469 Partial Differential Equations

Math 470 Mathematical Physics

Physics 355 Classical Mechanics

c. Suggested Courses for Non-Engineering Majors Pursuing Engineering School: The following technical/engineering courses should be included in a non-engineering major's course sequence if the cadet has aspirations to pursue an engineering degree in graduate school:

Math 243/253 Calculus III
Math 245 Differential Equations
Additional mathematics courses, when possible

2-5.16. BASIC METEOROLOGY PROGRAM (BMP)

The BMP is an opportunity for newly accessed officers from any commissioning source (USAF Academy, OTS, and AFROTC), to pursue a post-baccalaureate program in meteorology, with follow-on inclusion into the Weather and Environmental Sciences Officer (WESO) career field (15W). The BMP, managed by the Air Force Institute of Technology (AFIT), is a challenging non-degree program that averages 10-11 months in length.

a. It consists of:

- (1) Minimum of 24 semester hours of junior/senior level (possibly some graduate) courses in meteorology, with three semesters of course work in meteorology being the norm (on the order of 36-42 semester credit hours over summer, fall, spring)
- (2) Collateral study in mathematics, physics, and computer science may be required
- (3) BMP does not count against an individual's total 54-month allotment of AFIT graduate education time
- (4) A 3-year ADSC is incurred, served concurrent with any existing ADSC.
- (5) In certain cases, a BS in Meteorology may be attainable, assuming university prerequisites and/or requirements are fulfilled either prior to or as part of the BMP program

b. BMP candidates must be commissioned prior to program entry and possess a bachelor's degree in a technical field such as math or physics. Other degrees may be accepted depending on the applicant's math and physics coursework background. Eligibility requirements are determined by AFIT/CIGW. The current standards are as follows:

- (1) Typically a 2.8 minimum GPA required, both overall and within a student's major discipline
- (2) Minimum prerequisites include one year of calculus-based physics and one year of calculus through integral calculus (generally Calc I, II, III sequence) with minimum grades of "C" in each prerequisite course
- (3) A course in Differential Equations is also strongly recommended prior to program entry or else it will need to be taken as part of the BMP
- (4) Exceptions may be possible on a case-by-case basis, approved by AFIT/CIGW

c. Interested cadets should consult with the USAF Academy/DFPM Meteorology AIC to inquire about the BMP, the WESO career field, or to enroll in potentially helpful USAF Academy Meteorology courses (e.g., Advanced Core or Major's Options) in preparation for BMP.

SECTION 2-6 THE CORE

2-6.1. INTEGRATED CORE

Why do we have a large, integrated Core at the USAF Academy?

The Core is one of the distinctive elements that make a USAF Academy education particularly valuable to the Air and Space Forces and the Nation. The Core is purposefully and developmentally designed to build proficiencies in nine outcomes to prepare cadets for future service as commissioned officers. Components of the Core are taught by faculty and staff members within the Dean of the Faculty, the Commandant of Cadets, the Athletic Department, and the 306th Flying Training Group.

Over the years, our Core has changed to meet the needs of an evolving world. The Core builds on the best traditions of USAF Academy, takes advantage of current thinking in education and information technology, and keeps a keen eye on the future needs of a 21st century military serving in an increasingly complex global environment. The Core is infused with the ideals of a liberal education yet grounded in the needs of a modern military through a blend of education, training, and experience.¹

Because of the unique role the Core plays in developing officers of character for the U.S. Air and Space Forces, the Core is more extensive and more integrated across the institution than is commonly found at other universities and colleges. In fact, our Core is two to three times larger than the general education requirements found at typical colleges. Our Core depends on purposeful integration across athletics, academics, military training, and airmanship programs, and facilitates the uniquely immersive experience found at USAF Academy. The Core is truly a one-of-a-kind experience that prepares Cadets to serve in the greatest Air and Space Forces in the world.

2-6.2. FOUNDATIONAL PRINCIPLES

The Core is guided by foundational principles that ensure that it meets the highest ideals of a liberal education while providing the best preparation for a lifetime of service to the Nation. This balance of attaining a broad education while immersed in the history, traditions, and professional values of military service² is the unique and critical contribution of USAF Academy to the officer corps. The Core directly supports Air and Space Force commissioning requirements while providing the educational depth and breadth of a world-class Bachelor of Science degree. No other commissioning source can create the collaborative

The Core

The Core “is rooted in the best traditions of the past, taught in the context of the present, and continually reexamined in the light of the future needs of the Air Force.”
- Lt Gen James E. Briggs, USAF
ACADEMY 2nd Superintendent

Liberal Education

Liberal education is an “approach to learning that empowers individuals and prepares them to deal with complexity, **diversity** and change. It provides students with broad knowledge of the wider world (e.g. science, culture and society) as well as in-depth study in a specific area of interest.”
- American Association of Colleges and Universities

¹ Air Force Doctrine, Annex 1-1, *Force Development*, 15 Dec 2014, identifies education, training, and experience as the components of the Continuum of Learning (CoL). The CoL focuses on developing Airmen who thoroughly understand the mission, the organization, and Air Force Doctrine.

² DODD 1322.22, *Service Academies*, 24 Sep 2015

blending of ever-present military training, rigorous academics, and competitive athletics that defines the communal experience of every graduate of USAF Academy. While the size and content of the Core has changed over the years, this basic principle of a balanced, immersive USAF Academy experience remains constant. The depth and breadth found at USAF Academy provides “a core group of innovative leaders capable of thinking critically who will exert positive peer influences to convey and sustain the traditions, attitudes, values, and beliefs essential to the long-term readiness and success” of the Air and Space Forces.³

USAF Academy Foundational Core Principles

To achieve our Institutional Outcomes, we are committed to providing:

- A broad liberal education that imbues in cadets the knowledge, skills, and habits of mind necessary for service as exemplary officers and citizens; a curriculum fostering guided self-discovery and collaboration, the spirit of free inquiry, and the open exchange of ideas;
- A Core that calls for cadets to study and experience chosen subjects in depth, as creative, independent thinkers comfortable with uncertainty, paradox, and complexity; and
- A Core that prepares and inspires graduates to continue learning and serving throughout their lives.

This Core should ultimately deepen cadet understanding of what it means to serve as an American military officer dedicated to the profession of arms and ready for the responsibilities of command.

2-6.3. USAF ACADEMY OUTCOMES

Future Air and Space Force leaders must demonstrate a sophisticated combination of qualities that define the character of members of a modern profession of arms. At USAF Academy, we operationally define these professional characteristics in nine USAF Academy Outcomes. Every faculty and staff member serving at USAF Academy – regardless of their specific role – plays an important part in building Air and Space Force leaders of character by developing the proficiencies articulated in the following nine outcomes.

³ DODD 1322.22, *Service Academies*, 24 Sep 2015

USAF Academy Outcome Statement

USAF Academy develops a diverse group of professional Air and Space Force officers who think critically, lead with character, and serve the nation. These developmental goals are achieved by the USAF ACADEMY Course of Instruction, which is designed to accomplish nine institutional outcomes.

The USAF Academy Outcomes reflect the two complementary roles USAF Academy plays within the American military landscape: developing commissioned officers and providing a world-class college education. The higher education community has informed our Core with the best ideals of a liberal education that provide Cadets with a sophisticated understanding of the knowledge and thinking skills needed in our complex, 21st century world. Simultaneously, the Air and Space Forces have provided us with a sense of unity and mission not often shared by institutions of higher learning. Therefore, USAF Academy Outcomes reflect the joint contribution of both the Air and Space Forces and the higher education community as described in the Air Force's Commissioning Sources' Institutional Competency Learning Outcomes⁴ as well as the Association of American College and Universities' (AAC&U) *Essential Learning Outcomes*.⁵ The combination of these two cultures provides USAF Academy with a synergistic focus that is richer and more informed than either community provides on its own. The Outcome white papers are included in Appendix 1.

1. Critical Thinking – to apply self-aware, informed, and reflective reasoning for problem solving and decision making in the absence of ideal information.
2. Clear Communication – to express ideas in written or oral formats with the intent to enhance knowledge, foster understanding, or stimulate new thinking.
3. Application of Engineering Problem-Solving Methods – to understand the opportunities, requirements, and constraints imposed by the scientific and mathematical workings of the universe, supported by knowledge of the current and projected state of technology.
4. Scientific Reasoning and the Principles of Science – to apply scientific habits of mind, including proficiency in the nature of science, scientific reasoning, and the principles of science.
5. The Human Condition, Cultures, and Societies – to comprehend what it means to be human, the individual situated in a culture and society, and the interactions of people from different socio-cultural milieus.
6. Leadership, Teamwork, and Organizational Management – to apply character-based leadership principles at the personal, interpersonal, team, and organizational levels.
7. Ethics and Respect for Human Dignity – to recognize ethical alternatives among the options available, use ethical judgment to select the best alternative, and act consistently to respect the dignity of all affected persons.
8. National Security of the American Republic in a Complex Global Environment – to possess the knowledge necessary to protect the fundamental values and core interests of the United States and recognize the broader political context in which military force must be employed.
9. Warrior Ethos as Airmen and Guardians – to persevere despite physical and mental hardships, embrace the oath of office and the profession of arms, adopt the core values, and value all Airmen.

2-6.4. COURSES AND PROGRAMS

The USAF Academy Core consists of 29 Dean of Faculty academic courses (93 semester hours), 10 Athletic Department Physical Education courses (5 semester hours), and a large number of Commandant of Cadets and 306th Flying Training Group courses and programs. In addition to the

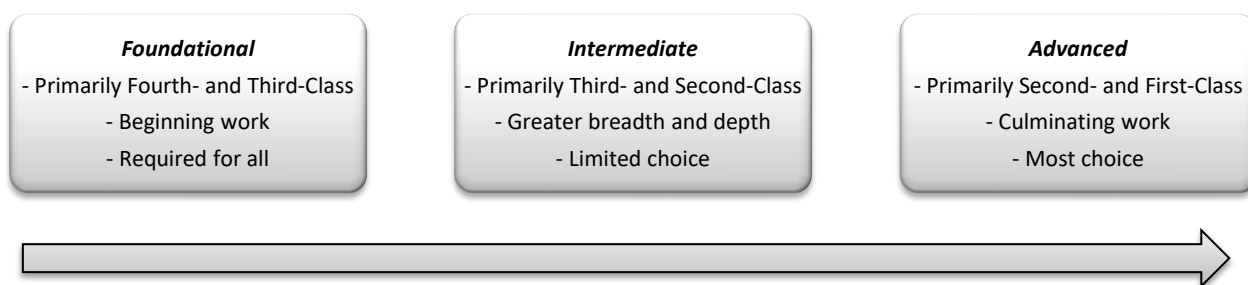
⁴ AFI 36-2014, *Commissioning Education Programs*, 14 Jul 2019

⁵ *College Learning for the New Global Century*, 2007

Academic Core, all Cadets take one of two academic programs described in Section 2-7. These programs include the Academic Majors (36 – 50 semester hours beyond the Core) and the Bachelor of Science Program (30 semester hours beyond the Core). Both options are fully described in Sections 2-8 – 2-9.

2-6.5. LEVELS OF THE CORE

The Core is designed to support USAF Academy Outcomes through a developmental sequencing of courses, programs, and training at foundational, intermediate, and advanced levels. Transitions between the levels represent a continuum rather than clearly defined stages.



What do we mean by foundational?

These courses are typically taken by fourth- and third-class cadets. These courses and programs serve as both an introduction to college level work and as an introduction to the history, traditions, and professional values of military service. Foundational Core experiences provide cadets with introductory courses and programs important to the more advanced Core as well as to their future service as Air and Space Force officers. Examples of these experiences include Basic Cadet Training, introductory academic and physical education courses, and an introduction to airmanship. After completing the Foundational Core, cadets have an introductory proficiency in all nine USAF Academy Outcomes.

Choice at the Foundational Level of the Core: All cadets take identical education, training, and experiences at the foundational level unless they have transfer or validation credit (for details on transfer/validation credit, go to the “Core Administration” section at the end of this chapter).

What do we mean by Intermediate?

These courses are typically taken by third- and second-class cadets. The Intermediate Core builds on education, training, and experiences found in the Foundational Core as cadets explore both depth and breadth activities in each of the nine USAF Academy Outcomes. In some cases, these courses and programs add depth to Cadet thinking by building on previous knowledge from courses in the same disciplines found in the Foundational level. Examples are second courses in math, physics, and chemistry or follow-on airmanship programs. In other cases, these courses and programs explore breadth in thinking through new courses in a related discipline not previously studied. An example of this is the three course breadth sequence in Air (Aeronautical Engineering), Space (Astronautical Engineering), and Cyberspace (Electrical and Computer Engineering) found at the Intermediate level in the Principles of Engineering Outcome. After completing the Intermediate Core, cadets have developed breadth and depth in the proficiencies in all nine USAF Academy Outcomes.

Choice at the Intermediate Level of the Core: At the Intermediate level, cadets have some choice in the Core. The choice is limited to provide some ability for cadets to tailor their experiences to personal and professional goals without compromising their ability to complete their graduation requirements in four years. This choice is primarily within and not across individual Outcomes and the choices may be constrained by a Cadet's chosen major. Cadets should refer to the Major's requirements listed in Section 2-8 or meet with their AAOCA or Academic Advisor before selecting their Intermediate option courses in order to create a program that meets their interests while ensuring all program and graduation requirements are met in time for graduation. The following are the choices available at the Intermediate level:

- In the Critical Thinking Outcome, all cadets are required to take a course in statistical reasoning. However, this requirement can be filled by taking Math 300, Introduction to Statistics; Math 356, Probability and Statistics for Scientists and Engineers; Math 377, Advanced Probability and Statistics; or the two-course Behavioral Sciences Methods and Statistics sequence of Beh Sci 231, Basic Research Methods and Statistical Tools, and Beh Sci 332, Advanced Research Methods and Statistical Tools.
- In the Scientific Reasoning and the Principles of Science Outcome, all cadets are required to take two Intermediate courses chosen from three available options. Cadets will pick two of the following three courses: Physics 215, General Physics II with Laboratory; Chem 200, General Chemistry II Lecture and Lab; or Biology 215, Introductory Biology with Laboratory.
- In the Warrior Ethos as Airmen and Guardians Outcome and the Leadership, Teamwork, and Organizational Management Outcome, all cadets are required to take four Physical Education courses in team and individual sports. Cadets may choose from the following sports to fulfill this requirement.
 - Team Sports Elective
 - Phy Ed 484 Volleyball
 - Phy Ed 486 Basketball
 - Phy Ed 487 Soccer
 - Phy Ed 488 Softball
 - Individual Sports Elective
 - Phy Ed 340 Racquetball
 - Phy Ed 341 Tennis
 - Phy Ed 342 Golf
 - Phy Ed 343 Indoor Rock Climbing
 - Phy Ed 344 Yoga
 - Phy Ed 345 Advanced Physical Development
 - Phy Ed 346 Pickleball
 - Open Electives 1 and 2
 - Any of the electives above not already taken
 - Phy Ed 347 Self-Protection
 - Phy Ed 348 Marksmanship
 - Phy Ed 477* Independent Exercise (first- or second-class cadets only)
 - Phy Ed 479* Cadet Instructor (first- or second-class cadets only)

* Cadets are registered for these courses by the Athletic Department Scheduling and Grading Division (ADPEG), IAW ADOI 36-3504.

What do we mean by Advanced?

These courses are typically taken by second- and first-class cadets. The Advanced Core represents the most depth and the most choice in the Core. Cadets take Advanced courses and programs in some, but not all, of the nine USAF Academy Outcomes. Cadets develop specific proficiencies in the Clear Communication and Critical Thinking Outcomes within their chosen major. Other programs such as the National Character and Leadership Symposium and Cadet Leadership requirements provide chances to dig deeply into the proficiencies described in the USAF Academy Outcomes. The Advanced Core represents the culmination of a Cadet's journey and provides the capstone experiences that complete each Cadet's preparation as new Second Lieutenants in the United States Air Force.

Choice at the Advanced Level of the Core: In the Advanced Core, cadets have the most choice. This provides a breadth of experience across the graduating class while providing individual students the ability to choose areas to explore with greater depth and effort. Advanced choice is available to cadets in both the Academic and Military/Airmanship Core.

Academic Advanced Core Choices: In the Advanced Academic Core, cadets have three choices. Some majors may require specific courses in order to meet graduation requirements for that major. Other majors may allow more freedom in choices. Cadets should refer to the Major's requirements listed in Section 2-8 or meet with their AAOCA or Academic Advisor before selecting their advanced option courses in order to create a program that meets their interests while ensuring all program and graduation requirements are met in time for graduation.

- **Choice #1:** Advanced Science, Technology, Engineering, and Math (STEM) Choice – Pick one of the courses below which support one of the following Outcomes: 1) Application of Engineering Problem-Solving Methods, or 2) Scientific Reasoning and the Principles of Science:
 - Biology 345 Aerospace Physiology
 - Biology 370 Human Nutrition
 - Chem 222 Analytical Chemistry
 - Chem 350 Chemistry of Weapons
 - Civ Engr 356 Introduction to Sustainability
 - Comp Sci 210 Programming Fundamentals
 - Geo 351 Physical Geography
 - Math 243/253 Calculus III
 - Math 245 Differential Equations
 - Meteor 320 Introduction to Meteorology and Aviation Weather
 - Ops Rsch 310 Systems Analysis
 - Physics 310 Principles of Nuclear Science
 - Physics 371 Astronomy
 - Sys Engr 310 Introduction to Systems Engineering
- **Choice #2:** Advanced Sociocultural Choice – Pick one of the courses below which support one of the following outcomes: 1) The Human Condition, Cultures, and Societies, 2) Leadership, Teamwork, and Organizational Management, 3) Ethics and Respect for Human Dignity, 4) National Security of the American Republic, or 5) Warrior Ethos as Airmen and Guardians:

- | | |
|---------------|---|
| ○ Beh Sci 360 | Sociology |
| ○ English 411 | War Stories |
| ○ Geo 412 | World Cultural Geography |
| ○ History 345 | The American Way of War |
| ○ Mgt 400 | Leading Innovation |
| ○ MSS 444 | Space & Cyber Strategy for National Security |
| ○ Philos 401 | Comparative Religion |
| ○ Pol Sci 302 | American Foreign and National Security Policy |
| ○ Soc Sci 483 | Principles of Negotiation |

- **Choice #3:** Advanced Open Choice – Choose any course from either choice #1 or choice #2. Cadets who have Health Professions Advisory Committee (HPAC) approval (usually during the Spring of 2-degree year) to apply for a health professions program may submit a waiver to count the third P/C/B Option as the Advanced Open Choice.

Military and Airmanship Advanced Core Choices: In the Leadership, Teamwork, and Organizational Management Outcome, cadets are required to complete a minimum of two Leadership Practicums in their second- or first-class year from the list below. Cadets choose from the following options to demonstrate and practice advanced leadership, teamwork, and organizational management abilities. At least one of these credits must be accomplished in a military program under the Commandant of Cadets (in bold in the list below).

- **Any commander selected from the Command Selection Board**
- **BCT Cadre, CST Cadre, Summer Ops Group Cadre and Staff**
- **CE-FERL Leadership, AETC Leadership Ops, Prep School BMT Cadre**
- Soaring Instructor, Parachuting Instructor, RPA Instructor, Cyber Instructor, or Space Instructor
- Intercollegiate or Competitive Club Sport Team Captain

2-6.6. OUTCOME COURSES AND PROGRAMS

The following pages describe the Core courses and programs that developmentally align with each of the nine USAF Academy Outcomes. Each Outcome is guided by an Outcome Team comprised of faculty and staff from the courses and programs listed for that Outcome. In addition, each team normally includes at least one member not in one of the aligned courses and programs, and at least one Cadet. All courses and programs listed in this Handbook contribute to one or more of our USAF Academy Outcomes. However, the courses and programs listed in the Outcome descriptions on the following pages are committed to a more intensive role in that Outcome. These courses and programs are committed to defining the proficiencies of that Outcome; aligning education, training, and experiences with the proficiencies; and leading Outcome assessment efforts.⁶

⁶ This process and a full description of Outcome Team membership is found in USAFI 36-3502, *Institutional Effectiveness*

Critical Thinking Outcome - to apply self-aware, informed, and reflective reasoning for problem-solving and decision-making in the absence of ideal information.

General Proficiencies⁷

- Self-aware reasoning – understand how biases, assumptions, and perspectives influence problem-solving and how others might approach the same problem.
- Informed reasoning – seek out the best information, separate relevant from irrelevant information, and identify additional information that may be needed to solve a problem.
- Reflective reasoning – evaluate how strongly information supports an idea and provide alternative interpretations for information or observations.
- Problem-solving and decision-making – identify problems; use a systematic process to problem solve, identify alternatives; and select an appropriate solution.
- Military profession – apply these tools to military problems taking into account system constraints (e.g., time) and incomplete or uncertain information.

Departments and Programs Represented on the Outcome Team: Behavioral Sciences and Leadership (DFBL), Economics and Geosciences (DFEG), Law (DFLA), Mathematical Science (DFMS), Majors Program Representatives (one from each Academic Division)

Aligned Courses and Programs

- Foundational
 - Econ 201
- Intermediate
 - Law 220
 - Math 300, Math 356, Math 377, or the two course Beh Sci 231 and 332 sequence
- Advanced
 - Major's Courses

⁷ For a detailed list of proficiencies and Commissioning Education requirements related to Critical Thinking, see Appendix 1.

Clear Communication Outcome - to express ideas in written or oral formats with the intent to enhance knowledge, foster understanding, or stimulate new thinking.

General Proficiencies⁸

- Analyze the communication situation.
- Build content/tell compelling stories.
- Employ professional conventions for language, syntax, and mechanics.
- Engage in revision and clarification processes.

Departments and Programs Represented on the Outcome Team: Center for Character and Leadership Development (CCLD), Cadet Wing (CW), at least one representative from each division across the Dean of Faculty (DF)

Aligned Courses and Programs

- Foundational
 - English 111
 - Beh Sci 110
 - CE 100
- Intermediate
 - English 211/212
- Advanced
 - Major's Courses

⁸ For a detailed list of proficiencies and Commissioning Education requirements related to Clear Communication, see Appendix 1.

Application of Engineering Problem-Solving Methods - to demonstrate knowledge of the current and projected state of technology; to understand opportunities, requirements, and constraints imposed by the physical workings of the universe; to demonstrate knowledge of the current and projected state of technology; and to use engineering problem-solving methods to create, evaluate, and iteratively optimize solutions to ill-defined problems.

General Proficiencies⁹

- Fundamental Domain Knowledge (i.e., knowledge of basic engineering principles across a variety of physical domains relevant to Air Force missions in air, space, and cyberspace, and the infrastructure within which they operate).
- Problem Solving Process (i.e., using a top-down, systematic problem solving method, shown via italicized steps, to address the kind of ill-defined problems they will encounter across domains in their USAF careers).

Departments and Programs Represented on the Outcome Team: Aeronautical Engineering (DFAN), Astronautical Engineering (DFAS), Civil and Environmental Engineering (DFCE), Computer and Cyber Sciences (DFCS), Electrical and Computer Engineering (DFEC), Mechanical Engineering (DFME), Operations Research, Systems Engineering

Aligned Courses and Programs

- Foundational
 - Comp Sci 110
 - Mech Engr 220
- Intermediate
 - Astr Engr 310
 - Aero Engr 315
 - ECE 315
- Advanced Choices
 - Comp Sci 210
 - Ops Rsch 310
 - Civ Engr 356
 - Sys Engr 310

⁹ For a detailed list of proficiencies and Commissioning Education requirements related to The Application of Engineering Problem-Solving Methods, see Appendix 1.

Scientific Reasoning and the Principles of Science Outcome - to apply scientific habits of mind, including proficiency in the nature of science, scientific reasoning, and the principles of science.

General Proficiencies¹⁰

- Nature of Science - Determine if explanations, claims, or statements are consistent with the Nature of Science and explain how a scientific explanation can simultaneously be broadly accepted as reliable yet provisional.
- Scientific Reasoning - Use if-then reasoning to generate a scientifically testable expectation; describe the effects of data collection methods on the reliability of results; use mathematics and appropriate technology to describe and represent data (e.g., symbolically, visually, or numerically); and systematically interpret results to draw valid conclusions.
- Principles of Science - Identify, explain, and discuss the role of foundational science principles in real world applications and apply foundational principles of science and mathematics to predict or explain natural phenomenon.

Departments and Programs Represented on the Outcome Team: Biology (DFBI), Chemistry (DFCH), Mathematical Science (DFMS), Physics and Meteorology (DFPM)

Aligned Courses and Programs

- Foundational
 - Chem 100
 - Physics 110
 - Math 141
- Intermediate
 - Math 142/152
 - Intermediate Choices – pick two of the following three courses:
 - Chem 200
 - Physics 215
 - Biology 215
- Advanced Choices
 - Biology 345
 - Biology 370
 - Chem 222
 - Chem 350
 - Geo 351
 - Math 243/253
 - Math 245
 - Meteor 320
 - Physics 310
 - Physics 371

¹⁰ For a detailed list of proficiencies and Commissioning Education requirements related to Scientific Reasoning and the Principles of Science, see Appendix 1.

Ethics and Respect for Human Dignity Outcome- to recognize ethical alternatives among the options available, use ethical judgment to select the best alternative, and act consistently to respect the dignity of all affected persons.

General Proficiencies¹¹

- Employ and defend the existence of moral knowledge in making moral judgments by recognizing theoretical approaches, relevant social science facts and theories, the effect of one's own perspective, and the ethical and legal foundations of the USAF mission.
- Respect the dignity of others by acquiring the behaviors and attitudes of professionalism and equity, demonstrate the ability to interact with others in a mature way, consider another person's basic rights, understand the perspectives of others and practice fair and equitable treatment.
- Act in accord with procedures that reflect sound moral judgment by integrating ethical theory, psychological and sociological facts, and principles of the profession of arms as part of deliberation and decision-making and recognize the place of their actions in a context that includes social and political systems.
- Cultivate habits of moral excellence including the virtues of integrity first, service before self, and excellence in all we do.

Departments and Programs Represented on the Outcome Team: Cadet Wing (CW), Center for Character and Leadership Development (CCLD), Behavioral Sciences and Leadership (DFBL), Philosophy (DFPY)

Aligned Courses and Programs

- Foundational
 - Mil Tng 100
 - Beh Sci 110
- Intermediate
 - Philos 210
 - Human Relations (Sexual Assault Prevention, Diversity, Religious Respect, etc.)
- Advanced
 - Required
 - National Character and Leadership Symposium
 - Academic Option
 - Philos 401

¹¹ For a detailed list of proficiencies and Commissioning Education requirements related to Ethics and Respect for Human Dignity, see Appendix 1.

The Human Condition, Cultures, and Societies Outcome - to comprehend what it means to be human, the individual situated in a culture and society, and the interactions of people from different socio-cultural milieus.

General Proficiencies¹²

- Articulate one's own identity as a human being, citizen in a republic, and officer-statesman in the United States Air Force.
- Articulate the identity of other human beings in diverse cultural and social milieus.
- Engage constructively with different human beings, cultures and societies, domestically and internationally.
- Recognize and respond prudentially in and to various cultural and social scenarios, settings, and situations, whether in the classroom or in the field.

Departments and Programs Represented on the Outcome Team: Center for Character and Leadership Development (CCLD), Languages and Cultures (DFLC), History (DFHI)

Aligned Courses and Programs

- Foundational
 - For Lang 131
- Intermediate
 - History 300
 - For Lang 132
- Advanced
 - Required
 - National Character and Leadership Symposium
 - Academic Option
 - Beh Sci 360/S
 - English 411
 - Geo 412

¹² For a detailed list of proficiencies and Commissioning Education requirements related to The Human Condition, Cultures, and Societies, see Section 2-11.

National Security of the American Republic in a Complex Global Environment

Outcome - to possess the knowledge necessary to protect the fundamental values and core interests of the United States and recognize the broader political context in which military force must be employed.

General Proficiencies¹³

- Explain the constitutional foundations of the American political and legal system.
- Explain the changing nature of the international environment in which our fundamental values and core interests are shaped, reinforced, or threatened.
- Identify and explain the historical and contemporary nature of U.S. national security strategy (i.e., how the U.S. aligns resources to protect its fundamental values and core interests).
- Explain the implications of contemporary U.S. national security strategy for joint and Air Force strategy, technology, doctrine, policy, force structure, and operational employment, especially with respect to the domains of air, space, and cyberspace.

Departments and Programs Represented on the Outcome Team: Cadet Wing (CW), Center for Character and Leadership Development (CCLD), Economics and Geosciences (DFEG), History (DFHI), Military and Strategic Studies (DFMI), Political Sciences (DFPS), Social Sciences and Humanities Division Representatives

Aligned Courses and Programs

- Foundational
 - Pol Sci 211
 - MSS 251
- Intermediate
 - Econ 201
 - Soc Sci 311
 - Mil Tng 201/300/301/351
- Advanced
 - Required
 - National Character and Leadership Symposium
 - Academic Options
 - History 345
 - MSS 444
 - Pol Sci 302

¹³ For a detailed list of proficiencies and Commissioning Education requirements related to National Security in the American Republic, see Appendix 1.

Warrior Ethos as Airmen and Guardians Outcome - to persevere despite physical and mental hardships, embrace the oath of office and the profession of arms, adopt the core values, and value all Airmen and Guardians.

General Proficiencies¹⁴

- Accurately describe warrior ethos for self and others. Comprehend the meaning of the profession of arms and oath of office, accept the AF core values, and recognize how all Airmen contribute to the mission.
- Exhibit grit – a hardiness of spirit and resistance to accept failure despite physical and mental hardships. Fight through all conditions to victory, no matter how much time or effort is required.
- Demonstrate courage – the moral, physical, and mental ability to act and do the right thing in the face of adversity; intrinsic ability to put the mission and others before self, even in the face of personal risk or failure.
- Develop disciplined, orderly, or prescribed conduct that conforms to professional AF standards.

Departments and Programs Represented on the Outcome Team: Athletic Department (AD), Cadet Wing (CW), Center for Character and Leadership Development (CCLD), History (DFHI), Military and Strategic Studies (DFMI), 306th Flying Training Group (306 FTG).

Aligned Courses and Programs

- Foundational
 - History 100
 - Phy Ed 100
 - Phy Ed 110
 - Phy Ed 111 (or 119)
 - Phy Ed 112 (or 113)
 - Phy Ed 215
 - Phy Ed 222 (or 211, 219)
 - Phy Ed 315
- Intermediate
 - Mil Tng 270
 - MSS 251
 - Phy Ed Individual Sport Elective #1
 - Phy Ed Open Electives
- Advanced
 - National Character and Leadership Symposium
- Intercollegiate Courses (cadets may substitute Phy Ed course credit for each year on an intercollegiate roster as follows):
 - Phy Ed 152 4th-Class Intercollegiate Sports (sub for Phy Ed 112)
 - Phy Ed 252 3rd-Class Intercollegiate Sports (sub for Individual Sport Elective)

¹⁴ For a detailed list of proficiencies and Commissioning Education requirements related to Warrior Ethos as Airmen and Guardians, see Appendix 1.

Leadership, Teamwork, and Organizational Management Outcome - to apply character-based leadership principles at the personal, interpersonal, team, and organizational levels.

General Proficiencies¹⁵

- Develop the Foundations of Character & Leadership within the Major Performance Areas
 Executing the Mission – Demonstrate effective planning and use of systems and processes to manage resources and align individuals toward organizational goals in complex environments.
 Leading People – Exhibit sound decision-making while appreciating and motivating others with respect and empathy.
 Managing Resources – Develop and implement valid performance measures to manage resources to provide accountability and fairly respond to affect mission accomplishment
 Improving the Unit – Understanding that organizations are complex systems, demonstrate unit improvement by using and creating tools to influence and develop others and facilitate responsible innovation.

Departments and Programs Represented on the Outcome Team: Athletic Department (AD), Cadet Wing (CW), Center for Character and Leadership Development (CCLD), Department of Behavioral Sciences and Leadership (DFBL), Department of Management (DFMA), 306th Flying Training Group (306 FTG)

Aligned Courses and Programs¹⁶

- Foundational
 - Ldrshp 100
 - Ldrshp 200
- Intermediate
 - Ldrshp 300
 - Ldrshp 400
 - Phy Ed Team Sport Elective #1
- Advanced
 - Required
 - National Character and Leadership Symposium
 - Academic Options
 - Mgt 400
 - Soc Sci 483
 - Leadership Credit Options - In the Leadership, Teamwork, and Organizational Management Outcome, cadets are required to complete a minimum of two Leadership Practicums during their second- or first-class year from the list below. Cadets choose from the following options to demonstrate and practice advanced leadership, teamwork, and organizational management abilities. At least one of these credits must be accomplished in a military program under the Commandant of Cadets (in bold in the list below).
 - **Any commander selected from the Command Selection Board**
 - **BCT Cadre, CST Cadre, Summer Ops Group Cadre and Staff**
 - **CE-FERL Leadership, AETC Leadership Ops, Prep School BMT Cadre**

¹⁵ For a detailed list of proficiencies and Commissioning Education requirements related to Leadership, Teamwork, and Organizational Management, see Appendix 1.

¹⁶ This outcome is served by an integrated academic and military training program taken over four years and aligned with the PITO (Personal, Interpersonal, Team, and Organizational) Model in the USAF ACADEMY Officer Development System (USAF ACADEMY PAM 36-3527).

- Soaring Instructor, Parachuting Instructor, UAS Instructor, Cyber Instructor, or Space Instructor
 - Intercollegiate or Competitive Club Sport Team Captain
- Intercollegiate Courses (cadets may substitute Phy Ed course credit for each year on an intercollegiate roster as follows):
 - Phy Ed 352 – Second-Class Intercollegiate Sports (sub for Team Sport Elective)
 - Phy Ed 452 – First-Class Intercollegiate Sports (sub for Open Elective)

Core Administration

Course Sequence and Flexibility in the Core

Core courses are numbered for the year in which the course is typically taken (e.g., 100-level for fourth-class cadets, 400-level for first-class cadets). The course number will therefore reflect the developmental level of the course, not necessarily the nature of the course content or the course's alignment with the developmental level of an Outcome. Core courses should be taken in their intended class year and follow the developmental sequence prescribed by the Outcome description as much as possible. Majors' sequencing should be designed to facilitate this, subject to required programmatic constraints. The flexibility in the Core should come from the majors' sequencing rather than from Core sequencing. Accommodations for specific Cadet needs can be made with the approval of the respective Department Head(s) and the Associate Dean for Student Academic Affairs.

Transfer/Validation Credit

Cadets who attended another college or university or who validate courses may earn validation or transfer credit that is included in the total semester hour count. If a cadet leaves USAF Academy prior to Lesson 9 of their first semester, transfer/validation credit will not appear on their USAF Academy transcript.

- a. A cadet who is readmitted following disenrollment or resignation may be given transfer or validation credit for courses taken while away from USAF Academy. If the transfer or validation credit for courses is for a course previously taken and failed at USAF Academy and subsequently repeated at another college or university, the transfer/validation credit should fill the course requirement on the grad check and the 'F' grade will be listed under "Other Courses Taken" for active cadets; the 'F' grade continues to count in the cumulative GPA.
- b. Credit (grades and corresponding quality points) will be accepted for courses completed with a proficient grade at USAF Academy by USAF Academy Preparatory School cadets upon entering USAF Academy. If a Cadet Candidate from the USAF Academy Preparatory School is receiving a deficient grade, the Cadet Candidate will be withdrawn from the course.
- c. Physical Education (Phy Ed) courses can be transferred from other universities, particularly for cadets on semester exchange to foreign military academies and sister service academies. Regardless of the total number of Phy Ed courses transferred, a minimum of eight USAF Academy Phy Ed courses must be taken in residence and counted toward graduation requirements.
- d. Incoming cadets who score well on placement exams, receive acceptable scores on AP and/or IB exams, or who have previously received college credit for certain core and upper level classes may receive validation or transfer credit for those classes.

- a. Placement Exams are completed by incoming cadets prior to or during Basic Cadet Training and determine the core Math and Foreign Language classes in which they are placed during their fourth-class year. Cadets placing into advanced courses (e.g. Math 152, Spanish 221) will receive validation credit for the preceding classes (e.g. Math 141, Spanish 131 and 132).
- b. AP/IB scores should be automatically delivered to USAF Academy during the summer of cadets' incoming year and are used to award validation credit as appropriate (see Table 1). Students who feel they have not been awarded appropriate credit, typically because the scores were not sent to USAF Academy, can provide their test scores to DFVR for evaluation.
- c. Transfer credit may be awarded for students who have completed post-secondary coursework comparable to the class for which credit is being sought from an accredited university. Transcripts should be sent to USAF Academy as part of the application and appointment acceptance process; however, missing transcripts can be forwarded to DFVR. The owning department of the class for which transfer credit is being requested will evaluate the course, sometimes requesting additional information such as a course syllabus, and will notify DFVR if transfer credit should be awarded.
- e. Cadets receiving validation or transfer credit will be placed in the next course in the sequence (e.g. a cadet receiving Chem 100 credit will be placed into Chem 200). In cases where the next class is not a requirement, cadets may work with their advisor to drop the class (e.g. because Chem 200 is not a core requirement, a cadet receiving Chem 100 credit can opt out of Chem 200 and instead schedule Physics 215 and Biology 215 to fill their core science option requirements). Similarly, a cadet can "give up" his or her transfer or validation credit and take the class for a grade (this is most often done for students pursuing the pre-med program).

Core Preparation Course

EAP 109 is a three-semester hour course, scheduled for international cadets. Whenever possible, ESL cadets will take EAP during their first semester, English 111 their second semester, and English 211 their third semester.

Grade Protection

Fourth-Class Advanced-Placement Courses. Cadets placed into Math 152 (Calculus II), Math 253 (Calculus III), Math 245 (Differential Equations) or Chem 200 (General Chemistry II Lecture and Lab) in their fourth-class fall will have grade protection.

- a. Cadets deficient ("C-" or "D" or "F") at prog may withdraw and receive a "W" grade on their transcript or they may stay enrolled in the course. A cadet who stays enrolled will not be placed on academic probation at prog solely based on a deficient or failing grade in their advanced-placed mathematics course.
- b. Cadets earning a "C-" or "D" at the end of the semester in one of the Math courses may either a) keep the grade earned in the course or b) immediately retake Calculus II (Math 142), Calculus III (Math 243), or Differential Equations (Math 245) respectively in the spring semester and receive a "WP" grade on their transcript in place of the deficient grade for the fall. Note: a proficient grade ("C" or better) is generally required to move on to the next higher mathematics course; see the course descriptions later in this handbook for specific details on course pre-requisites.

- c. Cadets who fail Math 152 at the end of the semester will be given a “W” on their transcript and be automatically enrolled in Math 142 in the spring semester.
- d. Cadets who fail Math 253 or Math 245 at the end of the semester will be given a “W” on their transcript and can retake Calculus III or Differential Equations respectively depending on the requirements of their selected major.
- e. Cadets who fail Chem 200 at the end of the semester will be given a “W” on their transcript.

Math 243. During their first attempt at Math 243, all cadets will have grade protection. Cadets may drop the course anytime during the semester through lesson 30 and receive a “W”. Cadets previously enrolled in Math 253 are not eligible for grade protection. A cadet will not be considered deficient in academics solely based on a deficient grade at prog in Math 243.

Core Requirements Checklists

Athletic Department Requirements

Cadets must pass Phy Ed 100, Basic Physical Training, during Basic Cadet Training, participate in a competitive experience (intramurals, clubs, or intercollegiate athletics) every semester, and pass a minimum of 10 Physical Education (Phy Ed) courses, each worth 0.5 semester hours of course credit. With few exceptions, cadets take Phy Ed courses each of their eight semesters. Most Phy Ed courses consist of an 8-lesson block of instruction. Two Phy Ed courses will be taken in the fourth- and first-class years. Three Phy Ed courses will be taken in the third- and second-class years. The normal Phy Ed progression is shown in *Table 17*; *Table 18* depicts the required core (Foundational) and elective (Intermediate) Phy Ed courses/options as well as the activities that meet advanced athletic criteria.

Table 17. Athletic Department Timeline

Class	Course 1	Course 2	Course 3
C4C	Boxing	Physical Development	
C3C	Swimming	Water Survival	Individual Sport Elective
C2C	Combatives I	Combatives II	Team Sport Elective
C1C	Open Elective	Open Elective	
Open Electives can be filled by an Individual or Team Elective or the following: Phy Ed 345 Advanced Physical Development Phy Ed 347 Self-Protection Phy Ed 348 Marksmanship Phy Ed 477* Independent Exercise (first- or second class cadets only) Phy Ed 479* Cadet Instructor (first- or second-class cadets only) * Cadets are registered for these courses by the AD Scheduling and Grading Division (ADPEG) IAW ADOI 36-3504.			

Table 18. Physical Education Requirements

Foundational		Intermediate	Advanced
Phy Ed 100	Basic Physical Training	Individual Sport Elective	Intercollegiate or Competitive Club Sport
Phy Ed 110	Boxing	Team Sport Elective	Team Captain (part of Leadership Credit Options)
Phy Ed 111 or Phy Ed 119	Swimming Basic Swimming	Open Electives	
Phy Ed 112 or Phy Ed 113	Physical Development Fundamentals of Physical Development		
Phy Ed 215	Combatives I		
Phy Ed 222 or Phy Ed 211 or Phy Ed 219	Water Survival Basic Water Survival Fundamentals of Personal Water Safety		
Phy Ed 315	Combatives II		

Military and Airmanship Requirements

Cadets complete two Foundational Leadership courses during their first two years in support of their military education. Intermediate military requirements include Leadership 300 and 400, required summer programs (Basic Cadet Training, Ops Air Force or equivalent, and Interpersonal Leadership Training), and several other mandatory training events and programs during the academic year. Cadets also have an opportunity to participate in a variety of Advanced Military and Airmanship programs to achieve leadership experience and growth.

Table 19. Military and Airmanship Requirements

Foundational	Intermediate	Advanced
Ldrshp 100	Mil Tng 100	National Character and Leadership Symposium
Ldrshp 200	Mil Tng 201/300/301/351	Leadership Credit Options
	Mil Tng 270	Any commander selected from the Command Selection Board
	Ldrshp 300	BCT, CST, Summer Ops Group Cadre and Staff
	Ldrshp 400	CE-FERL Leadership
	Military Speaking and Writing Certification	Soaring, Parachuting, RPA, Cyber or Space Instructor
	Human Relations (Sexual Assault Prevention, Diversity, Religious Respect, etc.)	CIC for Marine Leatherneck, Navy or Army Summer Programs
	Leadership, Ethics and Character Programs	Intercollegiate or Competitive Club Sport Team Captain

Academic Requirements

Academic graduation requirements for cadets include 93 semester hours of Dean of Faculty core courses, requirements for any declared major(s) or minor(s), and completion of 125 semester hours in-residence. The below tables provide additional information regarding the core curriculum: *Table 20* maps each core course to its corresponding “level” (Foundational, Intermediate or Advanced) in terms of cadet academic development; *Table 21* maps the core courses to USAF Academy Outcomes; and *Table 22* lists core course prerequisites and co-requisites.

Table 20. Academic Requirements

Academic Requirements	Intermediate	Advanced
Beh Sci 110	Aero Engr 315/316/210S	STEM Options:
Chem 100	Astr Engr 310	<ul style="list-style-type: none"> • Biology 345 • Biology 370 • Chem 222 • Chem 350 • Civ Engr 356 • Comp Sci 210 • Geo 351 • Math 243/253 • Math 245 • Meteor 320 • Ops Rsch 310 • Physics 310 • Physics 371 • Sys Engr 310
Comp Sci 110	ECE 215/315	Sociocultural Options:
Econ 201	Econ 201	
English 111	English 211/212	<ul style="list-style-type: none"> • Beh Sci 360 • English 400S/411 • Geo 412 • History 345 • Mgt 400 • MSS 444 • Philos 401 • Pol Sci 302 • Soc Sci 483
For Lang 131	For Lang 132	
History 100	History 300	Advanced Open Option: choose a course from either choice above
Ldrshp 100	Law 220	
Math 141	Ldrshp 200, 300, 400	Major’s Courses
Mech Engr 220	Math 142/152	
Physics 110	MSS 251	Major’s Courses
Pol Sci 211	Philos 210	
	Soc Sci 311/212	
	Science Option	
	<ul style="list-style-type: none"> • Biology 215 • Chem 200 • Physics 215 	
	Statistics Option	
	<ul style="list-style-type: none"> • Math 300 • Math 356 • Math 377 • Beh Sci 231 & 332 	
	<ul style="list-style-type: none"> • Major’s Courses 	

Table 21. Core and Outcome Map

	Foundational	Intermediate	Advanced	
Critical Thinking	• Econ 201	• Law 220 • Math 300/356/377 or Beh Sci 231/332 • Major's Courses	• Major's Courses	
Clear Communication	• English 111 • Beh Sci 110 • CE 100	• English 211/212		
Application of Engineering Problem-Solving Methods	• Mech Engr 220 • Comp Sci 110	• Astr Engr 310 • Aero Engr 315/316/210S • ECE 215/315	• STEM Basket • Socio-Cultural Basket • Leadership Credit Basket • NCLS	• Open Academic Basket
Scientific Reasoning and the Principles of Science	• Math 141 • Chem 100 • Physics 110	• Math 142/152 • Pick 2 from: Chem 200, Physics 215, Biology 215		
Ethics and Respect for Human Dignity	• Beh Sci 110 • Mil Tng 100 (BCT) • CE 200	• Philos 210 • Human Relations (SAPR, Respect, etc.) • CL 400		
The Human Condition, Cultures, and Societies	• For Lang 131	• History 300 • For Lang 132		
National Security of the American Republic in a Complex Global Environment	• Pol Sci 211 • MSS 251 (also aligned with Warrior Ethos as Airmen and Citizens)	• Econ 201 • Soc Sci 311/212 • Mil Tng 201/300/301/351 Ops Air Force		
Warrior Ethos as Airmen and Guardians	• History 100 • Phy Ed 100, 110, 111, 112, 215, 222, 315	• MSS 251 (also aligned with National Security of the American Republic) • Phy Ed Individual Sport Elective; Phy Ed Open Elective I; Phy Ed Open Elective II		

Leadership, Teamwork, and Organizational Management	<ul style="list-style-type: none"> • Ldrshp 100 • Ldrshp 200 	<ul style="list-style-type: none"> • Ldrshp 300 • Ldrshp 400 		
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Table 22. Academic Prerequisites¹⁷

COURSE	PREREQUISITES	COURSE	PREREQUISITES
Aero Engr 315 Aero Engr 316 Aero Engr 210S	Mech Engr 220 (Coreq for Aero Engr 315, Prereq for Aero Engr 316)	Ldrshp 100	
Astr Engr 310	Math 142, Physics 110	Ldrshp 200	Ldrshp 100
Beh Sci 110		Ldrshp 300	Ldrshp 200
Biology 215	Chem 100	Ldrshp 400	Ldrshp 300
Chem 100		Math 141	
Chem 200	Chem 100	Math 142/152	Math 141
Comp Sci 110	Comp Sci 110, Math 142	Math 300, Math 356, Math 377, or the 2-course Beh Sci 231/332 sequence	Math 142/152 , Math 243/253 Beh Sci 110, Beh Sci 231
ECE 215 ECE 315		Mech Engr 220	Math 141 Coreq: Physics 110
Econ 201		MSS 251	History 100
English 111		Open Advanced Choice	Varies – see course description
English 211 English 212	English 111	Philos 210	
For Lang 131		Physics 110	Coreq: Math 142
For Lang 132	For Lang 131	Physics 215	Physics 110, Math 142
History 100		Pol Sci 211	
History 300		Soc Sci 311/212	
Law 220	Econ 201	Sociocultural Advanced Choice	Varies – see course description
		STEM Advanced Choice	Varies – see course description

How does the Core Evolve?

The specific set of courses and programs currently aligned with each outcome was determined through extensive discussions between faculty and staff from all Mission Elements and an Ad Hoc Core Curriculum Review Committee. To aid in the implementation of this Core, USAF Academy codified an Assessment and Improvement Process (ref: USAF Academy Instruction 36-3502, *Institutional Effectiveness*) that explains how the Core will evolve over time. In short, USAF Academy has constructed a cross-functional team for each Outcome, and each of those teams is responsible for (1) revising the Outcome, as needed; (2) overseeing the integrated development of the Outcome; (3) coordinating efforts to assess cadet accomplishment of the Outcome; (4)

¹⁷ Prerequisites in bold are academic content prerequisites and must be followed. Prerequisites not in bold are the developmental order of Outcomes and should be followed unless program restrictions in a major or a large number of validation/transfer credits prevent scheduling in this order. For Outcome based prerequisites, at least one Foundational course within the Outcome should be completed before taking the first course at the Intermediate level in that Outcome. Accommodations for specific Cadet needs can be made with the approval of the respective Department Head(s) and the Associate Dean for Student Academic Affairs. All deviations to the Outcome sequence should be coordinated with the Outcome Team Lead for assessment and tracking purposes.

synthesizing assessment results for both internal and external reporting; and (5) facilitating improvements in courses and programs, as necessary.

The Assessment and Improvement Process is designed to reveal shortcomings in the Core as it currently exists, as well as opportunities for greater effectiveness in achieving Outcome proficiencies. As a result, there will undoubtedly be situations where core offerings associated with Outcomes will need to be changed in some way. Proposals for such changes should be coordinated with members of the relevant Outcome Team and all affected Academic Departments or Mission Elements prior to submission of a Course of Instruction Change Proposal (CCP) IAW USAF Academy Instruction 36-3526, *USAF Course of Instruction & Change Control*.

The potential also exists for Academic Departments and/or Mission Elements to pursue the addition of new courses, programs, or experiences to the current core associated with a given Outcome. These initiatives should be pursued in close collaboration with the affected Outcome Team and in keeping with guidance and processes outlined in USAF Academy Instruction 36-3502 and USAF Academy Instruction 36-3526.

SECTION 2-7 ACADEMIC PROGRAMS

2-7.1. PURPOSE OF THE ACADEMIC PROGRAM SECTION

- a. Selecting an academic program is one of the most important decisions a cadet makes during his or her career at USAF Academy. This handbook is designed to help make the best choice possible. The program chosen dictates which classes to attend, how many courses to take, future career fields, and graduate school opportunities. Cadets must be active participants in choosing and designing their academic programs and monitoring their progress.
- b. To determine their preference for an academic major, cadets should consider the kind of work they would like to do and consult their AAOCA, sponsor, career counselor, and an academic advisor or the AIC in that discipline. Cadets who determine their preference early enough can prepare to compete for limited entry specialties.
- c. For more information concerning majors, courses and career paths, many departments have home pages on the USAF Academy public website (<https://www.usafa.edu>).

2-7.2. HOW TO USE THE ACADEMIC PROGRAM SECTION

Programs are divided by type: disciplinary and interdisciplinary majors and minors (see Section 2-8), and the Bachelor of Science Program (see Section 2-9). Each program is described in a similar format, providing information about the program, program requirements, and a suggested course sequence. AAOCAs can help cadets find the appropriate person to talk to before registering for courses.

2-7.3. TYPES OF ACADEMIC PROGRAMS

USAF Academy offers a total of 30 academic majors and 18 minors. There are 23 disciplinary majors, 4 interdisciplinary majors and 3 divisional majors. The programs and sponsoring division or department are listed in *Table 23* below.

Table 23. Majors and Minors with Sponsoring Departments and Hours

MAJOR	SPONSORING DIVISION OR DEPARTMENT(S)	REQ SEM HRS
BASIC SCIENCES DIVISION		
Biology Major	Biology	143
Chemistry Major	Chemistry	143-150
Mathematics Major	Mathematical Sciences	141
Meteorology Major	Physics and Meteorology	140
Physics Major	Physics and Meteorology	145
Basic Sciences Major	Basic Sciences Division	134
ENGINEERING DIVISION		
Aeronautical Engineering Major	Aeronautics	144
Astronautical Engineering Major	Astronautics	146
Civil Engineering Major	Civil and Environmental Engineering	143
Computer Science Major	Computer and Cyber Sciences	144
Cyber Science Major	Computer and Cyber Sciences	145
Electrical & Computer Engineering Major	Electrical and Computer Engineering	147
Mechanical Engineering Major	Engineering Mechanics	144
General Engineering Major	Engineering Division	134

MAJOR	SPONSORING DIVISION OR DEPARTMENT(S)	REQ SEM HRS
Systems Engineering Major	Engineering Mechanics	144
HUMANITIES DIVISION		
English Major	English and Creative Arts	140
History Major	History	140
Philosophy Major	Philosophy	140
Humanities Major	Humanities Division	140
SOCIAL SCIENCES DIVISION		
Behavioral Sciences Major	Behavioral Sciences and Leadership	140
Economics Major	Economics and Geosciences	140
Geospatial Science Major	Economics and Geosciences	143
Legal Studies Major	Law	140
Management Major	Management	140
Military & Strategic Studies Major	Military & Strategic Studies	140
Political Science Major	Political Science	140
Social Sciences Major	Social Sciences Division	134
INTERDISCIPLINARY		
Data Science Major	Computer and Cyber Sciences, Management, and Mathematical Sciences	141
Foreign Area Studies Major	History, Foreign Languages, Political Science, Military & Strategic Studies	140
Operations Research Major	Computer and Cyber Sciences, Economics and Geosciences, Mathematical Sciences, Management	141
BACHELOR OF SCIENCE PROGRAM		
See Section 2-9	Office of Student Academic Affairs	128

MINOR	SPONSORING DIVISION OR DEPARTMENT(S)	REQ SEM HRS
Airpower Studies Minor	History, Military & Strategic Studies	**
American Studies Minor	English	**
Foreign Language Minors	Foreign Language	**
Global Logistics Management Minor	Management	**
High Performance Computing Minor	Aeronautics	**
Nuclear Weapons and Strategy Minor	Physics and Meteorology	**
Philosophy Minor	Philosophy	**
Pre-Health Professions Minor	Biology	**
Religion Studies Minor	Philosophy	**
Robotics and Autonomous Systems Minor	Electrical and Computer Engineering	**
Space Warfighting Minor	Astronautics	**
Sustainability Minor	Civil and Environmental Engineering	**
<p>**To earn a minor, you must complete the specific minor's requirements and the requirements for your academic major(s). Cadets may not earn a disciplinary minor in the same discipline as one's disciplinary major. You may earn more than one minor provided: 1) the specified criteria are met for each, and 2) each additional minor contains at least 2 non-core academic courses (6 semester hours) in residence that count exclusively toward the minor (i.e., are not double-counted with the advanced core baskets, major, or another minor).</p>		

2-7.4. ACADEMIC PROGRAM REQUIREMENTS

- a. Requirements for divisional majors begin at 36 semester hours beyond the core (134 semester hours total). Requirements for disciplinary and interdisciplinary majors begin at 42 semester hours beyond the core (140 semester hours total).
- b. Academic minors require at least five academic courses totaling no fewer than 15 semester hours. At least three of those courses must be at the 300-level or 400-level. Advanced core option courses can potentially “double count” as fulfilling both core requirements and the requirements of an academic minor. However, no other core courses can count toward a minor. Disciplinary minors are defined as minors in which at least 12 semester hours are within the same department. Interdisciplinary minors are defined as minors in which no more than 9 semester hours are from the same department.
- c. To complete a minor, you must complete at least 2 academic courses (6 semester hours) in residence that count exclusively toward the minor (i.e., are not double-counted with the advanced core baskets, major, or another minor).
- d. Minor owners should strive to create coherent course sequences that have the potential to enrich the education of the greatest possible number of cadets. Initial courses within minors shall not have prerequisites that are over and above the core curriculum (inclusive of advanced core options) which are not already contained within the minors' course sequence.

2-7.5. INITIAL CHOICE OF PROGRAM

Each semester, the faculty hosts Majors’ Night, an event designed to give cadets the opportunity to explore academic programs and talk with program representatives. While exploring programs, cadets seek advice from their AAOCAs. After selecting a program, cadets should seek help primarily from their academic advisors. While the information in this chapter may be useful to AAOCAs and academic advisors, its purpose is to answer common questions cadets often have regarding academic programs.

2-7.6. TIMELINE TO DECLARE A MAJOR

Cadets may declare a major as soon as they desire; however, academic advisors will highly recommend that cadets wait at least until their second semester. Declaring a major early does not allow cadets to adjust their courses during the first two semesters. Cadets must declare a major by the registration deadline of their third semester. However, several majors require cadets to take courses during their third semesters that are prerequisites for major’s courses. For example, if cadets plan to major in Aeronautical Engineering, Astronautical Engineering, Civil Engineering, Mathematics, Chemistry, Mechanical Engineering, Meteorology, Operations Research, or Physics, they should plan to take Math 243 their third semester if Math 243 (or Math 253) was not taken during the fourth-class year. If cadets are planning to major in Computer Science, Electrical and Computer Engineering, Cyber Science or Data Science they should declare before the registration deadline of their second semester and plan to enroll in Comp Sci 210 in their third semester. AAOCAs must discuss the requirements for the majors in which cadets have an interest. This information is provided in the course sequence tables for each major listed in this handbook. Cadets should also attend Majors' Night for in-depth academic program information. The process of declaring a major entails deciding on a course of study and scheduling a specific sequence of courses that meets graduation requirements. Cadets can change their major as long as they have

time to meet the major requirements. However, most majors have required non-core, 200-level courses, so, the longer cadets wait the more difficult changing majors becomes. Third-class cadets will not be permitted to depart on Thanksgiving Break until they have declared an academic major.

2-7.7. CHANGE OF MAJOR

You may change majors at any time preceding the deadline described in para 2-7.6. Initial selection or change of program should be timed so that no changes need be made for the current semester.

2-7.8. HOW DO I CHOOSE AN ACADEMIC PROGRAM?

Many factors go into deciding what program to choose. The first question you should ask yourself is, "What do I want to do once I am commissioned?" Talk to officers in varied career fields. Ask them what their majors were in college and ask if their majors are enhancing their career efforts. Remember, your major can dictate what career fields you may be eligible to enter. Even if your goal is to fly, your major can open or restrict future career opportunities. Many career fields have specific requirements or are limited in the numbers they accept each year. Remember, what job you do after commissioning will be determined by Air and Space Force requirements, by your qualifications, and by what you want to do. For more information concerning careers in the Air and Space Forces, Cadet Personnel (A1A) keeps up-to-date career briefs.

a. After you have looked at Air and Space Force requirements, consider what courses interest you. As you progress through the curriculum, the courses often become more difficult. If you are interested in a subject, you will more likely spend the time needed to do well in those courses. Look to your academic strengths. Even though you may like a particular major, if you do not do well in those types of courses, it is highly unlikely that you will succeed at that major. Talk to your AAOCA, AOC, and AMTs. They can be the most important people in helping you decide upon a program. Your AAOCA can direct you to people to talk with about your options. If you have unanswered questions about a program, find a faculty member with whom you can talk. One of the best times to do this is during Majors' Night at the beginning of each fall and spring semester. Cadet participation in Majors' Night is voluntary and provides a gathering of faculty from all academic departments, ready to discuss their departments' offerings and the potential benefits of their programs.

b. Finally, talk to peers in your squadron, in your classes, in clubs or on teams. Though "dorm advising" will not provide you with all the information you need to know, it will give you an additional perspective on the programs offered.

2-7.9. HOW DO I DECLARE A MINOR?

a. You should declare your intention to complete the requirements of a minor as early as possible. First, contact the department administering the minor. After discussing course requirements, meet with your academic advisor. The AIC for your academic major can add the minor to your academic program.

b. To earn a minor, you must complete the specific minor's requirements and the requirements for your academic major(s). Cadets may not earn a disciplinary minor in the same discipline as one's disciplinary major.

2-7.10. HOW DO I DECLARE AN ACADEMIC MAJOR?

To declare a major, meet with your academic advisor and communicate your intentions to declare. Cadets will be assigned an academic advisor from the appropriate academic department, and an entire four year course plan will be registered on-line using COMPASS.

2-7.11. WHAT IF I CHOOSE THE "WRONG" MAJOR?

After you have completed at least one semester in a major, you should have a better understanding of the major. If you find you have chosen the wrong major, you can change majors or options within the major. A decision to change a major should not be taken lightly; however, do not keep a program that might put your graduation and commissioning in danger. Talk to your advisor before you make a decision. Look at your performance in your current program. Are you doing poorly in the courses because you have difficulty comprehending the subject matter? Are you studying correctly? Remember, even though you want a specific major, your primary goal should be to become an Air or Space Force officer, not earn a specific major.

2-7.12. HOW CAN I LOSE MY ACADEMIC MAJOR OR MINOR?

An ARC or the Academy Board may direct you to change your major or drop your minor if you are academically deficient. When an ARC or the Academy Board removes you from your major or your minor, whether putting you into another major or the Bachelor of Science Program, you have turned your academic program over to them. Often, this happens to cadets who simply choose the wrong major. You will maintain better control of your academic program by making appropriate and timely decisions. The Department Head responsible for each major or minor may deny that major or minor to a cadet who does not maintain at least a 2.0 GPA in that major or minor or who has more than one deficient grade in courses used to determine the major's GPA or minor's GPA.

2-7.13. CAN I GET MY MAJOR BACK ONCE I HAVE LOST IT?

If you have previously been denied or removed from a major by a Department Head, you may again declare the major after obtaining approval from the Department Head. If you were ARC-directed to change majors, you may again declare your original major with the ARC Chair's approval.

2-7.14. MULTIPLE MAJORS OR MINORS

While at USAF Academy, you may earn more than one major, and/or one or more minors in addition to your major(s). Your diploma will reflect your major(s). Your transcript will reflect your major(s) as well as any minor(s). Individual courses required in multiple majors, or in a major and a minor, count for both, but cadets must meet all requirements for multiple majors and any minor(s). The following describes criteria for multiple majors and combinations of a major and a minor:

- a. Divisional majors at 134 semester hours (Social Sciences, General Engineering, and Basic Sciences) and another major: The majors must be in separate divisions. You must complete at least 4 non-core academic courses (≥ 12 semester hours) in residence in excess of the requirements of the major with the highest requirements and must meet all the requirements of both majors.

- b. Two Disciplinary Majors: You must complete at least 4 non-core academic courses (≥ 12 semester hours) in residence in excess of the major's requirements for the major with the greater number of required hours and must meet all requirements of both majors. Those 4 non-core academic courses (≥ 12 semester hours) should uniquely fill requirements in one major but not both majors. For example, a cadet majoring in both Aeronautical Engineering (144 semester hours) and Applied Mathematics (141 semester hours) would need to complete a total of 156 semester hours in order to be awarded both majors, regardless of which is listed as the primary major and which is listed as the second major.
- c. More Than Two Majors: You may receive a third or additional major, provided the additional major(s) meet(s) the above criteria, with each additional major requiring at least 4 courses (≥ 12 semester hours) that do not count toward core or other majors' requirements.
- d. You may earn more than one minor provided: 1) the specified criteria are met for each, and 2) each additional minor contains at least 2 non-core academic courses (6 semester hours) in residence that count exclusively toward the minor (i.e., are not double-counted with the advanced core baskets, major, or another minor).

2-7.15. HOW DO I DECLARE A DOUBLE MAJOR?

To declare a double major, meet first with your current academic advisor to discuss the additional requirements of the second major and how it will impact your academic program. Next, meet with the AIC of the second major you are declaring. Your academic advisor will ensure the second major is added to your academic program. Cadets pursuing double majors must ensure both majors are listed on the academic program summary. If a discipline has more than one option, you cannot earn a double major in that discipline.

2-7.16. CAN I DECLARE THE BACHELOR OF SCIENCE PROGRAM?

Cadets cannot declare the Bachelor of Science Program (BSP). The BSP must be recommended by an Academic Review Committee Chair or the Office of Student Academic Affairs and approved by the Vice Dean of Academics. Interested cadets should discuss the issue with their AAOCA/academic advisor and a member of the Curriculum Division of Student Academic Affairs (DFVRC). BSP approval can happen no earlier than the cadet's third semester. The expectation is that all cadets will earn a major; the BSP is an exception to this rule to provide an alternate path to graduation for a small number of cadets.

2-7.17. GOVERNANCE OF ACADEMIC MINORS

Any CCP proposing a new academic minor will provide both a list of course requirements and a rationale for those requirements. The rationale will include an explanation of semester hour minimums and if/how courses that count toward the minor may be "double counted" with the advanced core options and/or an academic major. CCPs for any new academic minors will address any staffing implications associated with offering that minor as well. Common requirements for all academic programs apply to academic minors as well, to include programmatic learning outcomes, regular program assessment and review, and continuous program improvement based on the discussion of assessment results.

2-7.18. ACCREDITATION

All graduates are awarded a Bachelor of Science Degree, accredited by The Higher Learning Commission (30 N. LaSalle Street, Suite 2400, Chicago, Illinois 60602-2504, phone (312) 263-0456). All graduates will have BACHELOR OF SCIENCE printed on their diploma. Cadets completing multiple majors will have each appear on their diplomas. For a limited number of disciplines, associated professional bodies have issued professional accreditation. The Aeronautical Engineering, Astronautical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Mechanical Engineering, and Systems Engineering majors are accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>. The Chemistry, Biochemistry, and Engineering Chemistry options within the Chemistry major are approved by the Committee on Professional Training of the American Chemical Society. The Computer Science major is accredited by the Computing Accreditation Commission of ABET, <http://www.abet.org>, under the commission's General Criteria and Program Criteria for Computer Science. The Management major is accredited by the Association to Advance Collegiate Schools of Business (AACSB). Many disciplines have no professional body that performs the accreditation functions; for those majors, the accreditation by The Higher Learning Commission is the highest possible review.

SECTION 2-8 DISCIPLINARY AND INTERDISCIPLINARY MAJORS AND MINORS

MAJOR/MINOR
Aeronautical Engineering
Airpower Studies Minor
American Studies Minor
Astronautical Engineering
Basic Sciences
Behavioral Sciences
Biology
Chemistry
Civil Engineering
Computer Science
Cyber Science
Data Science
Economics
Electrical & Computer Engineering
English
Foreign Area Studies
Foreign Language Minors
General Engineering
Geospatial Science
Global Logistics Management Minor
High Performance Computing Minor
History
Humanities
Legal Studies
Management
Mathematics
Mechanical Engineering
Meteorology
Military & Strategic Studies
Nuclear Weapons & Strategy Minor
Operations Research
Philosophy Major / Minor
Physics
Political Science
Pre-Health Professions Minor
Religion Studies Minor
Robotics and Autonomous Systems Minor
Social Sciences
Space Warfighting Minor
Sustainability Minor
Systems Engineering

AERONAUTICAL ENGINEERING

THE AERONAUTICAL ENGINEERING MAJOR AT A GLANCE: Aeronautical Engineering majors at USAF Academy design, build, and fly next-generation airplanes, jet engines, and hypersonic systems that go to the edge of space. Aero majors solve tough, novel, and real-world technical problems using supercomputers, high-tech simulation, and state-of-the-art tools such as transonic and supersonic wind tunnels. If you want to start your career on the leading edge of hypersonic research, this is the place to do it.

Aero majors agree this is a tough, but rewarding, course of study. As an Aero major, you will study flight control systems, propulsion, aerodynamics, aero structures and materials, flight testing and experimentation with some of the nation's leading experts in the field. Most of our students become published authors, some receive patents, and all take part in cutting-edge, real-world research programs. Our graduates pursue Air and Space Force careers as pilots, test pilots, flight test engineers, astronauts, program managers, developmental engineers, and undergraduate and graduate school professors.

The Aero department faculty and staff pride themselves on supporting you and ensuring your success. Always! Ask our students what they think of the faculty, staff, and facilities of the Aero Department. Our faculty includes test pilots, engineers, and world-class technicians with decades of flight and flight test, research, and classroom teaching experience. The faculty of the Aero department are internationally recognized experts, published authors, and have contributed directly to the development of new systems for the Air Force. We have world-class facilities and the largest and best-equipped undergraduate wind tunnel and research laboratory in the world.

Aero majors graduate with Bachelor of Science degree accredited by the Accreditation Board for Engineering and Technology (ABET), the organization that accredits all post-secondary education programs in applied and natural science, computing, engineering and engineering technology in the United States.

In concert with USAF Academy, the Aero major prepares graduates to be successful Air and Space Force officers with the ability to rapidly acquire knowledge, solve technical problems, lead others, apply ethical and moral standards, exercise critical thinking, and communicate effectively.

The foundation that prepares graduates for attaining the Program Objectives is provided by Student Outcomes. Attainment of these Student Outcomes prepares graduates to enter the professional practice of engineering. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. These Student Outcomes are:

- 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;
- 3) an ability to communicate effectively with a range of audiences;
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;

- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions; and
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

In the Aeronautical Engineering major, studies in aerodynamics, flight mechanics, propulsion, aircraft structures and materials, and experimental methods prepare cadets to succeed in either of the two-course design sequences, aircraft design or aircraft engine design.

Interested cadets are required to declare the Aeronautical Engineering major no later than the registration deadline in their third semester. However, late declarations or transfers to this major may be allowed at the beginning of the second-class year provided cadets have completed the following courses before enrolling: Math 243 (or Math 253), Math 245, Physics 215, Aero Engr 241 and Aero Engr 315. Cadets interested in the Aeronautical Engineering major are encouraged to discuss issues and concerns with an academic advisor or the Department of Aeronautics Advisor-In-Charge.

The Aeronautical Engineering major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 144 Semester Hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Aero Engr	Fundamentals of Aeronautics	Aero Engr 210/210S
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option	Differential Equations	Math 245

B. 5 Semester hours of Director of Athletics core courses.

C. 46 Semester hours of major's courses:

1. Aero Engr 206 Fundamental Tools for Engineering
 or Comp Sci 206 Fundamentals of Programming for Engineers
 or Comp Sci 211 Introduction to Programming for Scientists and Engineers
2. Math 346 Engineering Math
 or Engr 346 Engineering Mathematics with Applications
3. Mech Engr 330 Mechanics of Deformable Bodies

4. Mech Engr 350	Mechanical Behavior of Materials
5. Aero Engr 241	Aero-Thermodynamics
6. Aero Engr 341	Aeronautical Fluid Dynamics
7. Aero Engr 342	Computational Aerodynamics
8. Aero Engr 351	Aircraft Performance and Static Stability
9. Aero Engr 352	Aircraft Dynamic Stability and Control
10. Aero Engr 361	Propulsion I
11. Aero Engr 436	Aircraft Structures, Dynamics and Aeroelasticity
12. Aero Engr 442	Advanced Aerodynamics
13. Aero Engr 471	Aeronautics Laboratory
14. Aero Engr 480	Introduction to Aircraft Engine Design
or Aero Engr 481	Introduction to Aircraft Design
15. Aero Engr Elective	(See Supplemental Information)
16. Aero Design Elective (select one from the two courses listed below)	
a. Aero Engr 482	Aircraft Design
b. Aero Engr 483	Aircraft Engine Design

Supplemental Information:

The Aero Engr Elective must come from the list of courses below:

(electives are offered based on need and availability – see your advisor for details)

Aero Engr 446	Introduction to Hypersonics
Aero Engr 447	Advanced Applied Aerodynamics
Aero Engr 456	Flight Test Techniques
Aero Engr 457	Aircraft Feedback Control Systems
Aero Engr 466	Propulsion II (required for cadets in the propulsion track)
Aero Engr 472	Advanced Computational Dynamics
Aero Engr 482	Aircraft Design
Aero Engr 483	Aircraft Engine Design
Mech Engr 431	Introduction to Finite Element Analysis
Mech Engr 450	Aerospace Composite Materials
Aero Engr 495	Special Topics (3 sem hrs only, dept approval required)
Aero Engr 499	Independent Study (3 sem hrs only, dept approval required)
Other Engineering or Basic Science courses with dept approval.	

SUGGESTED COURSE SEQUENCE

Aeronautical Engineering Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Math 243	3	1	Aero Engr 341	3	1	Aero Engr 442	3	1
	Beh Sci 110	3	1	Aero Engr 210/S	3	1	Aero Engr 351	3	1	Aero Engr 471	3	2
	History 100	3	1	Econ 201	3.5	2	Mech Engr 350	3	1	Aero Engr 480/1	3	2
	Math 141	3	1	Mech Engr 220	3	1	Engr 346	3	1	Aero Engr 436	3	1
	Comp Sci 110	3	1	Physics 215	4	2	Pol Sci 211	3	1	Soc Sci 311	3	1
	Phy Ed	0.5	2	Philos 210	3	1	ECE 315	3	1	Phy Ed	0.5	2
		15.5	8	Phy Ed	1	2	Phy Ed	1	2			
					20.5	10				19	8	15.5 9
Spring	For Lang 2	3	2	Aero Engr 241	3	1	Aero Engr 342	3	2	Aero Design Elective	3	2
	Chem 100	4	2	Mech Engr 330	3	1	Aero Engr 352	3	1	Aero Engr Elective	3	1
	English 111	3	1	Aero Engr 206	1	1	Aero Engr 361	3	1	History 300	3	1
	Math 142	3	1	Math 245	3	1	English 211	3	1	Adv SocioCultural Opt	3	1
	Physics 110	4	2	Chem 200	4	2	Math 356	3	1	Astr Engr 310	3	1
	Ldrshp 100	0.75	0	MSS 251	4.5	2	Law 220	3	1	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Phy Ed	0.5	2
		18.25	10	Phy Ed	0.5	2	Phy Ed	0.5	2		16.5	8
					19.75	10		19.25	9			

Course Unit Summary
Core (29)
Major (16)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 46.0 "
Phy Ed = 5.0 "
Total = 144.0 "

AIRPOWER STUDIES MINOR

THE AIRPOWER STUDIES MINOR AT A GLANCE: The newest US Air Force mission statement is "To fly, fight, and win...airpower anytime, anywhere," and official USAF doctrine defines airpower as: "the ability to project military power through control and exploitation in, from and through the air." Recognizing this fact, the airpower minor focuses on war in the air domain, as well as the role and capabilities of airpower across the competition continuum—from times of peace to times of armed conflict and war. The Airpower Studies Minor is for those cadets who want to go beyond the basic understanding of air warfare and airpower capabilities offered in the core curriculum. It provides cadets exposure to tactical, operational, strategic considerations as well as technological capabilities and limits of the air domain. It adds to the core curriculum's foundation with greater depth in the specific application of airpower relevant to any Air Force operational specialty. Cadets will interrogate the implications of fighting in the air domain and chart a course sequence that inculcates air-mindedness, a habit of mind valuable for any Air Force officer. This minor is compatible with any academic major.

COURSE REQUIREMENTS:

The Airpower Studies Minor requires a minimum of 15 semester hours. The student must complete these five courses (15 semester hours) with a grade of "C" or better. This is an interdisciplinary minor. No more than 2 courses for the minor can be from any one department.

1-2. Two required foundational courses:

History 320	Airpower History
MSS 377	Airpower for Combined Effects

3. Choose one of the following technical options:

Aero Engr 241	Aero-Thermodynamics
Aero Engr 446	Introduction to Hypersonics
Biology 345	Aerospace Physiology
Chem 350	Chemistry of Weapons
Meteor 320	Introduction to Meteorology and Aviation Weather
Physics 370	Upper Atmospheric and Geo-Space Physics

4-5. Choose two of the following depth options (Reminder, cadets may not choose more than a total of two courses from the same discipline):

Aero Engr 241	Aero-Thermodynamics
Aero Engr 351	Aircraft Performance
Aero Engr 446	Introduction to Hypersonics
Beh Sci 375	Aviation Psychology and Human Factors
Biology 345	Aerospace Physiology
Chem 350	Chemistry of Weapons
History 321	STEM at War: History of Technology and Warfare
History 327	The Great War: The History of World War I
History 328	Axis and Allies: The History of World War II
History 329	Korean War and the Cold War
History 330	The Vietnam War

Meteor 320	Introduction to Meteorology and Aviation Weather
MSS 343	Foundations of Joint Air, Space, and Cyber Strategy
MSS 371	Joint Targeting and Strategy
MSS 381	Air Warfare Operations and Planning
Physics 370	Upper Atmospheric and Geo-Space Physics
Pol Sci 462	Politics and Intelligence
Pol Sci 496	Causes of War and Conflict Resolution

With the approval of the minor AIC and the Department Head of an instructor offering a 495 or 499, cadets may substitute a 495 or 499 course offered by any department for this requirement.

AMERICAN STUDIES MINOR

THE AMERICAN STUDIES MINOR AT A GLANCE: The American Studies minor at USAF Academy prepares students for leadership as officers for our military and as citizens for our nation. As the Constitution's "We the people" demands, citizens must know and work with fellow Americans of all backgrounds in order to form a more perfect union; as Master Sun asserts, officers must know their nation-its government, society, and people-just as they know themselves, or risk defeat. Bringing a unique blend of humanistic and social scientific inquiry, cadets will study various ideas about "America" and "Americanness" as it has been defined and experienced across time and by diverse peoples. Ultimately, by synthesizing evidence, theories, and methods drawn from more than one field of study, students will come to better understand the power of interdisciplinary thinking as a necessary tool for formulating their own response to the idea of America that will be the lifeblood of their careers of service to our Air Force and to our nation.

COURSE REQUIREMENTS:

The American Studies minor requires a minimum of five classes (15 credit hours). The minor is designed to pair well with majors in both hemispheres. Any of the approved courses in the literature, history, and government/law requirements below may also be used as an elective for the minor.

1. One U.S. literature course
Select from an approved list of English courses circulated each semester
2. One U.S. history course from the following:
History 210 Foundations of Modern America
History 220 American History Since Reconstruction
3. One U.S. government or law course from the following:
PolSci 392 American Political System and Theory
PolSci 451 American Political Thought
Law 331 Criminal Law and Procedure
Law 351 U.S. Constitutional Law
- 4-5. Two electives from an approved pool of U.S.-focused courses from any discipline
Any U.S.-focused literature course beyond the one required course above (selected from an approved list of English courses circulated each semester)
Econ 340 Economics of Inequality
History 328 Axis and Allies: The History of World War II
History 340 America and the World
History 341 American Regional Identities
History 342 Early Modern Warfare in the Atlantic World
History 343 The American Revolution
History 344 The American Civil War
History 345 The American Way of War
History 346 Great Americans
History 347 Power to the People
PolSci 481 American Elections and Political Parties
PolSci 482 The U.S. Supreme Court

PolSci 483	The U.S. Congress
PolSci 484	The American Presidency
Law 340	Business Law
Law 360	Law and Literature
Law 456	National Security Law
MSS 491	Strategy in the Americas
Philos 382	American Philosophy
Any approved 495 (Special Topics) or 499 (Independent Study) focused on an American topic or subject.	

ASTRONAUTICAL ENGINEERING

THE ASTRONAUTICAL ENGINEERING MAJOR AT A GLANCE: The Astronautical Engineering major is the broad application of science and engineering to aerospace operations. Special emphasis is placed on astrodynamics, aerospace systems design, and control systems. Thus, the cadet is prepared for duties in the Space or Air Forces with specialization in research, design, development and analysis of space technology and aerospace avionics. Cadets who successfully complete this major are awarded the degree of Bachelor of Science in Astronautical Engineering, accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

Interested cadets should declare the Astronautical Engineering major no later than the registration deadline in their second semester. However, in the event that you are late declaring the Astronautical Engineering major, you must discuss the transfer with an academic advisor from the Department of Astronautics. In any event, the course outline shown herein reflects the sequence of required major's courses that you must take. Please see an academic advisor or the Department of Astronautics Advisor-In-Charge to establish your specific course sequence.

To ensure the success of our graduates, we prepare them to attain Program Objectives two to five years after graduation. These are:

- 1) Recognition as successful Air or Space Force officers through demonstration of their ability to:
 - a. Rapidly acquire required knowledge,
 - b. Lead others effectively,
 - c. Effectively apply ethical and moral standards,
 - d. Improve unit performance by application of organizational skills,
 - e. Make sound decisions based on critical thinking, and
 - f. Communicate effectively.
- 2) Selection for career training on, or ahead of, schedule, and for a progression of assignments of increasing responsibility.
- 3) A demonstrated ability to solve Air and Space Force technical problems.
- 4) Success in continuing education.

The foundation that prepares graduates for attaining the Program Objectives is provided by Student Outcomes. Student Outcomes describe what students must attain prior to graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. These Student Outcomes are:

- 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;
- 3) an ability to communicate effectively with a range of audiences;
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;

- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions; and
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Incorporated within these outcomes, Astronautical Engineering majors must demonstrate a knowledge of orbital mechanics, space environment, attitude determination and control, telecommunication, space structures, and rocket propulsion. In addition, graduates must also demonstrate design competence that includes integration of Astronautical Engineering topics.

The Astronautical Engineering major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 146 Semester Hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option	Differential Equations	Math 245

B. 5 Semester hours of Director of Athletics core courses.

C. 48 Semester hours of major's courses:

- | | |
|------------------------|---|
| 1. Astr Engr 201 | Technology Skills for Astronautics |
| or Comp Sci 211 | (See Supplemental Information 1) |
| 2. Mech Engr 320 | Dynamics |
| or Physics 355 | Classic Mechanics |
| 3. Aero Engr 241 | Aero-Thermodynamics |
| 4. Astr Engr 321 | Intermediate Astrodynamics |
| 5. Math 346 | Engineering Math |
| 6. Engr 341 | Linear Systems Analysis and Design |
| 7. Engr 342 | Linear Control System Analysis and Design |
| 8. Astr Engr 331 | Space Systems Engineering |
| 9. Astr Engr 332 | Satellite Communications |
| 10. Mech Engr 330 | Mechanics of Deformable Bodies |
| 11. Astr Engr 351 | Rocket Propulsion |
| 12. Astr Engr 445 | Spacecraft Attitude Dynamics and Control |
| 13. Astr Engr Option 1 | (See Supplemental Information 2) |

- | | |
|----------------------------|----------------------------------|
| 14. Astr Engr Option 2 | (See Supplemental Information 3) |
| 15. Astr Capstone Option 1 | (See Supplemental Information 4) |
| 16. Astr Capstone Option 2 | (See Supplemental Information 4) |

Supplemental Information:

1. Astronautical Engineering majors may take Comp Sci 211 in lieu of Astro Engr 201.
2. The Astronautical Engineering Option 1 can be chosen from the following courses:

Astr Engr 422 (S)	Advanced Astrodynamics
Astr Engr 543 (S)	Methods of Optimization for Engineers
Engr 443 (F)	Advanced Control Theory and Design
3. The Astronautical Engineering Option 2 can be chosen from the following courses:

Astr Engr 422 (S)*	Advanced Astrodynamics
Astr Engr 423 (F)	Space Mission Design
Astr Engr 431 (S)	Space Warfighting Payload Design
Astr Engr 543 (S)*	Methods of Optimization for Engineers
Chem 325 (S)	Space Chemistry
Engr 443 (F)*	Advanced Control Theory and Design
Physics 375 (F)	Physics of Space Domain Awareness

*Available as Astro Engr Option 2 if not taken to satisfy Astro Engr Option 1.
4. Astro Capstone Option 1 and 2 consist of any combination of two of the following courses:

Astr Engr 436	Small Spacecraft Engineering I
Astr Engr 437	Small Spacecraft Engineering II
Astr Engr 438	Small Spacecraft Engineering III

SUGGESTED COURSE SEQUENCE

Astronautical Engineering Major

	4°			hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Astr Engr 201	1	1	Astr Engr 321	3	1	Astr Engr 445	3	1		
	Beh Sci 110	3	1	Math 243	3	1	Engr 341	3	1	Astr Engr 436	4	2		
	History 100	3	1	MSS 251	4.5	2	Math 346	3	1	Astr Engr Opt 1	3	1		
	Math 141	3	1	Mech Engr 220	3	1	English 211	3	1	Aero Engr 315	3	1		
	Comp Sci 110	3	1	Astr Engr 310S	3	1	Pol Sci 211	3	1	Philos 210	3	1		
	Phy Ed	0.5	2	Physics 215	4	2	Econ 201	3.5	2	Soc Sci 311	3	1		
	15.5			8	Phy Ed	1	2	Phy Ed	1	2	Phy Ed	0.5	2	
					19.5	10			19.5	9		19.5	9	
Spring							Astr Engr 331	3	2	Astr Engr 332	3	1		
	For Lang 2	3	2	Mech Engr 320	3	2	Astr Engr 351	3	1	Astr Engr Opt 2	3	1		
	Chem 100	4	2	Aero Engr 241	3	1	Engr 342	3	2	Astr Engr 437	4	2		
	English 111	3	1	Math 245	3	1	Mech Engr 330	3	1	Adv SocioCultural Optio	3	1		
	Math 142	3	1	Chem 200	4	2	Math 356 / Math 377	3	1	History 300	3	1		
	Physics 110	4	2	ECE 315	3	1	Law 220	3	1	Ldrshp 400	0.75	0		
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Phy Ed	0.5	2		
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2		16.5	8		
	18.25			10		17.25	9		19.25	10				

Course Unit Summary
Core (29)
Major (16)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 48.0 "
Phy Ed = 5.0 "
Total = 146.0 "

BASIC SCIENCES

THE BASIC SCIENCES MAJOR AT A GLANCE: The Basic Sciences major is a divisional major incorporating the basic sciences of Biology, Chemistry, Mathematics, and Physics. This divisional program is recommended for cadets already declared in either a Basic Sciences or an Engineering disciplinary major who, for a variety of reasons, find the divisional approach more suited to fulfilling graduation requirements.

Since the Basic Sciences major lacks the structure of a disciplinary major, it is generally not an appropriate path for cadets wishing to go to graduate school in a basic sciences field—they will most likely be required to take additional undergraduate courses in the selected discipline prior to entering graduate school.

The Basic Sciences Major must be recommended by the Academic Advisor, endorsed by the Department Head, and approved by the Division Chair. Alternatively, the Basic Sciences Major may be directed by the Academic Review Committee and coordinated with the Division Chair.

COURSE REQUIREMENTS: 134 Semester hours

A. *93 Semester hours of Dean's academic core courses to include:*

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics	Probability and Statistics for Engineers and Scientists or Advanced Probability and Statistics	Math 356 or Math 377
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. *5 Semester hours of Director of Athletics core courses.*

C. *36 Semester hours of major's courses:*

There are no specific mandatory Basic Sciences major's courses, so cadets have tremendous flexibility in designing their program. Cadets are free to pursue any avenue of interest in the sciences as long as they follow a coherent course of study approved by their advisor and the Basic Sciences AIC and satisfy the depth and breadth requirements below.

Depth Requirements:

- At least 18 semester hours at the 300- or 400-level.
- Special Topics (495) or Independent Study (499) courses from the four departments in the Basic Sciences Division may be included.

Distribution Requirements:

- At least 24 total semester hours earned through courses taught by the four departments in the Basic Sciences Division. Basic Sciences majors must satisfy both of the following provisions under this requirement. A course may not be simultaneously counted toward both distribution requirements nor may it simultaneously satisfy a core and distribution requirement.
- At least 12 of these 24 semester hours must comprise a coherent course of study from any of the disciplines in the Basic Sciences Division (including interdisciplinary majors).
- At least 12 of these 24 semester hours must consist of one non-core course from each of the primary Basic Sciences disciplines (Biology, Chemistry, Mathematics, and Physics). The P/C/B option course not used to satisfy the core must be taken and will be counted towards this requirement. Additional recommended courses that can meet this requirement include:

Biology

Biology 345	Aerospace Physiology
Biology 370	Human Nutrition
Biology 380	Principles of Ecology

Chemistry

Chem 222	Analytical Chemistry
Chem 230	Introductory Organic Chemistry
Chem 325	Space Chemistry
Chem 350	Chemistry of Weapons
Chem 434	Biochemistry

Mathematics

Math 243 (or Math 253)	Calculus III
Math 245	Differential Equations
Math 344	Applied Linear Algebra
Math 359	Design and Analysis of Experiments
Math 378	Applied Statistical Modeling

Physics

Physics 264	Modern Physics
Physics 370	Upper Atmospheric and Geo-Space Physics
Meteor 320	Introduction to Meteorology and Aviation Weather

Supplemental Information:

Cadets may also take up to twelve semester hours of courses outside of the Basic Sciences division that satisfy an elective for any of the disciplinary majors offered within the division. In addition, the following courses also may be used to satisfy this option:

Comp Sci 211/212	Programming for Scientists and Engineers/Analysts
Comp Sci 362	Computer Simulation
English 345	Digital Humanities
English 375	Literature, Language, and Science

Econ 365	Econometrics I
Econ 465	Econometrics II
Econ 411	Introduction to Game Theory
Ops Rsch 311	Deterministic Models
Ops Rsch 312	Probabilistic Models
Ops Rsch 417	Quick-Turn Analysis
Philos 360	Applied Reasoning
Philos 370	Introduction to Symbolic Logic

SUGGESTED COURSE SEQUENCE

Basic Sciences Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Econ 201	3.5	2	Bas Sci Option	3	1	Bas Sci Option	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Bas Sci Option	3	1	Bas Sci Option	3	1
	History 100	3	1	English 211	3	1	Bas Sci Option	3	1	Adv Sociocultural Opt	3	1
	Math 141	3	1	P / C / B Option	4	2	ECE 315	3	1	Soc Sci 311	3	1
	Comp Sci 110	3	1	Phy Ed	1	2	History 300	3	1	Adv STEM Option	3	1
	Phy Ed	0.5	2		16	9	Philos 210	3	1	Phy Ed	0.5	2
		15.5	8				Phy Ed	1	2		15.5	7
								19	8			
Spring	For Lang 2	3	2	Bas Sci Option	3	1	Bas Sci Option	3	1	Bas Sci Option	3	1
	Chem 100	4	2	Pol Sci 211	3	1	Bas Sci Option	3	1	Bas Sci Option	3	1
	English 111	3	1	P / C / B Option	4	2	Bas Sci Option	3	1	Bas Sci Option	3	1
	Math 142	3	1	Law 220	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
	Physics 110	4	2	Mech Engr 220	3	1	Math 356	3	1	Astr Engr 310	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	7		16.25	7

Course Unit Summary
Core (29)
Major (12)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 36.0 "
Phy Ed = 5.0 "
Total = 134.0 "

BEHAVIORAL SCIENCES

THE BEHAVIORAL SCIENCES MAJOR AT A GLANCE: No matter what you do in life, there is one irrefutable fact: you will work with other people. Therefore, your success in any field depends largely on your understanding of yourself, others, and how groups of people work together. The Behavioral Sciences major lays the foundation for this understanding and allows cadets the opportunity to map a path of study through a diverse menu of courses aligned with their professional and educational goals.

The mission of Department of Behavioral Sciences and Leadership (DFBL) is to nurture and empower cadets and faculty to grow professionally and personally in a culture of care, respect, and scientific thinking. We accomplish our mission by focusing on the following goals:

1. Deliver world-class education experiences using scientific thinking in psychology and sociology as our foundation.
2. Cultivate a community of learners dedicated to the application, advancement, and clear communication of our disciplinary knowledge.
3. Use empirically-driven content and analysis to develop inclusive leaders who respect the dignity of all people.

As you can see, Behavioral Sciences prepares our graduates to enter a wide variety of career fields in the Air and Space Forces, to include pilot training. Behavioral Sciences graduates are highly competitive for the Intel, Security Forces, Force Support, and Special Investigations (OSI) fields. It is important to note that Behavioral Sciences is the only degree at USAF Academy that qualifies cadets for the Information Operations career field.

Behavioral Sciences is also one of the top majors for Health Professionals. The following health profession concentrations are available for Behavioral Science majors:

- Pre-Med
- Pre-Nursing
- Dental
- Physician Assistant
- Physical Therapy
- Clinical Psychology
- Aerospace Physiology

Notably, DFBL will count up to three health profession courses toward Behavioral Sciences Electives under both the Psychology and Sociology Concentrations, and two under the Human Factors Concentration. Cadets are encouraged to use their two USAF Academy electives to fulfill other health profession course requirements. This flexibility allows cadets to develop a deeper understanding of human behavior and social processes through their Behavioral Sciences curriculum and at the same time gain vital knowledge necessary to their desired health profession, all the while counting up to give health profession courses toward their Behavioral Sciences degree. Cadets looking to pursue these concentrations should contact DFBL's Advisor-in-Charge for concentration requirement information. Cadets interested in any health profession concentration should coordinate with a Health Professions Advising Center (HPAC) advisor located within the Departments of Chemistry and Biology for additional registration information.

All cadet majors will choose one of three concentrations to gain depth in a specific discipline:

Psychology Concentration: This concentration explores the scientific study of behavior and mental activity from the individual perspective. Coursework emphasizes the rigorous

implementation of the scientific method: those aspects foundational to laboratory study, as well as more modern applied focuses. Psychological courses are the conceptual groundwork for those interested in clinical and counseling, as well as the study and practice of leadership. This concentration is an excellent choice for students wanting to learn more about many topics introduced in Beh Sci 110 and as preparation for students seeking a graduate degree in most psychology disciplines.

Sociology Concentration: The sociology concentration is the study of social life, social change, and the social causes and consequences of human behavior. Given the complexities and intricacies of societies and the fact that all human behavior is social, the subject matter of sociology ranges from the intimate family to the hostile mob; from organized crime to religious traditions; from the divisions of race, gender, and social class to the shared beliefs of the common culture. This concentration develops cross-cultural competence and the ability to understand and analyze the cultures, beliefs, values, and institutions of foreign societies. The increased cross-cultural competency gained from this concentration will enhance your ability to lead diverse teams in most Air Force Specialty Codes (AFSCs) including pilot, navigator, and other rated career fields.

Human Factors Concentration: Human factors is a scientific discipline that brings together psychology and design to develop effective systems based on human capabilities and limitations. Students will learn methods and concepts from experimental psychology, sensation and perception, cognition, physiology, human-computer interaction, and ergonomics. Applications include aviation, medicine, space, sports, and human-centered design of technology. Cadets will have the opportunity to study with faculty using eye-tracking, virtual reality, Tesla Model X, humanoid robots, and similar technologies After successfully completing this degree program, cadets will be prepared for graduate work in human factors and ergonomics, human systems integration, human-computer interaction, and related degree programs. NOTE: This concentration is not an accredited engineering degree; cadets interested in graduating with an HF-related accredited engineering degree should consider a Systems Engineering degree with an HF emphasis.

The Behavioral Sciences major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	Introductory Biology with Laboratory	Biology 215
P / C / B Option 2	General Chemistry II Lecture and Lab or General Physics II with Laboratory	Chem 200 or Physics 215
Statistics	Advanced Research Methods and Statistical Tools	Beh Sci 332

Adv STEM Option		Choose 1
Adv Sociocultural Option	Sociology	Beh Sci 360
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

1. Beh Sci 231 Basic Research Methods and Statistical Tools
2. Beh Sci 361 Social Problems
3. Beh Sci 498 Senior Capstone in the Behavioral Sciences

4. – 12. Concentrations

a. Psychology

- Two Neuroscience courses (see below)
- Two Psychology courses (see below)
- Two Sociology courses (see below)
- Any three additional Beh Sci courses (these may be used to fulfill requirements towards health professions. Those wishing to pursue a minor may substitute one class from their minor toward these electives).

b. Sociology

- Beh Sci 365 Sociological Theory (see below)
- Three additional Sociology courses (see below)
- One Neuroscience course (see below)
- One Psychology course (see below)
- Any three additional Beh Sci courses (these may be used to fulfill requirements towards health professions. Those wishing to pursue a minor may substitute one class from their minor toward these electives).

c. Human Factors

- Beh Sci 373 Human Factors Engineering
- Beh Sci 375 Aviation Psychology and Human Factors
- Beh Sci 390 Sensation and Perception
- Beh Sci 471 Engineering Psychology
- Beh Sci 473 HF Engineering in Systems Design
- One additional Neuroscience course (see below)
- One Sociology course (see below)
- Any two additional Beh Sci courses (these may be used to fulfill requirements towards health professions. Those wishing to pursue a minor may substitute one class from their minor toward these electives).

Psychology courses:

Beh Sci 330 Abnormal Psychology

Beh Sci 352 Social Psychology
 Beh Sci 380 Theories of Personality
 Beh Sci 440 Lifespan Development

Neuroscience courses:

Beh Sci 335 Learning and Cognition
 Beh Sci 355 Introduction to Neuroscience
 Beh Sci 390 Sensation & Perception

Sociology courses:

Beh Sci 358 Sociology of War and Violence
 Beh Sci 362 Class, Race, and Ethnicity in Society
 Beh Sci 363 Crime and Deviance
 Beh Sci 364 Gender, Sexuality, and Society
 Beh Sci 365 Sociological Theory
 Beh Sci 366 Environmental Sociology

13.-14. Academy Options Any two additional courses (≥ 3.0 sem hrs each) taught under the supervision of the Dean of Faculty. Cadets may use the Academy Options for a variety of purposes: supporting pre-med/health professional coursework, helping to meet a minor's requirements, independent study, pursuing an area of interest, etc.

SUGGESTED COURSE SEQUENCE

Behavioral Science Major: Sociology Concentration

	4°			3°			2°			1°		
	hrs	per		hrs	per		hrs	per		hrs	per	
Fall	For Lang 1	3	2	Beh Sci 360/5	3	1	Sociology 365	3	1	Sociology 2	3	1
	Beh Sci 110	3	1	Econ 201	3.5	2	BehSci 332	3	1	Neuroscience 1	3	1
	History 100	3	1	MSS 251	4.5	2	Pol Sci 211	3	1	Beh Sci Elective 1	3	1
	Math 141	3	1	English 211	3	1	ECE 315	3	1	Beh Sci 498	3	1
	Comp Sci 110	3	1	Biology 215	4	2	History 300	3	1	Academy Option 1	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Beh Sci 361	3	1	Astr Engr 310	3	1
	15.5	8		19	10	Phy Ed	1	2	Phy Ed	0.5	2	
							19	8		18.5	8	
Spring	For Lang 2	3	2	Beh Sci 231	3	1	Sociology 1	3	1	Beh Sci Elective 2	3	1
	Chem 100	4	2	Philos 210	3	1	Psychology 1	3	1	Sociology 3	3	1
	English 111	3	1	P / C / B Option	4	2	Soc Sci 311	3	1	Beh Sci Elective 3	3	1
	Math 142	3	1	Law 220	3	1	Aero Engr 315	3	1	Academy Option 2	3	1
	Physics 110	4	2	Mech Engr 220	3	1	Adv STEM Option	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
	18.25	10		17.25	8		16.25	7		16.25	7	

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93 Sem Hours
Major = 42 Sem Hours
Phy Ed = 5 Sem Hours
Total = 140 Sem Hours

Behavioral Science Major: Human Factors Concentration

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2		3	1	Beh Sci 375	3	1	Beh Sci 471	3	1
	Beh Sci 110	3	1		3.5	2	BehSci 332	3	1	Neuroscience 1	3	1
	History 100	3	1		4.5	2	Pol Sci 211	3	1	Sociology 1	3	1
	Math 141	3	1		3	1	ECE 315	3	1	Beh Sci 498	3	1
	Comp Sci 110	3	1		3	1	P / C / B Option	4	2	Academy Option 1	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	History 300	3	1		3	1
		15.5	8		18	10	Phy Ed	1	2	Phy Ed	0.5	2
								20	8		18.5	8
Spring	For Lang 2	3	2	Beh Sci 231	3	1	Beh Sci 361	3	1	Beh Sci Elective 1	3	1
	Chem 100	4	2	Beh Sci 373	3	1	Beh Sci 390	3	1	Beh Sci 473	3	1
	English 111	3	1	Biology 215	4	2	Soc Sci 311	3	1	Beh Sci Elective 2	3	1
	Math 142	3	1	Law 220	3	1	Aero Engr 315	3	1	Academy Option 2	3	1
	Physics 110	4	2	Mech Engr 220	3	1	Adv STEM Option	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	7		16.25	7

Course Unit Summary

Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary

Core = 93 Sem Hours
Major = 42 Sem Hours
Phy Ed = 5 Sem Hours
Total = 140 Sem Hours

Behavioral Science Major: Psychology Concentration

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Beh Sci 360/S	3	1	Psychology 1	3	1	Neuroscience 2	3	1
	Beh Sci 110	3	1	Econ 201	3.5	2	Beh Sci 332	3	1	Sociology 1	3	1
	History 100	3	1	MSS 251	4.5	2	Pol Sci 211	3	1	Beh Sci Elective 1	3	1
	Math 141	3	1	English 211	3	1	ECE 315	3	1	Beh Sci 498	3	1
	Comp Sci 110	3	1	Biology 215	4	2	History 300	3	1	Academy Option 1	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Beh Sci 361	3	1	Astr Engr 310	3	1
		15.5	8		19	10	Phy Ed	1	2	Phy Ed	0.5	2
								19	8		18.5	8
Spring	For Lang 2	3	2	Beh Sci 231	3	1	Neuroscience 1	3	1	Beh Sci Elective 2	3	1
	Chem 100	4	2	Philos 210	3	1	Psychology 2	3	1	Sociology 2	3	1
	English 111	3	1	P / C / B Option	4	2	Soc Sci 311	3	1	Beh Sci Elective 3	3	1
	Math 142	3	1	Law 220	3	1	Aero Engr 315	3	1	Academy Option 2	3	1
	Physics 110	4	2	Mech Engr 220	3	1	Adv STEM Option	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	7		16.25	7

Course Unit Summary

Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary

Core = 93 Sem Hours
Major = 42 Sem Hours
Phy Ed = 5 Sem Hours
Total = 140 Sem Hours

BIOLOGY

THE BIOLOGY MAJOR AT A GLANCE: The Biology major prepares cadets to become officers skilled at critical thinking, grounded in the natural world, open to alternative perspectives, and capable of identifying solutions in complex environments. The goal of the Biology major is to produce leaders who 1) are biologically literate, 2) use scientific thinking as a component of their decision-making process, 3) effectively communicate information to a wide variety of target audiences, and 4) cultivate attitudes and values consistent with biological literacy.

The Biology major offers an effective balance between required foundational courses and cadet-selected flexibility. In addition to the USAF Academy Core, the Biology major comprises 9 core courses (including organic chemistry), as well as 5 electives that include: 3 additional Biology courses, 1 Basic Sciences course and 1 Academy Option. The required courses represent and explore the spectrum of biological levels, from the molecules within cells to the organisms within ecosystems; the elective courses allow emphasis in environmental and organismal biology, cellular and molecular biology, and human biology. The strong biological foundation provided by these required courses, together with the flexibility and specialization provided by the electives, allows Biology majors to tailor an academic program to meet their own interests, to pursue specialized areas of interest, or to prepare for advanced degrees/careers in the health professions (medicine, dentistry, nursing, physician assistant) or in the Biomedical Sciences Corps (bioenvironmental engineering and physical therapy). Upon graduation, Biology majors enter a wide variety of career fields in the Air and Space Forces.

The most effective approach to the Biology major involves some early intentional scheduling of USAF Academy Core courses. Cadets considering the Biology major should enroll in Chem 100 and Chem 200 in their four-degree year. Biology 215 is a prerequisite for the Biology majors' courses, and should be taken by the fall semester of the three-degree year. However, if transferring from another major, a cadet can still complete a Biology major in two years. Biology 215 may be validated if a cadet received a 4 or 5 on the AP Biology Exam, a 6 or 7 on the IB Standard Level (SL) Biology Exam, or a 5, 6, or 7 on the IB Higher Level (HL) Biology Exam. Transfer credit may be awarded if a cadet has previously taken the equivalent of Biology 215 at another college and received a B or better in the course(s).

The Biology major is designed such that, by completion of our multi-disciplinary curriculum, our graduates shall demonstrate that they have attained the following Student Learning Outcomes:

- 1) an ability to apply a strong conceptual foundation of biological knowledge;
- 2) an ability to apply scientific and quantitative reasoning;
- 3) an ability to apply modeling and simulation;
- 4) an ability to operate within the multidisciplinary nature of science;
- 5) an ability to effectively interpret and communicate scientific information, including ethical and social controversies, to a targeted audience;
- 6) an ability to independently investigate and seek answers about the natural world; and
- 7) development of a thoughtful perspective on the inherent value of the natural world and humanity's relationship to it.

The Biology major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 143 Semester Hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	Introductory Biology with Laboratory	Biology 215
P / C / B Option 2	General Chemistry II Lecture and Lab	Chem 200
Statistics	Introduction to Statistics OR Probability and Statistics for Scientists and Engineers	Math 300 OR Math 356
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses

C. 45 Semester hours of major's courses:

- | | |
|-------------------------------|---|
| 1. Biology 330 | Zoology |
| 2. Biology 331 | Botany |
| 3. Biology 332 | Microbial Diversity |
| 4. Biology 360 | Cell and Molecular Biology |
| 5. Biology 363 | Genetics |
| 6. Biology 380 | Principles of Ecology |
| 7. Biology 459 | Principles of Evolution |
| 8. Biology Option 1 | 300-/400-level Biology course; Chem 234 or Chem 481 |
| 9. Biology Option 2 | 300-/400-level Biology course |
| 10. Biology Option 3 | 300-/400-level Biology course |
| 11. Biology Option 4 | 300-/400-level Biology course |
| 12. Chemistry Option | Chem 230 or Chem 233 |
| 13. Scientific Breadth Option | ≥200-level course in DFBI, DFCH, DFMS, or DFPM
Other courses with Department Head approval |
| 14. Academy Option | (See Supplemental Information) |

Supplemental Information:

An Academy Option course is any course, of 3.0 sem hrs or greater, taught under the supervision of the Dean of Faculty, Commandant of Cadets, Director of Athletics, or 306 FTG. Cadets can use the Academy Option for a variety of purposes, such as helping to meet minor's requirements, instructor upgrade coursework, independent study(ies), or to dig deeper into an area of interest.

SUGGESTED COURSE SEQUENCE

Biology Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Chem 230	3	1	Biology 380	3	1	Biology 459	3	1
	Chem 100	4	2	Biology 215	4	2	Biology 363	4	2	Biology Option #1	3	1
	History 100	3	1	Physics 110	4	2	Adv STEM Option	3	1	Biology Option #2	3	1
	Math 141	3	1	English 211	3	1	Philos 210	3	1	Adv SocioCultural Option	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	History 300	3	1	Astr Engr 310	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	ECE 315	3	1	Phy Ed	0.5	2
		16.5	9		19.5	10	Phy Ed	1	2		15.5	7
								20	9			

Spring	For Lang 2	3	2	Biology 330	4	2	Biology 360	3	1	Academy Option	3	1
	Chem 200	4	2	Biology 332	3	1	Sci Breadth Option	3	1	Biology Option #3	3	1
	Comp Sci 110	3	1	Econ 201	3.5	2	Biology 331	4	2	Biology Option #4	3	1
	English 111	3	1	Pol Sci 211	3	1	Aero Engr 315	3	1	Soc Sci 311	3	1
	Math 142	3	1	Law 220	3	1	Math 300/Math 356	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Phy Ed	0.5	2
		17.25	9	Phy Ed	0.5	2		17.25	8		16.25	7
					20.75	10						

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 45.0 "
Phy Ed = 5.0 "
Total = 143.0 "

CHEMISTRY

THE CHEMISTRY MAJOR AT A GLANCE: From developing the materials employed in the F-35 Joint Strike Fighter, or extending the life of our aircraft fleet, to understanding space sensor and satellite technology, to analyzing for chemical and biological warfare agents, chemistry is at the forefront of Air Force research. The three tracks in chemistry are recommended for those who are interested in chemical, biochemical, or advanced materials research and applications, or medical career fields. They provide fundamental knowledge in analytical, biological, inorganic, organic, and physical chemistry and allow the cadet to select a specialized degree track for in-depth study. The tracks in chemistry emphasize the use of the laboratory methods for reinforcement of lecture material and individual research projects. All three American Chemical Society (ACS) certified tracks prepare cadets for a junior officer position in research, development, or graduate training. A junior officer may be assigned to Air Force Labs, such as the High Explosive Research and Development Facility (HERD), the Directed Energy Lab, the Propulsion Directorate, or the Materials and Manufacturing Directorate. Additionally, cadets graduating with one of the chemistry tracks are very competitive for medical school, dental school, bioenvironmental engineering, pilot, navigator, aircraft maintenance, intelligence, and a host of other operational and support career fields.

All cadets interested in the medical career fields or a science major to include the Chemistry, Engineering Chemistry, Biochemistry tracks, and Biology major should enroll in Chem 100 in the 4th fall, followed by Chem 200 in the 4th spring to allow proper sequencing for medical school application timelines. Cadets should declare one of the American Chemical Society approved Chemistry tracks prior to the fall semester of their third-class year. Cadets can still complete one of the Chemistry tracks if they declare in the fall of their 3rd year, however, course sequencing will not be ideal. Cadets with validation credit will have the opportunity to take additional courses at USAF Academy, and they will be strongly encouraged to take any additional courses in the Humanities and Social Sciences Divisions to better support achievement of the USAF Academy outcomes. To discuss the Chemistry major, contact the DFCH advisor-in-charge.

The Chemistry major tracks are designed such that, by completion of our multi-disciplinary curriculum, our graduates shall demonstrate that they have attained the following Student Learning Outcomes:

- 1) master the fundamental principles of chemistry;
- 2) perform laboratory-based experimentation to reinforce chemical principles and to develop laboratory technique;
- 3) solve problems in the laboratory and classroom to improve scientific reasoning;
- 4) communicate chemistry using written and oral delivery methods; and
- 5) learn in a supportive environment where faculty plan and utilize the best resources in student engagement.

COURSE REQUIREMENTS: 143 – 150 Semester hours

A. 94 - 95 Semester hours of Dean's academic core courses.

Chemistry Track Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Analytical Chemistry	Chem 222
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1*

* Cadets in the Chemistry Track should take an Advanced Sociocultural Option to fulfill the Advanced Open Option.

Biochemistry Track Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Analytical Chemistry	Chem 222
Adv Sociocultural Option		Choose 1
Adv Open Option	Introductory Biology with Laboratory	Biology 215*

* Biology 215 is an approved requirement for the Advanced Open Option for the Biochemistry track. If Biology 215 is validated, cadets should choose any Advanced Sociocultural Option course to fulfill the Advanced Open Option requirement.

Engineering Chemistry Track Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Analytical Chemistry	Chem 222
Adv Sociocultural Option		Choose 1
Adv Open Option	Calculus III / Differential Equations	Math 243/245*

* If any core math course(s) (e.g., Math 141, Math 142, Math 243, and/or Math 245) is(are) validated, the cadet should choose any Advanced Sociocultural Option course to fill the Advanced Open Option requirement.

B. 5 Semester hours of Director of Athletics core courses

C. 48-51 Semester hours of major's courses:

The major's three tracks are Chemistry, Biochemistry, and Engineering Chemistry. Depending on the number and type of course validation(s), cadet academic goals, and performance, major courses may be moved into the fourth-class year (e.g., Math 243, Math 245, and/or Chem 222) or course loading in specific semesters can be adjusted.

Certification/Qualification for 62E (Developmental Engineer): In addition to the three major tracks, expansion upon the core curriculum's engineering background may lead to consideration of Engineering Chemistry track majors award of the Project Engineer (62E1G) Air Force Specialty Code (AFSC), with coordination by the Air Force 62E functional manager and approval of the Air Force Personnel Center (AFPC). Interested cadets must complete two additional engineering courses that must meet the following criteria: 1) both courses will be from the same discipline, 2) both courses will be 300-/400-level equivalents (as determined by the discipline's Department Head), and 3) requires their discipline's core course as a prerequisite. Below are the recommended follow-on courses that have been selected by discipline that meet these criteria.

DFAS	DFAN*	DFME	DFEC	DFCE**
Astr Engr 331	Aero Engr 361	Mech Engr 340	ECE 332	Civ Engr 362
Astr Engr 351	Aero Engr 466	Mech Engr 440	ECE 321 or ECE 281	Civ Engr 463
Astr Engr 436			ECE 382	

* DFAN: Aero Engr 361 requires Aero Engr 241 as a prerequisite.

** DFCE: Civ Engr 362 requires Civ Engr 361 as a co-requisite.

Chemistry Course Sequence (143 semester hours)

The Chemistry track is the most flexible track offered by DFCH, allowing a broader spectrum of in-depth studies. Cadets successfully completing this track are awarded the ACS certified degree of Bachelor of Science in Chemistry.

- | | |
|-------------------|--|
| 1. Chem 233 | Organic Chemistry I |
| 2. Chem 234 | Organic Chemistry II |
| 3. Chem 243 | Organic Chemistry Laboratory |
| 4. Chem 335 | Physical Chemistry I |
| 5. Chem 336 | Physical Chemistry II |
| 6. Chem 344 | Instrumental Analysis |
| 7. Chem 431 | Theoretical Inorganic Chemistry |
| 8. Chem 432 | Special Topics in Inorganic Chemistry |
| 9. Chem 444 | Integrated Chemistry Laboratory |
| 10. Chem 445 | Advanced Laboratory Techniques |
| 11. Chem 481 | Biochemistry I |
| 12. Chem Option 1 | (See Supplemental Information 1) |
| 13. Chem Option 2 | (See Supplemental Information 1) |
| 14. Chem 499 | Independent Study (See Supplemental Information 2) |

Supplemental Information:

1. Chemistry Options can be selected from the following courses: Chem 325, Chem 350, Chem 381, Chem 433, Chem 435, Chem 440, Chem 465, Chem 491, Math 243, Math 245, and Chem 499 (a maximum of 6 semester hours of Chem 499 can count toward Chem Options, although more can be taken if validation or transfer credit permits). Math 243 and Math 245 cannot count towards both a Core option and a Chemistry option.
2. Chem 499, independent research, is the major's capstone course and can only be replaced by exception with Department Head approval. Cadets are expected to complete two semesters of Chem 499B (1.5 units each) or a single Chem 499 (3 units) course. Cadets can use an additional 6 units of Chem 499/499B to fulfill Chem Options (for a maximum of 9 semester hours of 499) with Department Head approval.

Biochemistry Course Sequence (148 semester hours)

Biochemistry investigates the rapidly changing arena where chemistry and biology merge. This provides an excellent foundation in the sciences for those interested in medical school or research fields, such as medicinal chemistry, biopolymers, biosensors, and nanoscience. Cadets successfully completing this track are awarded the ACS certified degree of Bachelor of Science in Chemistry.

- | | |
|---------------------------|--|
| 1. Chem 233 | Organic Chemistry I |
| 2. Chem 234 | Organic Chemistry II |
| 3. Chem 243 | Organic Chemistry Laboratory |
| 4. Chem 335 | Physical Chemistry I |
| 5. Chem 344 | Instrumental Analysis |
| 6. Chem 431 | Theoretical Inorganic Chemistry |
| 7. Chem 444 | Integrated Chemistry Laboratory |
| 8. Chem 445 | Advanced Laboratory Techniques |
| 9. Chem 481 | Biochemistry I |
| 10. Chem 482 | Biochemistry II |
| 11. Chem 491 | Biochemistry Laboratory |
| 12. Biochemistry Option 1 | (See Supplemental Information 1) |
| 13. Biochemistry Option 2 | (See Supplemental Information 1) |
| 14. Biochemistry Option 3 | (See Supplemental Information 1) |
| 15. Chem 499 | Independent Study (See Supplemental Information 2) |

Supplemental Information:

1. Biochemistry Options include the following courses: Chem 336 (Physical Chemistry II), Biology 332, Biology 345, Biology 360, Biology 363, Biology 364, Biology 410, Biology 431, and Biology 440. Cadets interested in Medical School are encouraged to take Biology 360 and/or Biology 363 in their 2^o year, and Biology 410 & Biology 440 in their 1^o year if scheduling permits. If considering Chem 336 as a Biochemistry Option,

cadets with validation and/or transfer credit should consider taking Math 243 or Math 245. Other related courses not specifically listed above can be selected as a biochemistry option with Department Head approval.

2. Chem 499, independent research, is the major's capstone course and can only be replaced by exception with Department Head approval. Cadets are expected to complete two semesters of Chem 499B (1.5 units each) or a single Chem 499 (3 units) course. Cadets can use an additional 3 units of Chem 499/499B to fulfill Chem Options (for a maximum of 6 semester hours of 499) with Department Head approval.
3. Cadets with validation and/or transfer credit who are interested in attending medical school are encouraged to take additional coursework (e.g., Philos 410 Medical Ethics) beyond the conventional Biochemistry Options.

Engineering Chemistry Course Sequence (150 semester hours)

Engineering Chemistry is an interdisciplinary program designed to meet the Air Force's need for qualified personnel with an understanding of modern materials, such as composites, ceramics, polymers, alloys, semiconductors, superconductors, and nanomaterials. This course of study bridges the gap between designing and developing materials at the molecular level and the physical application of these materials at the macro level for structural, electronic, and optical uses. To investigate this relatively new field of study we have taken advantage of a wide range of expertise found at USAF Academy. Cadets who successfully complete this option are awarded the ACS certified degree of Bachelor of Science in Chemistry.

- | | |
|------------------------|--|
| 1. Chem 233 | Organic Chemistry I |
| 2. Chem 234 | Organic Chemistry II |
| 3. Chem 243 | Organic Chemistry Laboratory |
| 4. Chem 335 | Physical Chemistry I |
| 5. Chem 336 | Physical Chemistry II |
| 6. Chem 344 | Instrumental Analysis |
| 7. Chem 431 | Theoretical Inorganic Chemistry |
| 8. Chem 432 | Special Topics in Inorganic Chemistry |
| 9. Chem 440 | Polymer Chemistry |
| 10. Chem 444 | Integrated Chemistry Laboratory |
| 11. Chem 445 | Advanced Laboratory Techniques |
| 12. Chem 465 | Chemistry of Advanced Materials |
| 13. Chem 481 | Biochemistry I |
| 14. Engr Chem Option 1 | (See Supplemental Information 1) |
| 15. Engr Chem Option 2 | (See Supplemental Information 1) |
| 16. Chem 499 | Independent Study (See Supplemental Information 2) |

Supplemental Information:

1. Chem Engr Options: the most commonly used courses for the Engineering Chemistry Track that qualify degree holders for the Project Engineer and Developmental

Engineering AFSCs are Mech Engr 340 (Materials Science for Engineers) and Mech Engr 440 (Physical Metallurgy), but others can be substituted (see Engineering Chemistry Track table above).

- Chem 499, independent research, is the major's capstone course and can only be replaced by exception with Department Head approval. Cadets are expected to complete two semesters of Chem 499B (1.5 units each) or a single Chem 499 (3 units) course. Cadets can use an additional 6 units of Chem 499/499B to fulfill Chem Engr Options (for a maximum of 9 semester hours of 499) with Department Head approval.

SUGGESTED COURSE SEQUENCE

Chemistry Track

	4 ^o	hrs	per	3 ^o	hrs	per	2 ^o	hrs	per	1 ^o	hrs	per
Fall	For Lang 1	3	2	Chem 233	3	1	Chem 481	3	1	Chem 431	3	1
	Beh Sci 110	3	1	Chem 222	4	2	Chem 344	4	2	Chem 444	3	2
	History 100	3	1	Physics 215	4	2	Chem 335	3	1	Chem 499B	1.5	1
	Math 141	3	1	Comp Sci 110	3	1	Econ 201	3.5	2	Chem Option / 499	3	1
	Chem 100	4	2	MSS 251	4.5	2	ECE 315	3	1	Adv SocioCultural Opt	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Phy Ed	1	2	History 300	3	1
		16.5	9		19.5	10		17.5	9	Phy Ed	0.5	2
											17	9
Spring	For Lang 2	3	2	Chem 234	3	1	Chem 499B	1.5	1	Chem 445	3	2
	Physics 110	4	2	Chem 243	4	2	Chem 336	3	1	Chem 432	3	1
	English 111	3	1	Law 220	3	1	Chem Option	3	1	Adv SocioCultural Opt	3	1
	Math 142	3	1	Mech Engr 220	3	1	Aero Engr 315	3	1	Soc Sci 311	3	1
	Chem 200	4	2	Pol Sci 211	3	1	Astr Engr 310	3	1	Philos 210	3	1
	Ldrshp 100	0.75	0	English 211	3	1	Math 356	3	1	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Phy Ed	0.5	2
		18.25	10	Phy Ed	0.5	2	Phy Ed	0.5	2		16.25	8
					20.25	9		17.75	8			

Course Unit Summary	
Core (29)	
Major (14)	
Phy Ed (10)	

Semester Hour Summary	
Core =	94.0 Sem Hours
Major =	44.0 "
Phy Ed =	5.0 "
Total =	143.0 "

Biochemistry Track

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Chem 233	3	1	Chem 481	3	1	Chem 431	3	1
	Beh Sci 110	3	1	Chem 222	4	2	Chem 344	4	2	Chem 444	3	2
	History 100	3	1	Physics 215	4	2	Chem 335	3	1	Chem 491	4	2
	Math 141	3	1	Comp Sci 110	3	1	Mech Engr 220	3	1	Chem 499B	1.5	1
	Chem 100	4	2	MSS 251	4.5	2	Econ 201	3.5	2	Biochem Option	3	1
	Phy Ed	0.5	2	Phy Ed	0.5	2	Law 220	3	1	History 300	3	1
		16.5	9		19	10	Phy Ed	0.5	2	Phy Ed	0.5	2
								20	10		18	10
Spring	For Lang 2	3	2				Chem 499B	1.5	1	Chem 445	3	2
	Physics 110	4	2	Chem 234	3	1	Chem 482	3	1	Biochem Option	3	1
	English 111	3	1	Chem 243	4	2	Biochem Option	3	1	Astr Engr 310	3	1
	Math 142	3	1	Biology 215	4	2	Aero Engr 315	3	1	Adv SocioCultural Opt	3	1
	Chem 200	4	2	Pol Sci 211	3	1	Math 356	3	1	Soc Sci 311	3	1
	Ldrshp 100	0.75	0	English 211	3	1	ECE 315	3	1	Philos 210	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	1	2	Phy Ed	1	2	Phy Ed	0.5	2
					18.75	9		18.25	8		19.25	9

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 95.0 Sem Hours
Major = 48.0 "
Phy Ed = 5.0 "
Total = 148.0 "

Engineering Chemistry Track

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Chem 233	3	1	Chem 481	3	1	Chem 431	3	1
	Beh Sci 110	3	1	Chem 222	4	2	Chem 344	4	2	Chem 499B	1.5	1
	History 100	3	1	Physics 215	4	2	Chem 335	3	1	Chem 444	3	2
	Math 141	3	1	Comp Sci 110	3	1	English 211	3	1	Engr Chem Option	3	1
	Chem 100	4	2	Math 243/245	3	1	Econ 201	3.5	2	Engr Chem Option/499	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	ECE 315	3	1	History 300	3	1
		16.5	9		18	9	Phy Ed	1	2	Phy Ed	0.5	2
								20.5	10		17	9
Spring	For Lang 2	3	2	Chem 234	3	1	Chem 499B	1.5	1	Chem 445	3	2
	Physics 110	4	2	Chem 243	4	2	Chem 336	3	1	Chem 432	3	1
	English 111	3	1	MSS 251	4.5	2	Chem 440/465	4	2	Chem 440/465	3	2
	Math 142	3	1	Pol Sci 211	3	1	Aero Engr 315	3	1	Soc Sci 311	3	1
	Chem 200	4	2	Mech Engr	3	1	Math 356	3	1	Adv SocioCultural Opt	3	1
	Ldrshp 100	0.75	0	Law 220	3	1	Astr Engr 310	3	1	Philos 210	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
					21.75	10		18.75	9		19.25	10

Course Unit Summary
Core (29)
Major (16)
Phy Ed (10)

Semester Hour Summary
Core = 94.0 Sem Hours
Major = 51.0 "
Phy Ed = 5.0 "
Total = 150.0 "

CIVIL ENGINEERING

THE CIVIL ENGINEERING MAJOR AT A GLANCE: Civil engineers solve physical problems that meet human needs. As such, civil engineering is one of the broadest of the engineering disciplines, encompassing many interdependent technical specialties. As a civil engineer, you will plan, design, and supervise the construction of a wide variety of facilities in the natural and built environment, such as bridges, buildings, tunnels, highways, transit systems, dams, airports, irrigation projects, water distribution networks, waste collection and treatment facilities, and offshore structures.

You will use technology's newest applications. Civil engineers are leading users of state-of-the-art computer methods in design, construction, project scheduling, and cost control. Civil engineers are problem solvers, meeting challenges like providing safe drinking water, preventing pollution, restoring deteriorating infrastructure, easing traffic congestion, providing resilient energy supplies, responding to disasters like floods and earthquakes, promoting sustainable development, and community planning. Additionally, civil engineers may perform work in engineering forensics, analyzing failed structures to determine cause of failure. As you develop your skills, you can move into engineering management, oversee the completion of entire projects, and work closely with architects, owners, contractors, government officials, and others involved in all aspects of construction to make people's lives better.

What is civil engineering like in the Air Force? The Air Force civil engineer career field is also broad, including civil and environmental engineers, as well as architects, electrical engineers, and mechanical engineers. Typically, an Air Force civil engineer officer can expect to work at both base and headquarters level assignments. The civil engineer at the base level is responsible for the sustainable construction and maintenance of all facilities; mechanical, electrical, and waste disposal systems; hazardous waste management, runways, and roads. Accordingly, Air Force civil engineering requires many specialties. Your tasks may include technical design, project planning and programming, and possibly managing the maintenance work force of civilian and military personnel. At a headquarters level, your expertise is required to plan, manage, and direct the civil engineering efforts at larger scales across the Air and Space Forces. As a civil engineer, you will have the opportunity to contribute across the world – nearly every USAF and USSF garrison and contingency installation has civil engineers assigned to support the mission!

If your goal is to improve people's lives and their interaction with the built and natural environment, if you like science and mathematics, and are curious about how things work, then perhaps civil engineering is the major for you. The civil engineering major is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>. Upon graduation, you earn a Bachelor of Science in Civil Engineering. A graduate with a civil engineering degree is eligible for a civil engineer, general engineer, bioenvironmental engineer, developmental engineer, rated, or various other Air Force and Space Force Specialty Codes.

To ensure the success of our graduates, we prepare them to attain Program Educational Objectives two to five years after graduation. These are:

- 1) Recognition as successful Air or Space Force officers through demonstration of their ability to:
 - a. Rapidly acquire required knowledge,
 - b. Lead others effectively,
 - c. Effectively apply ethical and moral standards,
 - d. Improve unit performance by application of organizational skills,
 - e. Make sound decisions based on critical thinking, and
 - f. Communicate effectively.
- 2) Selection for career training on, or ahead of, schedule, and for a progression of assignments of increasing responsibility,
- 3) A demonstrated ability to solve Air and Space Force technical problems,
- 4) Success in continuing education, and
- 5) Success in contingency operations.

The foundation that prepares graduates for attaining the Program Educational Objectives is provided by Student Outcomes. Student Outcomes describe what students must attain prior to graduation. These outcomes relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. These are:

- 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;
- 3) an ability to communicate effectively with a range of audiences;
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;
- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions; and
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Incorporated within these outcomes, civil engineering majors must demonstrate knowledge of fundamental concepts of civil engineering commonly applied to solve the types of complex, multidisciplinary problems they will face as Air or Space Force officers. In addition, graduates must demonstrate design competence that includes integration of construction processes.

COURSE REQUIREMENTS: 143 Semester Hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	Introductory Biology with Laboratory	Biology 215
P / C / B Option 2	General Chemistry II Lecture and Lab	Chem 200
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option	Differential Equations	Math 245

B. 5 Semester hours of Director of Athletics core courses.

C. 45 Semester hours of major's courses:

- | | |
|------------------------------|--|
| 1. Civ Engr 330 | Elementary Structural Analysis |
| 2. Civ Engr 351 | Civil Engineering Practices – Field Engineering
(taken 1 st period of 2 ^o summer) |
| 3. Civ Engr 361 | Fundamental Hydraulics |
| 4. Civ Engr 362 | Introduction to Environmental Engineering |
| 5. Civ Engr 372 | Behavior and Analysis of Structures |
| 6. Civ Engr 385 | Project Management and Contract Administration |
| 7. Civ Engr 390 | Introduction to Geotechnical Engineering |
| 8. Civ Engr 451 | Capstone 1 |
| 9. Civ Engr 452 | Capstone 2 |
| 10. Civ Engr 461* | Hydraulic Design |
| 12. Civ Engr 485 | Construction Engineering and Management |
| 12. Civ Engr 488 | Pavement Design and Rehabilitation |
| 13. Civ Engr 405 | Civil Engineering Seminar |
| 14. Structural Design Option | (See Supplemental Information 1) |
| 15. Design Option | (See Supplemental Information 2) |
| 16. Engineering Option | (See Supplemental Information 3) |

* Cadets wishing to participate in either of the Cadet Semester Exchange Abroad or Cadet Semester Study Abroad Programs during the fall semester of the first-class year may, with department head approval, substitute Civ Engr 462 - Site Assessment & Remediation in place of Civ Engr 461 at another point in their academic program. In these cases, Civ Engr 462 may not be used to satisfy the Design Option requirement. Semester Exchange or Study Abroad cadets may also substitute a Design Option or Independent Study for Civ Engr 451 with Department Head approval. Additionally, Engr 402, Professional Engineering Development, is highly recommended.

Supplemental Information:

- Structural Design Option (choose one of the following courses):
 Civ Engr 373 Behavior and Design of Steel Members
 Civ Engr 474 Behavior and Design of Concrete Members
- Design Options (choose two of the following courses):
 Civ Engr 373* Behavior and Design of Steel Members
 Civ Engr 462 Site Assessment & Remediation
 Civ Engr 463 Wastewater Treatment Plant Design
 Civ Engr 464 Architectural Design
 Civ Engr 473 Structural Design
 Civ Engr 474* Behavior and Design of Concrete Members
 Civ Engr 491 Foundation Engineering
 Civ Engr 492 Earth Structures
 * Available as a Design Option if not taken to satisfy the Structural Design Option
- An Engineering Option is any course or course sequence of at least three semester hours taught by the Engineering Division that has not been used to satisfy another curriculum requirement.

SUGGESTED COURSE SEQUENCE

	4°		hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2		Chem 200	4	2	Civ Engr 361	3	1	Civ Engr 461	3	1
	English 111	3	1		Mech Engr 220	3	1	Civ Engr 372	3	1	Civ Engr 485	3	1
	Physics 110	4	2		Pol Sci 211	3	1	Civ Engr 390	3	2	Civ Engr 451	3	2
	Math 141	3	1		English 211	3	1	Engr Option	3	1	History 300	3	1
	Comp Sci 110	3	1		Math 243	3	1	ECE 315	3	1	Astr Engr 310	3	1
	Phy Ed	0.5	2		Philos 210	3	1	Law 220	3	1	Phy Ed	0.5	2
		16.5	9		Phy Ed	1	2	Phy Ed	1	2		15.5	8
						20	9		19	9			
Spring	For Lang 2	3	2								Civ Engr 452	3	2
	History 100	3	1		Civ Engr 330	3	1	Civ Engr 362	3	1	Civ Engr 488	3	1
	Beh Sci 110	3	1		Math 245	3	1	Struct Design Option	3	1	Design Opt	3	1
	Math 142	3	1		MSS 251	4.5	2	Civ Engr 385	3	1	Engr 402	0.5	1
	Chem 100	4	2		Biology 215	4	2	Aero Engr 315	3	1	Civ Engr 405	0	1
	Ldrshp 100	0.75	0		Econ 201	3.5	1	Math 356	3	1	Soc Sci 311	3	1
	Phy Ed	0.5	2		Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Adv SocioCultural Opt	3	1
		17.25	9		Phy Ed	0.5	2	Phy Ed	0.5	2	Ldrshp 400	0.75	0
						19.25	9		16.25	7	Phy Ed	0.5	2
												16.75	10

Course Unit Summary	
Core (29)	
Major (15)	
Phy Ed (10)	

Semester Hour Summary	
Core =	93.0 Sem Hours
Major =	43.0 "
Civ Engr 351 (summer)	3 "
Phy Ed =	5.0 "
Total =	143.0 "

COMPUTER SCIENCE

THE COMPUTER SCIENCE MAJOR AT A GLANCE: Computer Science is the study of computers and their application. The Computer Science major at USAF Academy focuses on computer programming, software engineering, and computing theory. The skills and abilities developed in the Computer Science major are in high demand and may be applied in all Air Force career fields.

Computer Science majors who become cyber operations officers will have opportunities to conduct offensive and defensive cyber operations; establish and operate combat communications capabilities; operate, maintain, and defend computer and communications networks; provide command and control capabilities; and contribute to the development and acquisition of new systems.

Computer Science majors who become pilots (including test pilots) will have greater insight into their aircraft and weapons systems which are highly dependent on software systems. They also may contribute to units by developing applications that improve mission effectiveness through areas such as operations support, data analysis, scheduling, and resource management.

Computer Science is a challenging major. Successful majors typically have strong quantitative and analytical skills and enjoy computer programming. Prior programming experience is neither assumed nor required for success in the major.

Graduates of the Computer Science program will have attained the following Student Outcomes:

- 1) Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.
- 2) Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
- 3) Communicate effectively in a variety of professional contexts.
- 4) Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
- 5) Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
- 6) Apply computer science theory and software development fundamentals to produce computing-based solutions.
- 7) Apply security principles and practices to maintain operations in the presence of risks and threats.

Successful completion of the Computer Science major leads to the degree of Bachelor of Science in Computer Science. The Computer Science program is accredited by the Computing Accreditation Commission of ABET, <http://www.abet.org>, under the commission's General Criteria and Program Criteria for Computer Science.

Computer Science majors must take Programming Fundamentals (Comp Sci 210) in the fall of their 3-degree year or validate the course. If you have any questions about the Computer Science

major or career opportunities, please stop by the Computer and Cyber Sciences department or call the Computer Science Advisor-in-Charge at 333-6802.

The Computer Science major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 144 Semester Hours

A. 94 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Physics II with Laboratory	Physics 215
P / C / B Option 2	Introductory Biology with Laboratory or General Chemistry II Lecture and Lab	Biology 215 or Chem 200
Statistics	Probability and Statistics for Scientists and Engineers or Advanced Probability and Statistics	Math 356 or Math 377
Adv STEM Option	Programming Fundamentals	Comp Sci 210
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 45 Semester hours of major's courses:

- | | |
|---------------------|--|
| 1. Math 340 | Discrete Mathematics |
| or Math 474 | Combinatorics and Graph Theory |
| 2. Comp Sci 220 | Data Structures and Systems Programming |
| 3. Comp Sci 330 | Software Design and Development |
| 4. Comp Sci 350 | Software Engineering |
| 5. Comp Sci 351 | Computer Organization and Architecture |
| 6. Comp Sci 364 | Databases and Applications |
| 7. Comp Sci 380 | Design and Analysis of Algorithms |
| 8. Comp Sci 426 | Languages and Machines |
| 9. Comp Sci 453 | Software Engineering Capstone Project I |
| 10. Comp Sci 454 | Software Engineering Capstone Project II |
| 11. Comp Sci 467 | Computer Networks |
| 12. Comp Sci 483 | Operating Systems |
| 13. Comp Sci Option | (See Supplemental Information 1) |
| 14. Comp Sci Option | (See Supplemental Information 1) |
| 15. Math Option | (See Supplemental Information 2) |
| Colloquium Courses: | |
| Comp Sci 405 | Computer Science Colloquium I |
| Comp Sci 406 | Computer Science Colloquium II |

Supplemental Information:

1. The following are Comp Sci Options:

Comp Sci 362	Computer Simulation
Comp Sci 385	Software Dev for Mobile Devices
Comp Sci 471	Artificial Intelligence
Comp Sci 472	Autonomous Systems Integration
Comp Sci 474	Computer Graphics
Comp Sci 495	Special Topics in Computer Science
Comp Sci 496	Computer Science Seminar
Comp Sci 499	Independent Study
Cyber Sci 333	Cyber Warfare
Cyber Sci 334	Cyber Defense
Cyber Sci 431	Cryptography
Astr Engr 436	Small Spacecraft Engineering I
Astr Engr 437	Small Spacecraft Engineering II
ECE 281	Digital Design and Computer Architecture
ECE 348	Telecommunication Principles
ECE 448	Applications of Software Defined Radios
Law 440	Cyber Law
MSS 444	Space and Cyber Strategy for National Strategy
Ops Rsch 310	Systems Analysis
Pol Sci 466	Cyber Security Policy and Politics
Sys Engr 311	Model Based Systems Engineering
Sys Engr 460	Unmanned Aerial Vehicle (UAV) Systems
Note: Only one Astr Engr course can count as a Comp Sci option.	

2. The following are Math options:

Cyber Sci 431	Cryptography
ECE 346	Engineering Math with ECE Applications
Math 243 (or Math 253)	Calculus III
Math 245	Differential Equations
Math 344	Applied Linear Algebra
Math 359	Design and Analysis of Experiments
Math 378	Applied Statistical Modeling
Philos 370	Introduction to Symbolic Logic

SUGGESTED COURSE SEQUENCE

Computer Science Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Comp Sci 210	4	2	Comp Sci 330	3	1	Comp Sci 426	3	1
	Beh Sci 110	3	1	Physics 215	4	2	Comp Sci 350	3	1	Comp Sci 453	3	2
	History 100	3	1	ECE 315	3	1	Math Option	3	1	Comp Sci Option 1	3	1
	Math 141	3	1	English 211	3	1	Comp Sci 467	3	1	Comp Sci 405	0	1
	Comp Sci 110	3	1	Law 220	3	1	Pol Sci 211	3	1	Aero Engr 315	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Econ 201	3.5	2	Soc Sci 311	3	1
		15.5	8		18	9	Phy Ed	0.5	2	Phy Ed	0.5	2
								19	9		15.5	9

Spring	For Lang 2	3	2	Comp Sci 220	3	1	Comp Sci 364	3	1	Comp Sci 454	3	2
	Chem 100	4	2	Comp Sci 351	3	1	Comp Sci 380	3	1	Comp Sci Option 2	3	1
	English 111	3	1	Math 340	3	1	Comp Sci 483	3	1	Comp Sci 406	0	1
	Math 142	3	1	MSS 251	4.5	2	Philos 210	3	1	History 300	3	1
	Physics 110	4	2	Chem 200 or Bio 215	4	2	Math 356	3	1	Astr Engr 310	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	Open Option	3	1	SocioCultural Choice	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2	Phy Ed	1	2	Phy Ed	0.5	2
					21.75	10		19.75	8		16.25	9

Course Unit Summary
Core (31)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 94.0 Sem Hours
Major = 45.0 "
Phy Ed = 5.0 "
Total = 144.0 "

CYBER SCIENCE

THE CYBER SCIENCE MAJOR AT A GLANCE: The Cyber Science major focuses on computer programming, embedded systems, networks, telecommunications, computer systems, computer investigations, and cyber operations. The skills developed in the Cyber Science major uniquely prepare cadets to 1) establish, operate, maintain, and defend computer and communications networks, 2) provide secure command and control capabilities, and 3) contribute to a variety of cyber operation missions. Successful completion of the Cyber Science major leads to a Bachelor of Science in Cyber Science.

Cyber Science majors who become cyber operations officers will have opportunities to: conduct offensive and defensive cyber operations; establish and operate combat communications capabilities; operate, maintain, and defend computer and communications networks; provide command and control capabilities; and contribute to the development and acquisition of new systems.

Cyber Science majors who become pilots will have greater insight into their aircraft and weapons systems which are highly dependent on software systems. They will have an in-depth knowledge of how cyberspace risks may impact mission capabilities. They may also contribute to units by developing applications that improve mission effectiveness through areas such as operations support, data analysis, scheduling, and resource management.

Cyber Science is a challenging major. Successful cadets typically have strong quantitative and analytical skills and enjoy computer programming. Prior programming experience is neither assumed nor required for success in the major. Graduates of the Cyber Science program will have attained the following Student Outcomes:

- 1) Analyze a complex computing problem, and apply principles of computing and other relevant disciplines to identify solutions.
- 2) Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
- 3) Communicate effectively in a variety of professional contexts.
- 4) Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
- 5) Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
- 6) Apply security principles and practices to maintain operations in the presence of risks and threats.
- 7) Create intentional effects through social and technical manipulation of adversarial systems.

Cyber Science majors must take Programming Fundamentals (Comp Sci 210) in the fall of their 3-degree year or validate the course. If you have any questions about the Cyber Science major or career opportunities, please stop by the Computer and Cyber Sciences department or call the Cyber Science Advisor-in-Charge at 333-7622.

The Cyber Science major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 145 Semester Hours

A. 94 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Physics II with Laboratory	Physics 215
P / C / B Option 2	Introductory Biology with Laboratory or General Chemistry II Lecture and Lab	Biology 215 or Chem 200
Statistics	Probability and Statistics for Scientists and Engineers or Advanced Probability and Statistics	Math 356 or Math 377
Adv STEM Option	Programming Fundamentals	Comp Sci 210
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 46 Semester hours of major's courses:

- | | |
|--------------------------------------|--|
| 1. Math 340 | Discrete Mathematics |
| or Math 474 | Combinatorics and Graph Theory |
| 2. Comp Sci 220 | Data Structures and Systems Programming |
| 3. Cyber Sci 333 | Cyber Warfare |
| 4. Cyber Sci 334 | Cyber Defense |
| 5. Cyber Sci 431 | Cryptography |
| 6. Cyber Sci 435 | Cyber Operations |
| 7. Cyber Sci 438 | Cyber Science Capstone I |
| 8. Cyber Sci 439 | Cyber Science Capstone II |
| 9. Comp Sci 467 | Computer Networks |
| 10. Comp Sci 483 | Operating Systems |
| 11. ECE 281 | Digital Design and Computer Architecture |
| 12. ECE 348 | Telecommunication Principles |
| 13. Cyber Science Technical Elective | (See Supplemental Information 1) |
| 14. Cyber Science Policy Elective | (See Supplemental Information 2) |
| 15. Cyber Science Open Elective | (See Supplemental Information 3) |
| Colloquium Courses: | |
| Cyber Sci 405 | Cyber Science Colloquium I |
| Cyber Sci 406 | Cyber Science Colloquium II |

Supplemental Information:

- The following are Cyber Science Technical Elective Options:

Comp Sci 330	Software Design and Development
Comp Sci 350	Software Engineering

Comp Sci 364	Databases and Applications
Comp Sci 385	Software Development for Mobile Devices
Comp Sci 426	Languages and Machines
Comp Sci 471	Artificial Intelligence
Comp Sci 472	Autonomous Systems Integration
Comp Sci 495	Special Topics in Computer Science
Comp Sci 499	Independent Study
Cyber Sci 499	Independent Study
ECE 382	Embedded Computer Systems I
ECE 383	Embedded Computer Systems II
ECE 448	Applications of Software Defined Radios
ECE 484	Advanced Digital System Design
ECE 485	Advanced Computer Architecture
Math 378	Applied Statistical Modeling

- The following are Cyber Science Policy Elective Options

Law 440	Cyber Law
MSS 444	Space and Cyber Strategy for National Security
Pol Sci 466	Cyber Security Policy and Politics
- Cyber Science Open Elective Options:
Any course from the Cyber Science Technical Electives or the Cyber Science Policy Elective lists above.

SUGGESTED COURSE SEQUENCE

Cyber Science Major

	4 ^o	hrs	per	3 ^o	hrs	per	2 ^o	hrs	per	1 ^o	hrs	per
Fall	For Lang 1	3	2	Comp Sci 210	4	2	Cyber Sci 333	4	2	Cyber Sci 435	3	1
	Beh Sci 110	3	1	Physics 215	4	2	Comp Sci 467	3	1	Cyber Sci 438	3	2
	History 100	3	1	ECE 315	3	1	Cyber Sci Elective #1	3	1	Cyber Sci Elective #2	3	1
	Math 141	3	1	English 211	3	1	Pol Sci 211	3	1	Cyber Sci 405	0	1
	Comp Sci 110	3	1	MSS 251	4.5	2	Econ 201	3.5	1	ECE 348	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	History 300	3	1	Aero Engr 315	3	1
		15.5	8		19.5	10	Phy Ed	0.5	2	Phy Ed	0.5	2
								20	9		15.5	9
Spring	For Lang 2	3	2	Comp Sci 220	3	1	Cyber Sci 334	3	1	Cyber Sci 439	3	2
	Chem 100	4	2	ECE 281	3	1	Cyber Sci 483	3	1	Cyber Sci Elective #3	3	1
	English 111	3	1	Math 340	3	1	Cyber Sci 431	3	1	Cyber Sci 406	0	1
	Math 142	3	1	Law 220	3	1	Philos 210	3	1	Astr Engr 310	3	1
	Physics 110	4	2	Chem 200 or Bio 215	4	2	Math 356	3	1	Soc Sci 311	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	Adv Open Option	3	1	Adv SocioCultural Op	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2	Phy Ed	1	2	Phy Ed	0.5	2
					20.25	9		19.75	8		13.25	7

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 94.0 Sem Hours
Major = 46.0 "
Phy Ed = 5.0 "
Total = 145.0 "

DATA SCIENCE

THE DATA SCIENCE MAJOR AT A GLANCE: The Data Science major focuses on planning for, acquisition, management, analysis of, and inference from data. The multidisciplinary skills developed in the major draw from the fields of mathematics, statistics, computer science, and information science. The Data Science major places a strong emphasis on critical thinking and problem solving within the context of data-driven decision making.

The field of Data Science is experiencing rapid growth, due to the massive amounts of newly available data in science, industry, and government. Consequently, the Department of Defense desires to become a truly data-driven organization that can access, manage, and secure data and turn it into actionable insight for faster and more effective decision making. This is reflected in the 2018 National Defense Strategy, which lists advanced computing, “big data” analytics, and artificial intelligence as new technologies that are changing the character of war. Military leaders with data science knowledge, skills, and abilities will be vital to winning the wars of the future.

For the Air and Space Forces in particular, officers with Data Science expertise are in high demand. Data Science majors will be uniquely qualified for careers in operations research analysis, cyberspace operations, information operations, and intelligence. However, students who pursue operational careers as pilots, combat systems, or space operations officers will also greatly benefit from the skills developed within the major, given the massive amounts of data produced by 5th generation aircraft and satellites. Additionally, graduates of the Data Science major will have the strong decision-making capabilities expected of Air and Space Force leaders in this increasingly data-driven world.

The prevalence of data in academic disciplines and Air and Space Force career fields dictates that the Data Science major be interdisciplinary. Consequently, the major is jointly administered by the Departments of Computer and Cyber Sciences, Management, and Mathematical Sciences. Additionally, the major includes a multi-course focus track that permits exposure to a variety of topics in Basic Sciences, Social Sciences, Engineering, and Humanities. Data Science is an exciting and challenging major. Successful students typically demonstrate a balance of intellectual curiosity along with strong quantitative and communication skills. Graduates of the Data Science program will have attained the following Student Outcomes:

- 1) An understanding of and an ability to apply the following data science concepts, tools and methods to data analysis pipelines:
 - a) Data acquisition;
 - b) Data preprocessing;
 - c) Exploratory data analysis;
 - d) Inferential and predictive thinking, modeling and analysis; and
 - e) Computational thinking, data structures, and algorithms.
- 2) An understanding of ethical, legal, societal, and economic concerns in application of data science concepts.
- 3) An ability to visualize, interpret and communicate the output of data analysis pipelines to Stakeholders.

- 4) An ability to function on multi-disciplinary teams using concepts and tools from data science.

The Data Science major contributes to both the development and assessment of the critical thinking outcome.

COURSE REQUIREMENTS: 141 Semester hours

A. 94 Semester hours of Dean's academic core courses:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics	Advanced Probability and Statistics	Math 377
Adv STEM Option	Programming Fundamentals	Comp Sci 210
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 27 Semester hours of required major's courses:

- | | |
|-----------------|---|
| 1. Comp Sci 220 | Data Structures and Systems Programming |
| 2. Data 364 | Data Acquisition and Management |
| 3. Comp Sci 471 | Artificial Intelligence |
| 4. Data 421 | Capstone in Data Science I |
| 5. Data 422 | Capstone in Data Science II |
| 6. Mgt 391 | Business Data Analytics |
| 7. Math 344 | Applied Linear Algebra |
| 8. Math 378 | Applied Statistical Modeling |
| 9. Philos 320 | Ethics and Technology |

D. 6 Semester hours from a Domain Emphasis Track.

Each track is designed to give students background knowledge in a specific domain by taking two courses where data science techniques are applied in support of problem solving, decision making, and/or persuasive argument. Ideally, a student's capstone experience should focus on research within their chosen domain. Example tracks are listed below, but other sequences may be approved by the Chair of the Data Science Committee.

Domain Emphasis Track Examples (choose a track or work with your advisor to create your own):

Behavioral Sciences
 Biology
 Chemistry
 Computer Science
 Cyber Science
 Ecology
 Economics
 Engineering
 Finance
 Genetics
 Geospatial Analysis

Marketing
 Meteorology
 Microbiology
 Military Strategic Studies
 Physics
 Political Science
 Operations Research
 Remote Sensing
 Software Development
 Sports Analytics

E. 9 Semester hours of Data Science Option courses. These courses allow students to explore topics foundational to data science and/or provide experiences for students to acquire, curate, and analyze data and to communicate results. In addition to the list below, other courses may be approved by the Chair of the Data Science Committee.

Comp Sci 330	Software Design and Development
Comp Sci 350	Software Engineering
Comp Sci 351 (or ECE 281)	Computer Organization and Architecture (or Digital Design and Computer Architecture)
Comp Sci 362	Computer Simulation
Comp Sci 380	Design and Analysis of Algorithms
Comp Sci 472	Autonomous Systems Integration
Econ 365	Econometrics I
Econ 465	Econometrics II
Econ 466	Advanced Econometrics
Geo 440	Advanced Geospatial Analysis
Geo 482	Advanced Remote Sensing
Math 243 (or Math 253)	Calculus III (or Advanced Placed Calculus III)
Math 340	Discrete Mathematics
Math 359	Design and Analysis of Experiments
Ops Rsch 476	Sports Analytics
Data 495	Special Topics in Data Science
Data 499	Independent Study
Cadets may choose no more than one of the following courses as a Data Science Option:	
English 335	Speech and Communication Studies
English 345	Digital Humanities

SUGGESTED COURSE SEQUENCE

Data Science Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	Beh Sci 110	3	1	Comp Sci 210	4	2	Domain Emph 1	3	1	Comp Sci 471	3	1
	Comp Sci 110	3	1	MSS 251	4.5	2	Data Option 1	3	1	Data 421	3	2
	English 111	3	1	Econ 201	3.5	1	Mgt 391	3	1	Philos 320	3	1
	For Lang 1	3	2	P / C / B Option 1	4	2	Math 377	3	1	ECE 315	3	1
	Math 141	3	1	English 211	3	1	Astr Engr 310	3	1	History 300	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Adv Sociocultural Opt	3	1	Phy Ed	0.5	2
		15.5	8		20	10	Phy Ed	1	2		15.5	8
								19	8			
Spring	Chem 100	4	2	Comp Sci 220	3	1	Domain Emph 2	3	1	Data Option 3	3	1
	For Lang 2	3	2	Math 344	3	1	Comp Sci 364	3	1	Data 422	3	2
	History 100	3	1	Law 220	3	1	Math 378	3	1	Aero Engr 315	3	1
	Math 142	3	1	Mech Engr 220	3	1	Data Option 2	3	1	Soc Sci 311	3	1
	Physics 110	4	2	Pol Sci 211	3	1	Philos 210	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	P / C / B Option 2	4	2	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10	Phy Ed	0.5	2		16.25	7		16.25	8
					20.25	9						

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 94.0 Sem Hours
Major = 42.0 "
PhyEd = 5.0 "
Total = 141.0 "

ECONOMICS

THE ECONOMICS MAJOR AT A GLANCE: Economics is the scientific study of decision making. Individuals and institutions have limited resources which forces them to make tradeoffs. Economists employ the scientific method to formulate theories, gather data, and analyze these tradeoffs to recommend optimal decisions, make predictions about behavior, and evaluate policy effectiveness. The strength of the U.S. economy contributes directly to our national defense. Both the Air and Space Forces rely on industry partners to develop and provide military platforms and capabilities. Our nation uses economic tools to support our allies and thwart our enemies.

The course of study includes a foundational sequence of core courses in microeconomics, macroeconomics, and econometrics. Microeconomics is the study of resource allocation at the producer and consumer levels. It includes an investigation of government policies that can help or hinder the efficiency of market outcomes. Macroeconomics aggregates market results to study economies at the national level. Courses in macroeconomics can also focus on international and regional issues that influence economies. Econometrics is used at all levels of economics to evaluate theories and policy outcomes using statistical and data science techniques.

The economics program is designed to develop officers who can:

- 1) Apply the economic way of thinking to analyze problems,
- 2) Evaluate the strengths and limitations of economic analysis,
- 3) Collect and analyze economic data to recognize trends, test economic theories, and evaluate economic arguments; and
- 4) Effectively communicate economic concepts and analyses.

Program electives allow cadets to apply quantitative economic methods to focus on business, finance, international economics, public policy, and other fields of applied economics. Cadets develop analytic and empirical skills necessary to solve a wide range of problems such as resource allocation, production efficiency, incentive design, and policy evaluation. The economics major develops critical thinking and problem-solving skills and is widely recognized as a solid background for careers as leaders and practitioners in a wide range of fields including data science, technology, business, education, government, and law.

Officers with a background in economics will find themselves well prepared to serve as leaders in the Air and Space Forces. Commanders are required to lead people, execute missions, improve organizations, and manage resources. The study of economics will provide a theoretical and empirical framework to understand incentives, production, policymaking, and resource allocation.

The Economics major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option	Systems Analysis	Ops Rsch 310
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

Required Economics Courses (10 courses – 30 Sem Hrs)

1. Econ 332 Intermediate Microeconomics I: Competitive Markets
2. Econ 333 Intermediate Microeconomic II: Market Failures & Advanced Topics
3. Econ 355 Principles of Macroeconomics
4. Econ 356 Intermediate Macroeconomics
5. Econ 361 Econometric Research Methods and Statistical Tools

6. Econ 365 Econometrics I
7. Econ 465 Econometrics II
8. Econ 450 International Economics
9. Econ 440 Development of Economic Thought
10. Capstone Econ 480 or Econ 482

Economics Electives (3 courses – 9 Sem Hrs)

11. Economics Elective #1
12. Economics Elective #2

Any of the following courses may fill Economics Electives #1 & #2

- Econ 351 Comparative Economic Systems
- Econ 367 Industrial Organization
- Econ 377 Financial Markets *
- Econ 411 Introduction to Game Theory *
- Econ 422 Labor Economics
- Econ 447 Quantitative Economic Methods *
- Econ 454 Economics of Development and Conflict
- Econ 466 Advanced Econometrics
- Econ 473 Public Economics
- Econ 475 Money, Banking, and Financial Institutions
- Econ 476 Economics of Sports

Econ 480	Defense Economics (if not filling major requirement #9)
Econ 481	Applied Economic Research Capstone I
Econ 495	Special Topics
Econ 499	Independent Study in Economics
Soc Sci 420	Law and Economics
Soc Sci 444	International Political Economy
Or any other Economics elective that the department creates in the future	

13. Economics Elective #3

In addition to the above courses, any course from the list below may fill Economics Electives #3.

Geo 360	Economic Geography
Law 340	Business Law
Math 243/253	Calculus III / Advanced Placed Calculus III *
Math 245	Differential Equations *
Math 320	Foundations of Mathematics *
Math 340	Discrete Mathematics *
Math 342	Numerical Analysis *
Math 344	Applied Linear Algebra *
Math 359	Design and Analysis of Experiments *
Math 360	Linear Algebra *
Math 366	Real Analysis I
Math 378	Applied Statistical Modeling
Mgt 337	Managerial Finance
Mgt 341	Financial Accounting
Mgt 342	Managerial Accounting
Mgt 375	Market Analysis
Mgt 382	Investments
Ops Rsch 311	Determinate Models *
Ops Rsch 312	Probabilistic Models *
Ops Rsch 421	Capstone in Operations Research I *
Ops Rsch 422	Capstone in Operations Research II *
Philos 200	Introduction to Philosophy
Philos 370	Introduction to Symbolic Logic
Soc Sci 483	Principles of Negotiation
Sys Engr 301	Project Engineering
Sys Engr 310	Introduction to Systems Engineering *

Academy Option (1 course – 3 Sem Hrs)

14. Academy Option: any course taught for credit under the supervision of the Dean of the Faculty, Commandant of Cadets, the Director of Athletics, or the 306 FTG. Courses must carry at least three semester hours of credit.

Supplemental Information:

Curriculum

The economics major does not require cadets to declare a specific sub track; cadets are encouraged to create their own program of study within the broader constraints of selecting from the provided list of electives. Cadets may use these suggested tracks as a starting point to develop, with an advisor, an individualized program of study.

Behavioral Economics

Econ 411, SocSci 420, Mgt 375, SocSci 483

Data Analysis in Economics

Econ 466, Econ 481, Math 344, Math 378

Managerial Economics/Finance

Econ 377, Econ 475, Mgt 341, Law 340

Public Policy

Econ 351, Soc Sci 444, Econ 473, Econ 340

Quantitative Economics

Econ 447, Econ 466, Math 245, Math 366

International Economics

Econ 351, Soc Sci 444, Econ 454, Econ 480

Note: Econ 374 and Econ 423 are not intended for economics majors.

Air and Space Force Career Fields

- Most career fields are open to economics majors. Economics majors who do not go into rated career fields tend to favor one of the career fields below; see the following list of suggestions for students interested in these career fields.
- 15A (Operations Analysis Officer) has no additional requirements; electives listed above with an “*” are recommended.
- 63A (Acquisition Manager) has no additional requirements; Sys Engr 301 or Mgt 401 is recommended.
- 64P (Contracting) has no additional requirements; Law 340 & Soc Sci 483 are recommended.
- 65x (Financial Management and Cost Analysis) has no additional requirements; Mgt 341 & Mgt 342 are recommended.

Graduate School

- Students considering graduate school in economics should take as many quantitative economics courses as possible.

- Students considering graduate school in finance should take the finance enrichment electives and Math 243/253, Math 344, and Ops Rsch 312.
- Students considering a Masters of Business Administration (MBA) program should consider Mgt 337, Mgt 342, Mgt 345, and Mgt 375 to meet likely MBA program prerequisites.

SUGGESTED COURSE SEQUENCE

Economics Major

4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
For Lang 1	3	2	Econ 201	3.5	2	Econ 333	3	1	Econ 465	3	1
Beh Sci 110	3	1	MSS 251	4.5	2	Econ 355	3	1	Econ 450	3	1
History 100	3	1	English 211	3	1	Econ 361	3	1	Econ Elective	3	1
Math 141	3	1	Pol Sci 211	3	1	Statistics Option	3	1	Econ Elective	3	1
Comp Sci 110	3	1	P / C / B Option	4	2	ECE 315	3	1	Adv Open Option	3	1
Phy Ed	0.5	2	Phy Ed	1	2	Adv Sociocultural Opt	3	1	Phy Ed	0.5	2
	15.5	8		19	10	Phy Ed	1	2		15.5	7
							19	8			

For Lang 2	3	2	Econ 332	3	1	Econ 356	3	1	Econ 480 or 482	3	1
Chem 100	4	2	Philos 210	3	1	Econ 365	3	1	Econ 440	3	1
English 111	3	1	OpsRsch 310	3	1	History 300	3	1	Econ Elective	3	1
Math 142	3	1	P / C / B Option	4	2	Aero Engr 315	3	1	Academy Option	3	1
Physics 110	4	2	Law 220	3	1	Soc Sci 311	3	1	Astr Engr 310	3	1
Ldrshp 100	0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Phy Ed	0.5	2
	18.25	10	Phy Ed	0.5	2		16.25	7		16.25	7
				20.25	9						

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

ELECTRICAL AND COMPUTER ENGINEERING

THE ELECTRICAL AND COMPUTER ENGINEERING MAJOR AT A GLANCE: The impact of Electrical and Computer Engineering (ECE) in the 21st century battlefield is more vital than ever before. The Air and Space Forces' increasing reliance on electronic surveillance, electronic warfare, cyber warfare, advanced communication systems, and modern computers has created an insatiable demand for Electrical and Computer Engineers. The ECE major prepares the student with a deep understanding of the basic principles of modern electronic systems such as "smart" computer-guided munitions, advanced "fly-by-wire" aircraft radio systems capable of communicating through hostile electronic jamming environments, terrain-following radar, and much more.

As an Air or Space Force Electrical and Computer Engineer, you will combine your creativity and analytic ingenuity to optimize existing electronic systems, as well as design new systems that have not yet even been conceived. Air and Space Force officers who understand these emerging technologies can use their expertise to gain a "combat edge" over our adversaries. If you want to help the Air and Space Forces develop new and better techniques to accomplish its mission, this major may be for you.

Required coursework in the ECE major includes the core curriculum and courses that apply physics, mathematics, and computer science, such as electrical and electronic circuit and systems analysis, computer systems, signal processing, electromagnetic fields and waves, wireless communications, and electrical power systems. The ECE curriculum culminates in a two-semester capstone design course where seniors work on a team, building on their coursework to design an electronic system that meets the needs of a real customer.

To ensure the success of our graduates, we prepare them to attain Program Educational Objectives (PEOs) two to five years after graduation. These PEOs are:

Cadets who major in Electrical and Computer Engineering will have been successful Air or Space Force Officers who have:

- 1) Applied their engineering, management, and leadership skills in service to our nation;
- 2) Demonstrated intellectual growth through self-study, continuing education, and professional development;
- 3) Provided technical leadership and disciplinary knowledge, with a broad understanding of the potential ethical and societal impacts of technology; and
- 4) Applied engineering methodology and creativity to technological problems while effectively communicating to diverse audiences.

The qualities, or outcomes, of the ECE major that prepare each graduate for attaining these PEOs are the following Student Outcomes (SOs). Each Electrical and Computer Engineering graduate shall demonstrate:

- 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;

- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;
- 3) an ability to communicate effectively with a range of audiences;
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;
- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions; and
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The Electrical and Computer Engineering major is an excellent choice if you are interested in an advanced degree. As an electrical and computer engineer, your knowledge and skill will be in high demand, both in the Air and Space Forces and in society as a whole.

If considering Electrical and Computer Engineering, you should take ECE 215 and ECE 245 no later than the fall semester of your 3^o year, if not sooner. Additionally, Math 243 should be taken no later than the spring semester of your 3^o year.

COURSE REQUIREMENTS: 147 Semester hours

A. 94 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Physics II with Laboratory	Physics 215
P / C / B Option 2	Introductory Biology with Laboratory or General Chemistry II Lecture and Lab	Biology 215 or Chem 200
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option	Programming Fundamentals	Comp Sci 210
ECE 315	Principles of Electronic Cyber Warfare	ECE 215

B. 5 Semester hours of Director of Athletics core courses.

C. 48 Semester hours of major's courses:

1. ECE 245 Differential Equations with Circuit Applications I
2. ECE 281 Digital Design and Computer Architecture

3. ECE 321	Electronics I
4. ECE 332	Differential Equations with Circuit Applications II
5. ECE 333	Signal Processing and Linear Systems
6. ECE 343	Electromagnetics
7. ECE 346	Engineering Math with ECE Applications
8. ECE 382	Embedded Computer Systems I
9. ECE 463	Capstone Design Project I
10. ECE 464	Capstone Design Project II

Additional depth and breadth will come from choosing six technical electives:

11. ECE Option #1: Choose ECE 447, ECE 485, or ECE 487
12. – 16. ECE Option #2, #3, #4, #5, #6: Choose five from the following list, without repeating a course:
- | | |
|--------------|---|
| ECE 311 | Electric Power |
| ECE 383 | Embedded Computer Systems II |
| ECE 386 | AI Hardware Applications |
| ECE 387 | Introduction to Robotic Systems |
| ECE 423 | Power Electronics |
| ECE 444 | Introduction to Antenna Theory and Design |
| ECE 447 | Communication Systems |
| ECE 434 | Digital Signal Processing |
| ECE 448 | Applications of Software Defined Radios |
| ECE 485 | Advanced Computer Architecture |
| ECE 487 | Advanced Robotics |
| Comp Sci 220 | Data Structures and Systems Programming* |
| Comp Sci 471 | Artificial Intelligence |
| Comp Sci 472 | Autonomous Systems Integration |
| Comp Sci 483 | Operating Systems* |

While the following tracks are not required, they are encouraged.

Electrical Engineering Track

ECE 311	Electric Power
ECE 434	Digital Signal Processing
ECE 447	Communications Systems
Pick 1:	
ECE 383	Embedded Computer Systems II
ECE 387	Introduction to Robotic Systems
ECE 423	Power Electronics
ECE 444	Introduction to Antenna Theory and Design
ECE 448	Applications of Software Defined Radios
ECE 487	Advanced Robotics

Computer Engineering Track

Comp Sci 220

ECE 383

ECE 485

Pick 2:

ECE 387

ECE 434

ECE 448

ECE 487

Comp Sci 471

Comp Sci 472

Comp Sci 483

Data Structures and Systems Programming*

Embedded Computer Systems II

Advanced Computer Architecture

Introduction to Robotic Systems

Digital Signal Processing

Introduction to Software Defined Radios

Fundamental of Robotics

Artificial Intelligence

Autonomous Systems Integration

Operating Systems*

AFIT Computer Engineering Master's program requires Comp Sci 220 and Comp Sci 483

SUGGESTED COURSE SEQUENCE

Electrical and Computer Engineering Major

(Electrical Engineering Track)

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	Comp Sci 110	3	1	ECE 210*	1	1	ECE 321	3	2	ECE 434	3	1
	Beh Sci 110	3	1	ECE 245	3	1	ECE 346	3	1	ECE 447	3	1
	History 100	3	1	ECE 215	3	1	ECE 382	3	1	ECE 463	3	2
	For Lang 1	3	2	Comp Sci 210	4	2	ECE 311	3	1	Aero Engr 315	3	1
	Math 141	3	1	Physics 215	4	2	Econ 201	3.5	2	Adv SocioCultural Opt	3	1
	Phy Ed	0.5	2	Pol Sci 211	3	1	Law 220	3	1	Philos 210	3	1
		15.5	8	Phy Ed	1	2	Phy Ed	1	2	Phy Ed	0.5	2
					19	10		19.5	10		18.5	9
Spring	Chem 100	4	2	ECE 281	3	1	ECE 333	3	1			
	English 111	3	1	ECE 332	3	1	ECE 343	3	1	ECE 448	3	1
	For Lang 2	3	2	Mech Eng 220	3	1	ECE Option	3	1	ECE Option	3	1
	Math 142	3	1	Math 243	3	1	History 300	3	1	ECE 464	3	2
	Physics 110	4	2	English 211	3	1	Math 356	3	1	Astr Engr 310	3	1
	Ldrshp 100	0.75	0	P/C/B Option 2	4	2	MSS 251	4.5	2	Soc Sci 311	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
					20.25	9		20.75	9		16.25	8

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 94.0 Sem Hours
Major = 48.0 "
Phy Ed = 5.0 "
Total = 147.0 "

* ECE 210 is suggested, not required.

Electrical and Computer Engineering Major

(Computer Engineering Track)

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	Comp Sci 110	3	1	ECE 210*	1	1	ECE 321	3	2	ECE Option	3	1
	Beh Sci 110	3	1	ECE 245	3	1	ECE 346	3	1	ECE Option	3	1
	History 100	3	1	ECE 215	3	1	ECE 382	3	1	ECE 463	3	2
	For Lang 1	3	2	Comp Sci 210	4	2	Mech Engr 220	3	1	Aero Engr 315	3	1
	Math 141	3	1	Physics 215	4	2	Econ 201	3.5	2	Adv SocioCultural Opt	3	1
	Phy Ed	0.5	2	Pol Sci 211	3	1	Law 220	3	1	Philos 210	3	1
		15.5	8	Phy Ed	1	2	Phy Ed	1	2	Phy Ed	0.5	2
					19	10		19.5	10		18.5	9
Spring	Chem 100	4	2	ECE 281	3	1	ECE 333	3	1			
	English 111	3	1	ECE 332	3	1	ECE 343	3	1	ECE Option	3	1
	For Lang 2	3	2	Comp Sci 220	3	1	ECE 383	3	1	ECE 485	3	1
	Math 142	3	1	Math 243	3	1	History 300	3	1	ECE 464	3	2
	Physics 110	4	2	English 211	3	1	Math 356	3	1	Astr Engr 310	3	1
	Ldrshp 100	0.75	0	P/C/B Option 2	4	2	MSS 251	4.5	2	Soc Sci 311	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
					20.25	9		20.75	9		16.25	8

Course Unit Summary	
Core (29)	
Major (15)	
Phy Ed (10)	

Semester Hour Summary	
Core =	94.0 Sem Hours
Major =	48.0 "
Phy Ed =	5.0 "
Total =	147.0 "

* ECE 210 is suggested, not required.

ENGLISH

THE ENGLISH MAJOR AT A GLANCE: You study at USAF Academy to become a leader for our military and democratic nation. Drawing on the resources of evidence and imagination, outstanding leaders deploy the power of narrative to influence people and shape policy. This is the essence of the USAF Academy English major, where you'll explore enduring questions; formulate transformative ideas; and read, reflect, communicate, and create.

What is English?

- Our small, interactive classes are full of big ideas that engage literature, communication, film, creative writing, digital humanities, and artistic creation.
- We are a community that is open to students of all backgrounds and abilities. English majors are leaders in the Cadet Wing, IC athletes, and members of performance clubs and the Forensics Team.
- The English major is flexible and pairs well with other majors. English majors have pursued the pre-med track as well as second majors in Legal Studies and Computer Science and minors in Philosophy and Foreign Languages.
- All senior English majors have a chance to undertake an independent research project through the optional Capstone Experience.

Why English?

- ***Skills:*** One of the most valued and highly sought after aspects of any career or vocation is the ability to communicate effectively and to think critically. In the Air Force and Space Force, wing commanders have identified effective communication as the *most* vital skill that officers need for a successful career. The imperative to “get it all, get it right, and make it clear” is mission critical, and English majors are often sought out for this level of work.
- ***Job Opportunities:*** As an English major, all Air and Space Force career fields are open to you, except for a few highly specialized fields. Recent English major AFSCs include pilot (to include ENJJPT), CSO, acquisitions, OSI, maintenance, munitions and missiles maintenance, intelligence, contracting, acquisitions with intelligence OPEX, and space. As General Goldfein points out, “Don’t stop writing. Such is the nature of a profession of arms that debates serious matter. We must engage thoughtfully, humbly, and with mindfulness for operational security.” English is attractive in the civilian world as well. Entrepreneurs in the corporate sector and policy leaders within the public sector fit the same mold. As former Google executive Santosh Jayaram put it, “English majors are exactly the people I’m looking for.”

With English as your major, along with the technical training and experience you'll gain as an officer, you'll be poised to lead in the Air or Space Force, the civilian sector, and as a citizen. In short, English makes you ready for the *world*. For more information, visit our departmental website at <https://www.usafa.edu/academic/english/>, call 333-3930, or set up an appointment with our AIC team.

Majoring in English prepares a student to:

Read closely, with an awareness of the significance of the choices at work in various texts, works of art, and technologies. English majors will learn how these choices speak with various contexts, including the work itself; related works; the creator's oeuvre; and broader social, historical, and artistic contexts.

Communicate clearly and eloquently while also articulating complex thinking. English majors will identify genre-specific conventions of their writing and creation tasks and incorporate evidence, and engage with the ideas of others appropriately according to these conventions.

Think critically, with awareness of one's own preconceptions, and with broader contextual awareness of cultural, political, and historical factors. English majors will acquire a growing awareness of multiple backgrounds and perspectives in human interactions; they will have the ability to approach different situations with appropriate understanding and methods.

Know the field of English studies. English majors will gain familiarity with the breadth of English and the arts (e.g. significant literary and cultural periods); creative endeavors; digital humanities; and communication and rhetoric.

The English major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome and Clear Communication Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include the following core substitutes:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option	War Stories, or Special Topics in War and Literature	English 411, or English 370
Adv Open Option		Choose 1 Advanced Sociocultural Option

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

1. One pre-1800 English 303, 308, or 313
 2. One post-1800 English 319, 324, or 330
 3. One focusing on diversity, race, class or gender English 355, 360 or 365
- 4-10. English and Creative Arts Options
Choose seven courses from among non-core English and Creative Arts courses.
Law 360 counts in this category.
- 11-14. Academy Options
Four non-core courses from any academic division.

Yearlong Capstone Sequence Option:

English 489 (fall, 1.5 semester hours), Capstone Research
English 490 (spring, 3.0 semester hours), Capstone Colloquium
English 490 counts as one of the English Options in 4-10 above.

SUGGESTED COURSE SEQUENCE

Fall	Beh Sci 110	3	1	P / C / B Option	4	2	English Option 2	3	1	English Option 4	3	1
	History 100	3	1	Econ 201	3.5	2	Academy Option 2	3	1	English Option 5	3	1
	Math 141	3	1	English 211	3	1	Philos 210	3	1	Adv SocioCultural Opt	3	1
	Comp Sci 110	3	1	MSS 251	4.5	2	ECE 315	3	1	Soc Sci 311	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Adv STEM Option	3	1	Phy Ed	0.5	2
		15.5	8		19	10	Phy Ed	0.5	2		15.5	7
								18.5	8			

Spring	For Lang 2	3	2	Engl 300 or Engl Opt 1	3	1	Engl 319, 324, or 330	3	1	English Option 6	3	1
	Chem 100	4	2	Academy Option 1	3	1	English Option 3	3	1	Engl Opt 7 (Engl 490)	3	1
	English 111	3	1	History 300	3	1	Academy Option 3	3	1	Academy Option 4	3	1
	Math 142	3	1	Law 220	3	1	Aero Engr 315	3	1	Astr Engr 310	3	1
	Physics 110	4	2	P / C / B Option	4	2	Stats Option	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	1	2	Phy Ed	0.5	2
		18.25	10	Phy Ed	0.5	2		16.75	7		16.25	7
					20.25	9						

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

FOREIGN AREA STUDIES

THE FOREIGN AREA STUDIES MAJOR AT A GLANCE: Are you fascinated by other languages and cultures? Are you interested in focusing your studies on a particular region of the world? Then the Foreign Area Studies (FAS) major may be the right choice for you. Depending on the foreign language you are studying, you will delve into an interdisciplinary exploration of one of six geo-cultural regions: Africa, Latin America, Europe, Asia, the Middle East, or Slavic countries. You will also select an emphasis from one of three academic disciplines: History, Military & Strategic Studies, or Political Science. The major offers you a wide selection of courses that includes foreign language, history, military and strategic studies, political science, economics, geospatial science, as well as coursework that incorporates a comparative framework for understanding cross-cultural dynamics. The academic program leads to a Bachelor of Science Degree in Foreign Area Studies. In addition, Foreign Area Studies majors may earn an academic minor in a foreign language related to their area of study.

“Language, regional and cultural skills ... are critical to mission readiness in today’s dynamic global environment. Our forces must have the ability to effectively communicate with and understand the cultures of coalition forces, international partners, and local populations.”

SECDEF Memo “Language Skills, Regional Expertise, and Cultural Capabilities in the DoD”,
10 Aug 2011

Our program’s curriculum is designed such that, by completion of our program, our graduates shall demonstrate that they have attained the following Student Learning Outcomes:

1. Gain an interdisciplinary understanding and achieve relative expertise in a specific region of the world (Africa, Latin America, Europe, Asia, Middle East, or Slavic Region), and in the larger global context in which these regions operate.
2. Achieve a moderate level of fluency in a specific foreign language related to their region of study.
3. Gain understanding and achieve relative expertise in a specific academic track related to the FAS major: history, and military & strategic studies, political science.
4. Achieve cultural competency through study and/or immersion in the culture and language related to their region of study.

The FAS major defines expertise as the ability to perform the following skills:

1. Conduct research
2. Apply concepts
3. Analyze problems
4. Evaluate options
5. Formulate solutions
6. Communicate information

The Foreign Area Studies major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Soc Sci 311	International Security	Soc Sci 212
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

1. – 3. For Lang I, II, and III

Cadets must complete at least *five*
For Lang courses at the 200-level or
higher in the same language to earn
the minor

Required Disciplinary-Track Courses

4 - 7. Cadets take 4 courses consistent with their disciplinary track and region of study.

Req't		Pol Sci Track	History Track	MSS Track
4.	Africa	Pol Sci 479	History 280	MSS 494
	Asia	Pol Sci 473	History 270	MSS 490
	Europe	Pol Sci 471	History 230	MSS 493
	Latin America	Pol Sci 475	History 260	MSS 491
	Middle East	Pol Sci 477	History 250	MSS 494
	Slavic	Pol Sci 469	History 240	MSS 493
5.		Pol Sci 394	History 362 History 363	MSS 421
6.	Methods	Pol Sci 300	History 200	MSS 298
7.	Capstone	Pol Sci 491	History 402	MSS 498

Additional FAS Required Courses Outside Disciplinary-Track:

8 - 12. Cadets take five courses outside their disciplinary track consistent with their region of study.

Req't		Pol Sci Track	History Track	MSS Track
8.	Economics	Econ 374 or Soc Sci 444	Econ 374	Econ 374
9.	Human Geo	Geo 250	Geo 250	Geo 250
10.	Africa Asia Europe Latin America Middle East Slavic	History 280 History 270 History 230 History 260 History 250 History 240	Pol Sci 479 Pol Sci 473 Pol Sci 471 Pol Sci 475 Pol Sci 477 Pol Sci 469	History 280 History 270 History 230 History 260 History 250 History 240
11.	Africa Asia Europe Latin America Middle East Slavic	MSS 494 MSS 490 MSS 493 MSS 491 MSS 494 MSS 493	MSS 494 MSS 490 MSS 493 MSS 491 MSS 494 MSS 493	Pol Sci 479 Pol Sci 473 Pol Sci 471 Pol Sci 475 Pol Sci 477 Pol Sci 469
12.	Foreign Policy	History 340 or Pol Sci 302	History 340 or Pol Sci 302	History 340 or Pol Sci 302

FAS Electives:

13 – 14. Cadets choose 2 additional courses from the list below. Courses on this list will have a global, regional, or U.S. foreign relations focus with a comparative or cross-cultural framework.

Economics	Geospatial Science	Humanities	Military Strategic Studies	Political Science	History
Econ 351	Geo 380	Hum 200S	MSS 369	Pol Sci 301	History 230
Econ 450	Geo 412	Hum 400S	MSS 421	Pol Sci 302	History 240
Econ 454	Geo 470	Hum 430	MSS 422	Pol Sci 390	History 250
	Geo 471	Hum 461	MSS 423	Pol Sci 394	History 260
	Geo 475	Hum 463	MSS 490	Pol Sci 421	History 270
	Geo 480		MSS 491	Pol Sci 423	History 280
			MSS 493	Pol Sci 425	History 290
			MSS 494	Pol Sci 445	History 324
				Pol Sci 460	History 325
				Pol Sci 464	History 326
				Pol Sci 469	History 327
Behavioral Science	Legal Studies	Foreign Area Studies	Foreign Language	Pol Sci 471	History 328
Beh Sci 360	Law 363	FAS 400 or >	*For Lang 300 or >	Pol Sci 473	History 329
Beh Sci 362	Law 463		†For Lang 100 or >	Pol Sci 475	History 330
				Pol Sci 477	History 340
				Pol Sci 479	History 360
English	Philosophy	Management	Creative Art	Pol Sci 496	History 361
English 303	Philos 391	Mgt 498	Creative Art 330		History 362
English 308	Philos 392		Creative Art 335		History 363
English 350	Philos 393				History 364
	Philos 401		Other		History 365
			Any relevant 495		History 366
			Any relevant 499		History 367
*Primary language courses			Soc Sci 444		History 368
†Other than primary language courses					History 369

SUGGESTED COURSE SEQUENCE

Foreign Area Studies Major (Pol Sci Track)

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	For Lang 3	3	1	For Lang 5	3	1	Pol Sci 491	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Pol Sci 394	3	1	FAS Elective	3	1
	History 100	3	1	Econ 201	3.5	1	P / C / B Option	4	2	Astr Engr 310	3	1
	Math 141	3	1	Pol Sci 211	3	1	English 211	3	1	Adv SocioCultural Opt	3	1
	Comp Sci 110	3	1	Mech Engr 220	3	1	ECE 315	3	1	Adv STEM Option	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Math 300	3	1	Philos 210	3	1
		15.5	8		18	8	Phy Ed	1	2	Phy Ed	0.5	2
								20	9		18	6
Spring	For Lang 2	3	2	For Lang 4	3	1	Regional History	3	1	FAS Elective	3	1
	Chem 100	4	2	Geo 250	3	1	History 340/Pol Sci 302	3	1	Area MSS	3	1
	English 111	3	1	History 300	3	1	Pol Sci 300	3	1	Econ 374/Soc Sci 444	3	1
	Math 142	3	1	P / C / B Option	4	2	Area Pol Sci	3	1	Aero Engr 315	3	2
	Physics 110	4	2	Soc Sci 212	3	1	Law 220	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	7		16.25	8

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

Foreign Area Studies Major (History Track)

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	For Lang 3	3	1	For Lang 5	3	1	FAS Elective	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Area History 1	3	1	FAS Elective	3	1
	History 100	3	1	History 300	3	1	P / C / B Option	4	2	Astr Engr 310	3	1
	Math 141	3	1	Pol Sci 211	3	1	English 211	3	1	Adv SocioCultural Opt	3	1
	Comp Sci 110	3	1	Mech Engr 220	3	1	ECE 315	3	1	Adv STEM Option	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Math 300	3	1	Philos 210	3	1
		15.5	8		17.5	8	Phy Ed	1	2	Phy Ed	0.5	2
								20	9		18.5	6
Spring	For Lang 2	3	2	For Lang 4	3	1	History World Empires	3	1	Area Pol Sci	3	1
	Chem 100	4	2	Geo 250	3	1	History 340/Pol Sci 302	3	1	Area MSS	3	1
	English 111	3	1	History 200	3	1	Econ 201	3.5	2	Econ 374	3	1
	Math 142	3	1	P / C / B Option	4	2	Aero Engr 315	3	1	History 402	3	1
	Physics 110	4	2	Soc Sci 212	3	1	Law 220	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.75	8		16.25	7

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

Foreign Area Studies Major (MSS Track)

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	For Lang 3	3	1	For Lang 5	3	1	FAS Elective	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Philos 210	3	1	FAS Elective	3	1
	History 100	3	1	Econ 201	3.5	2	P / C / B Option	4	2	MSS 421	3	1
	Math 141	3	1	Pol Sci 211	3	1	English 211	3	1	Astr Engr 310	3	1
	Comp Sci 110	3	1	Mech Engr 220	3	1	ECE 315	3	1	Adv SocioCultural Opt	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Math 300	3	1	Adv STEM Option	3	1
		15.5	8		18	9	Phy Ed	20	9		18.5	6
Spring	For Lang 2	3	2	For Lang 4	3	1	Regional History	3	1	Area Pol Sci	3	1
	Chem 100	4	2	MSS 298	3	1	History 340/Pol Sci 302	3	1	Area MSS	3	1
	English 111	3	1	History 300	3	1	Geo 250	3	1	Econ 374	3	1
	Math 142	3	1	P / C / B Option	4	2	Aero Engr 315	3	1	MSS 498	3	1
	Physics 110	4	2	Soc Sci 212	3	1	Law 220	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	7		16.25	7

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

SUMMARY:

US national security strategy, since the end of the Cold War, has shifted from a policy of containment to strategies of global engagement, partnership, and expanded mutual security responsibilities. Enduring Air Force missions continue to promote regional stability, provide humanitarian assistance, encourage emerging democracies, gathering intelligence, and projecting and applying air power when necessary. Air Force officers in all career fields and specialties will find themselves globally engaged, and such engagement requires global skills. The Foreign Area Studies major is designed to give future officers broad-based, foreign area-related skills for worldwide service commitments.

The FAS Major is a qualifying degree for all rated career fields and a desired major for the Intelligence career field (14N AFSC). The combined FAS Major and associated Foreign Language Minor can open the way for opportunities such as the Language Enabled Airmen Program (LEAP), graduate school, serving as a Foreign Area Officer (FAO), and competing to become an Olmsted Scholar or an Air Attaché at an embassy abroad.

FOREIGN LANGUAGE MINORS

WHAT LANGUAGES ARE TAUGHT AT USAF ACADEMY? You may study Arabic, Chinese, French, German, Japanese, Portuguese, Russian, or Spanish—eight of the most important languages in the world. Within each language there is a broad spectrum of courses. The 100- and 200-level courses, and For Lang 321 and For Lang 322 are primarily skills development courses. The remaining courses are regarded as enhancement courses and are designed to develop a broader based appreciation of a particular culture, history, and literature, providing additional opportunities to develop and refine your language skills. The following courses comprise the curriculum of the Department of Languages and Cultures (DFLC):

SKILLS DEVELOPMENT COURSES

For Lang 131/132	Introduction to the Language, Culture, and Civilization
For Lang 221	Intermediate I: Refinement of Language Skills
For Lang 222	Intermediate II: Continued Development of Language Skills
For Lang 321	Advanced I: Capstone Course for Skills Development
For Lang 322	Advanced II: Follow-on Capstone Course for Skills Development

ENHANCEMENT COURSES

For Lang 365	Civilization and Culture
For Lang 410	Current Events
For Lang 420	Introduction to Literature
For Lang 430	Advanced Studies
For Lang 495	Special Topics
For Lang 499	Independent Study (normally offered only to those students who have completed all courses)

NOTE: After completion of For Lang 365, enhancement courses may be taken out of sequence.

The chart below clarifies the foreign language course sequences:

Language	Typical Course Sequence							
		Fall	Spring	Fall	Spring	Fall	Spring	Fall
Arabic		131	132	221	222	321	322	365
Chinese		131	132	221	222	321	322	365
French		131	132	221	222	321	322	365
German		131	132	221	222	321	322	365
Japanese		131	132	221	222	321	322	365
Portuguese		131	132	221	222	321	322	365
Portuguese		---	---	211	212	321	322	365
Russian		131	132	221	222	321	322	365
Spanish		131	132	221	222	321	322	365

COURSE REQUIREMENTS FOR THE FOREIGN LANGUAGE MINORS: Cadets majoring in any academic division or discipline may earn a specific foreign language minor provided they meet the DF minor policy requirements, complete five language courses at or above the 200 level (in residence and in the same language with a grade of 'C' or better), and complete the requirements for their major. Cadets who place at or above the 200 level will receive validation credit for up to four language courses. Regardless of the number of courses validated, no more than two will count towards the minor, leaving a requirement of at least three in-residence courses. For Lang 400/401 (Cadet Summer Language Immersion Program) and For Lang 402 (language credit for semester abroad) can also fill course requirements for the minor.

HOW CAN I BENEFIT FROM FOREIGN LANGUAGE STUDY? Beyond helping to understand culture and broadening your worldview, studying a foreign language can influence your military career. Our ever-expanding global Air Force mission not only demands increasing foreign language capability to support the national security military strategies, but also provides challenging assignment opportunities for those looking for experience and diversification. Officers with foreign language proficiency are candidates for opportunities such as the Language Enabled Airmen Program (LEAP), graduate school, serving as a Foreign Area Officer (FAO), and competing to become an Olmsted Scholar or an Air Attaché at an embassy abroad. Moreover, someday you may want to return to USAF Academy as a language instructor, a position that is both rewarding and career enhancing while providing the opportunity to influence other cadets toward becoming language-qualified Air Force officers. By speaking a foreign language, you become an "ambassador" helping to shape the opinions that others will have of our country and its armed forces...a crucial role in our increasingly interdependent world.

WHY STUDY A FOREIGN LANGUAGE? "Americans' scandalous incompetence in foreign languages explains our dangerously inadequate understanding of world affairs. Our schools graduate a large majority of students whose knowledge and vision stop at the American shoreline, whose approach to international affairs is provincial, whose heads have been filled with astonishing misinformation....The United States requires far more reliable capacities to communicate."

The quote above from the President's Commission on Foreign Languages and International Studies underscores the importance of foreign language. Learning a foreign language opens up an entirely new world. The study of languages will further your understanding of other peoples, ourselves, and of our own culture. This understanding is of even greater importance for the military leader than for the public at large, as evidenced by the following foreign policy experts.

"In the post-Cold War world, the most important distinctions between peoples are no longer ideological, political, or economic. The distinctions are cultural."—Samuel P. Huntington

"We need policy-makers, diplomats, and intelligence analysts expert in cultures and languages that encompass all regions of the world."—Former Senator Sam Nunn

GENERAL ENGINEERING

THE GENERAL ENGINEERING MAJOR AT A GLANCE: The General Engineering major is recommended for cadets who prefer a broad, flexible curriculum with a high degree of individual choice. It is also a sensible alternative for cadets already declared in a STEM disciplinary major who, for a variety of reasons, find the divisional approach more suited to fulfilling graduation requirements. The General Engineering major is **not** ABET accredited.

The General Engineering major must be recommended by the Academic Advisor, endorsed by the Department Head, and approved by the Division Chair. Alternatively, the General Engineering Major may be directed by the Academic Review Committee and coordinated with the Division Chair.

COURSE REQUIREMENTS: 134 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics	Probability and Statistics for Engineers and Scientists	Math 356 or Math 377
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 36 Semester hours of major's courses:

- | | |
|------------------------|----------------------------------|
| 1. Engr Option | (See Supplemental Information 1) |
| 2. Engr Option | |
| 3. Engr Option | |
| 4. Engr Option | |
| 5. Engr Option | |
| 6. Engr Option | |
| 7. Engr Option | |
| 8. Engr/Bas Sci Option | (See Supplemental Information 2) |
| 9. Engr/Bas Sci Option | (See Supplemental Information 2) |
| 10. Math Option | (See Supplemental Information 3) |
| 11. Math Option | (See Supplemental Information 3) |
| 12. Open Option | Any 200-level or higher course |

Supplemental Information:

1. An Engineering Option is any course taught by the Engineering Division not used to satisfy any other requirement. There is no required distribution of courses from each department.
2. An Engineering/Basic Science Option is any course taught by the Basic Science or Engineering Divisions not used to satisfy any other curriculum requirement. Additionally, Geo 351 (Introduction to Physical Geography) and Geo 353 (Geomorphology) may be used to satisfy this option.
3. Math Options may include any 200-level or above Math-prefix course. Additionally, ECE 245 (Differential Equations with Circuit Applications I), ECE 332 (Differential Equations with Circuit Applications II), ECE 346 (Engineering Math with ECE Applications), Engr 346 (Engineering Math with Applications), or CyberSci 431 (Cryptography) may be used to satisfy this option. The Math Options may not be used to fill the Advanced STEM or Advanced Open Option in the Core requirements simultaneously (i.e. may not be double-counted for the Core Baskets and General Engineering Math Options requirements).

4.

SUGGESTED COURSE SEQUENCE

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Econ 201	3.5	2	Engr Option	3	1	Engr Option	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Engr Option	3	1	Engr/Bas Sci Option	3	1
	History 100	3	1	English 211	3	1	Engr Option	3	1	Adv Sociocultural Opt	3	1
	Math 141	3	1	P / C / B Option	4	2	ECE 315	3	1	Soc Sci 311	3	1
	Comp Sci 110	3	1	Phy Ed	1	2	History 300	3	1	Adv STEM Option	3	1
	Phy Ed	0.5	2		16	9	Philos 210	3	1	Phy Ed	0.5	2
		15.5	8				Phy Ed	1	2		15.5	7
								19	8			
Spring	For Lang 2	3	2	Math Option	3	1	Engr Option	3	1	Engr Option	3	1
	Chem 100	4	2	Pol Sci 211	3	1	Engr Option	3	1	Engr/Bas Sci Option	3	1
	English 111	3	1	P / C / B Option	4	2	Math Option	3	1	Open Option	3	1
	Math 142	3	1	Law 220	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
	Physics 110	4	2	Mech Engr 220	3	1	Math 356	3	1	Astr Engr 310	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	7		16.25	7

Course Unit Summary
Core (29)
Major (12)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 36.0 "
PhyEd = 5.0 "
Total = 134.0 "

GEOSPATIAL SCIENCE

THE GEOSPATIAL SCIENCE MAJOR AT A GLANCE: The Geospatial Science program emphasizes learning about diverse cultures, physical landscapes, and geospatial tools that Expeditionary Air and Space Force officers use. This major offers a diverse and challenging program focusing on contemporary world issues. A flexible curriculum has been carefully designed to permit either an in-depth or cross-disciplinary approach to the study of geospatial science, maximizing a cadet's ability to design their academic program beyond the core disciplinary requirements. Course offerings within the discipline represent a broad cross-section of the key geospatial science sub-fields including physical, human, and regional geography, as well as state-of-the-art geographic information processing methods such as digital image processing and geographic information systems. Furthermore, cadets who wish to complement their major in Geospatial Science with a foreign language minor will be able to achieve both without carrying an academic course overload.

Geospatial Science graduates distinguish themselves from other college graduates by the conceptual framework in which they view the world. They use an inherently geospatial approach to interpret landscapes by applying knowledge of culture, physical processes, and digital modeling techniques to evaluate the effects of location, scale, and place.

Geospatial Science graduates will demonstrate geospatial analysis through mastery of the following skills:

- 1) Formulate a geospatial question;
- 2) Describe the relevant physical and/or human spatial data needed to answer a geospatial question;
- 3) Acquire usable relevant geospatial data;
- 4) Process geospatial data to produce a useable and relevant result;
- 5) Interpret the patterns, processes, and/or interrelationships represented by geospatial data/information, and
- 6) Effectively defend your interpretation or recommendation.

The Geospatial Science major provides excellent preparation for any assignment in the Air and Space Forces. The major also helps cadets develop international insight and cultural understanding of the battle space. Most Geospatial Science majors become pilots, intelligence officers, or special tactics officers. The Geospatial Science major also offers cadets the opportunity to earn the Geospatial Intelligence Certificate, an academic credential administered by the United States Geospatial Intelligence Foundation. This credential better positions USAF Academy cadets for future employment in military or civilian intelligence agencies.

Cadets who excel in this program are eligible to compete for scholarships to graduate school. These scholarships include not only the prestigious national scholarships, such as the Rhodes, Fulbright, and Marshall, but the USAF Academy Graduate Scholarship Program, in which graduates are sponsored by the Air Force Institute of Technology to earn a master's degree from a civilian institution.

The Geospatial Science major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

Foundational Course (all required):

Geospatial Techniques

1. Geo 310 Map Design and Graphic Communication
2. Geo 340 Introduction to Geographic Information Systems
3. Geo 382 Remote Sensing and Imagery Analysis

Human Geography

4. Geo 250 Human Geography: A Global Cultural Awareness
5. Geo 412 World Cultural Geography Physical Geography

Physical Geography

6. Geo 351 Physical Geography
7. Geo 353 Geomorphology

Further Depth in Geospatial Science (any 4 courses required; 8. – 11.)

Geospatial Techniques

- Geo 385 Applied UAS Photogrammetry
- Geo 440 Advanced Geospatial Analysis*
- Geo 482 Advanced Remote Sensing*

Human Geography

- Geo 360 Economic Geography
- Geo 366 Introduction to Urban Planning
- Geo 375 Geography of International Conflict
- Geo 380 Geography of Travel and Culture

Physical Geography

Geo 355 Field Experience in the Geosciences
Geo 452 Physical Geography of Volcanic Landscapes
Meteor 320 Introduction to Meteorology and Aviation Weather
Meteor 352 Climatology

Environmental, Social, and Economic Sustainability

Civ Engr 356 Introduction to Sustainability
Econ 340 Economics of Inequality
Geo 360 Economic Geography
Geo 365 Sustainability and Resilience in Practice

Other Geospatial Science Courses

Geo 488 Geospatial Intelligence*
Geo 495 Special Topics in Geosciences
Geo 499 Independent Study
For Lang 365
Other Geo prefixed, Foreign Area Studies prefixed, or regional courses as offered**

Synthesis or Capstone (1 course required; 12.)

Geo 491 Capstone Seminar in Geospatial Science: Military Geography*
OR
Geo 498 Research in Geospatial Science*

Academy Option (2 courses required; 13. – 14.)

Any course offered for academic credit

*Denotes required courses to obtain the Geospatial Intelligence Certificate.

** Regional courses without Geo prefix require Geospatial Science AIC approval

SUGGESTED COURSE SEQUENCE

Geospatial Science Major

4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
For Lang 1	3	2	Geo 310	3	1	Geo 351	3	1	Geo 498 (if not Geo 491	3	1
Beh Sci 110	3	1	Econ 201	3.5	2	Geo 382	3	1	Geo 412	3	1
History 100	3	1	MSS 251	4.5	2	ECE 315	3	1	Geo Sci Depth 2	3	1
Math 141	3	1	English 211	3	1	History 300	3	1	Academy Option	3	1
Comp Sci 110	3	1	P / C / B Option	4	2	Soc Sci 311	3	1	Adv STEM Option	3	1
Phy Ed	0.5	2	Phy Ed	1	2	Phy Ed	1	2	Astr Engr 310	3	1
	15.5	8		19	10		16	7	Phy Ed	0.5	2
										18.5	8
				3	1						
For Lang 2	3	2	Geo 250	3	1	Geo 353	3	1	Geo 491 (If not Geo 498	3	1
Chem 100	4	2	Philos 210	3	1	Geo 340	3	1	Geo Sci Depth 3	3	1
English 111	3	1	Pol Sci 211	4	2	Geo Sci Depth 1	3	1	Geo Sci Depth 4	3	1
Math 142	3	1	P / C / B Option	3	1	Adv Sociocultural	3	1	Academy Option	3	1
Physics 110	4	2	Law 220	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
Ldrshp 100	0.75	0	Mech Engr 220	0.75	0	Math 300	3	1	Ldrshp 400	0.75	0
Phy Ed	0.5	2	Ldrshp 200	0.5	2	Ldrshp 300	0.75	0	Phy Ed	0.5	2
	18.25	10	Phy Ed	20.25	9	Phy Ed	0.5	2		16.25	7
							19.25	8			

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 45.0 "
Phy Ed = 5.0 "
Total = 143.0 "

THE GEOSPATIAL INTELLIGENCE (GEOINT) CERTIFICATE AT A GLANCE:

WHY PURSUE A CERTIFICATE IN GEOSPATIAL INTELLIGENCE?

Accurate intelligence is critical to the warfighter to achieve mission success. The field of intelligence incorporates the collection, analysis, and exploitation of multiple forms of information. GEOINT addresses the collection, analysis, and exploitation of geospatial data. Examples of geospatial data, which contain a location on the Earth, include imagery, maps, census data, GPS coordinates, and digital models of the Earth.

GEOINT is critical to military operations and there is currently a scarcity of GEOINT-educated individuals. The GEOINT Certificate Program at USAF Academy is constructed in coordination with federal and industry experts via the United States Geospatial Intelligence Foundation (USGIF)* and prepares cadets as GEOINT-skilled critical thinkers and leaders.

The GEOINT Certificate requires completion of the following courses:

- | | |
|-----------------|--|
| 1. Comp Sci 110 | Introduction to Computing and Cyber Operations |
| 2. Law 220 | Law for Department of the Air Force Officers |
| 3. Philos 210 | Ethics |
| 4. Geo 310 | Map Design and Graphic Communication |
| 5. Geo 340 | Geographic Information Systems |
| 6. Geo 382 | Remote Sensing and Imagery Analysis |
| 7. Geo 391 | Capstone Seminar in Geospatial Science |
| 8. Geo 440 | Advanced Geospatial Analysis |
| 9. Geo 482 | Advanced Remote Sensing |
| 10. Geo 498 | Research in Geospatial Science |
| 11. Pol Sci 462 | Politics and Intelligence |
| or Geo 488 | Geospatial Intelligence |

REQUIREMENTS:

Application for admission into the GEOINT Certificate program at USAF Academy is open to all cadets. The GEOINT Certificate requires completion of the above courses with a collective "B" average and no single course grade lower than a "C". The Department of Economics and Geosciences administers the program and oversees admissions decisions.

* Further information about the USGIF and the GEOINT certificate is available at USGIF.org.

GLOBAL LOGISTICS MANAGEMENT MINOR

THE GLOBAL LOGISTICS MANAGEMENT MINOR AT A GLANCE: The Global Logistics Management minor provides a route for cadets from all majors to build the analytical and practical foundation to lead in the global logistics modernization for the Department of the Air Force. Logistics has always played a critical role in whether conflicts are won or lost and future competitions and conflicts will also be won or lost on the backbone of logistics. The Global Logistics Management minor focuses on the fundamentals of logistics, to include supply chain management, transportation, sustainability, information analytics, and control. The skills gained by graduates who complete the minor will equip them to handle the ever changing speed, demands, security, and interdependencies of logistics, which touch and enable nearly every element of the Air Force, and enhance a greater understanding of the function of logistics in any academic discipline.

COURSE REQUIREMENTS:

The Global Logistics Management Minor requires a minimum of 15 semester hours. The student must complete all courses with a grade of "C" or better. This is an interdisciplinary minor. No more than 3 courses for the minor can be from any one department.

1. Three required foundational courses:

Civ Engr 356	Introduction to Sustainability*
Mgt 476	Logistics and Transportation Management
Mgt 478	Supply Chain Management

2. Choose at least one of the following analytic options:

Geo 440	Advanced Geospatial Analysis
Math 378	Applied Statistical Modeling
Mgt 391	Business Data Analytics
Ops Rsch 310	Systems Analysis*

3. Choose at least one of the following breadth options:

Comp Sci 362	Computer Simulation
Comp Sci 471	Artificial Intelligence
Econ 374	Survey of International Economics
Econ 423	Managerial Economics
Econ 480	Defense Economics
Geo 340	Introduction to Geographic Information Systems
Geo 360	Economic Geography
History 369	Globalization: The History of People, Products, Ideas, and Systems in Motion
Mgt 477	Operations & Project Management
Mgt 498	International Management
MSS 421	International Power Projection

Pol Sci 445	Global Governance and International Institutions
Soc Sci 444	International Political Economy
Soc Sci 483	Principles of Negotiation*
Sys Engr 336	Engineering Economics and Financial Management

*These courses are also in the Core Advanced Choices Basket

HIGH PERFORMANCE COMPUTING MINOR

THE HIGH PERFORMANCE COMPUTING MINOR AT A GLANCE: High Performance Computing is becoming increasingly important in many aspects of our lives. For example, simulations of multiscale, multiphysics problems such as modeling and simulation of hypersonic and space vehicles or modeling of multiple earth system components to increase fidelity and skill of weather and climate predictions require tremendous computational resources. Other examples include extremely short design analysis cycles and analyses of increasingly complex systems and processes (e.g. in biological/biomedical applications), large-scale, heterogeneous data analytics, or comprehensive situational awareness. In the end, the desire to transform data into knowledge, insights, and actions, is resulting in data-intensive application workflows across all of science and engineering, requiring High Performance Computing. The High Performance Computing Minor will provide interested cadets a better understanding of modern high performance computing systems, preparing them to thrive in any career requiring advanced knowledge of these computing systems and their usage. The High Performance Computing Minor requires students to gain an understanding of computing system architectures and then allows flexibility to tailor their course of study to meet their individual interests, align it with their major, and maximize their academic strengths. The breadth of courses available in this minor makes this minor compatible with any academic major.

COURSE REQUIREMENTS:

The High Performance Computing Minor requires a minimum of 15 semester hours. The student must complete these five courses (15 semester hours) with a grade of “C” or better. There are four tracks available in this Minor. The intent of the High-Performance Computing Minor is that cadets take courses they would not normally take but which may serve as a complementary skillset for advanced computational techniques within their discipline. To earn the minor, cadets are required to complete at least two courses beyond the requirements for their major.

Each of the four tracks below requires 5 courses that form a coherent body of study in a particular focus on high performance computing and cumulates with a capstone experience in a high performance computing application. Each track has been designed so that any cadet NOT enrolled in the corresponding major can complete the requirements for the track. The requirements for each track are listed below.

Computer Science Track^{1,2}

Math 340	Discrete Mathematics
Comp Sci 220	Data Structures and Systems Programming
Comp Sci 362	Computer Simulation
Comp Sci 380	Design and Analysis of Algorithms
Comp Sci 471	Artificial Intelligence

Computer Engineering Track³

Four required courses

ECE 281	Digital Design and Computer Architecture
ECE 382	Embedded Computer Systems I
ECE 383	Embedded Computer Systems II
ECE 485	Advanced Computer Architecture

Choose one of the following options:

Comp Sci 362	Computer Simulation
ECE 386	AI Hardware Applications

Computational Aerodynamics⁴

Engr 346/Math 346	Engineering Math
Aero Engr 241	Aero-Thermodynamics
Aero Engr 341	Aeronautical Fluid Dynamics
Aero Engr 342	Computational Aerodynamics
Aero Engr 472	Advanced Computational Aerodynamics

High Performance Data Analytic⁵

Math 340	Discrete Mathematics
Math 344/Math 360	Applied Linear Algebra / Linear Algebra
Ops Rsch 311	Deterministic Models
Comp Sci 471	Artificial Intelligence
Capstone Experience	

1 – This track requires completion of Math 356/Math 377 and Comp Sci 210/212 as prerequisites. These courses would count towards Core STEM Advanced and Advanced Open Choice requirements.

2 – This track as defined currently does not have a clear “capstone experience” focused on HPC application. It addresses parallel computing and applications, but might not address these topics at scale of HPC.

3 – This track requires completion of Math 356/Math 377 and Comp Sci 210/212 as prerequisites. These courses would count towards Core STEM Advanced and Advanced Open Choice requirements.

4 – This track requires completion of Math 243/Math 253 and Math 245 as prerequisites. These courses would count towards Core STEM Advanced and Advanced Open Choice requirements.

5 – This track requires completion of Math 243/Math 253 and Ops Rsch 310 as prerequisites. These courses would count towards Core STEM Advanced and Advanced Open Choice requirements.

6 – This track does not have a predefined “capstone experience” focused on HPC application. This requirement can be satisfied with an Ops Rsch 495/499 or with the approval of the High

Performance Minor AIC and the Department Head of an instructor offering an appropriate capstone course, 495, or 499. A 495 or 499 course offered by any department may meet this requirement if a preponderance of the 495 or 499 involves a project using the high performance supercomputing resources from USAF Academy's High-Performance Computing Research Center.

HISTORY

THE HISTORY MAJOR AT A GLANCE: For over two thousand years, history has been a warrior's constant companion, a guide for leading, deciding, and acting wisely in challenging and uncertain times. The study of history, however, provides no static model or formula for action. Instead, the examination of the human condition in breadth, depth, and context provides leaders with a diverse and dynamic toolkit to facilitate success in an ever-changing and often irrational world. History is a unique discipline because it instills powerfully logical, but not rigid, habits of mind; it recognizes that humans, individually and collectively, primarily shaped the past and will shape the future; and it is based on the fundamental belief that no event or decision is exactly the same as any other, although discernable patterns exist. Rather than engaging in the futile quest to predict the future, historians see a deep, nuanced, and balanced understanding of the past as an essential foundation for effectively confronting complex and ambiguous situations. In short, the study of history sharpens judgment by allowing one to transcend personal experience.

Majoring in history prepares a student to:

- 1) Understand factual historical data.
- 2) Gather and analyze historical sources comparatively and in context.
- 3) Formulate evidence-based, critical interpretations of appropriately contextualized historical events, processes, and people.
- 4) Communicate critical interpretations of history clearly and cogently.

The History major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome. History is a qualifying degree for all rated career fields (including Pilot, RPA, CSO, ABM, Space Operations & Cyberspace Operations) and is a desired major for the Intelligence career field (14N AFSC).

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
World History		History 300S (optional)
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

1. History 200	The Historian's Craft: Introduction to Historical Methodology
2. History 210	Foundations of Modern America
3. History 220	Let Freedom Ring? American History since Reconstruction
4. Airpower History Option	(See Supplemental Information 1)
5. Regional History Option	(See Supplemental Information 2)
6. Socio-Cultural History Option	(See Supplemental Information 3)
7-11. History Options	(See Supplemental Information 4 & 5)
12. Humanities Option	(See Supplemental Information 6)
13. History 400	Advanced Seminar: Historiography
14. History 401	Senior Seminar: Research/Senior Thesis or Project

Supplemental Information:

1. Airpower History Option: Either of the following two courses:
History 320 Winged Defense: The History of Airpower
History 322 Conquest of the New Frontier: The History of Space Power
2. Regional History Option: Any course from the following fulfills this requirement:
History 230 Bastille to Brexit: Introduction to Modern European History
History 240 Steppes, Stalin, and Sputnik: Introduction to Russia and Eurasia
History 250 Introduction to the History of the Middle East
History 260 Historia Pasada y Presente: Introduction to Modern Latin American History
History 270 Modern East Asian History
History 280 Africa South of the Sahara
History 290 Global Contact and Local Responses in South and Southeast Asia
3. Socio-Cultural History Option: Any course from the following fulfills this requirement:
History 331 History of War and Society
History 341 Regional Identities in US History
History 347 Power to the People: American Culture in the 1960s and 1970s
History 364 Gender and Sexuality in History
History 366 Race, Nationality, and Ethnicity in History
Hum 430 The Holocaust
5. History Options: Select any five total 300-level history courses (including Hum 430) or a foreign language course at or above Foreign Language 365 from the USAF Academy Course of Instruction. Cadets may only use one foreign language course as a history option. If cadets select History 345: The American Way of War as an advanced open option in the core, that course may not count toward one of these five history options.
6. American, Military, or International History Designation. To achieve an American History, Military History, or International History designation on your transcript, four 300-level history options (including Hum 430) must be American History (A), International History (I), or Military History (M) courses, respectively.

7. Humanities Option: Select any non-core course offered in the areas of English, Creative Arts, History, Humanities, Foreign Area Studies, Foreign Languages, or Philosophy.

SUGGESTED COURSE SEQUENCE

History Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	History 200	3	1	Regional/Socio Option	3	1	History Option 4	3	1
	Beh Sci 110	3	1	History 210	3	1	History Option 1	3	1	History 401	3	1
	History 100	3	1	MSS 251	4.5	2	Airpower Option	3	1	Astr Engr 310	3	1
	Math 141	3	1	English 211	3	1	Law 220	3	1	Math 300	3	1
	Comp Sci 110	3	1	Pol Sci 211	3	1	Adv STEM Option	3	1	Soc Sci 311	3	1
	Phy Ed	0.5	2	P / C / B Option	4	2	Econ 201	3.5	2	Phy Ed	0.5	2
		15.5	8	Phy Ed	1	2	Phy Ed	1	2		15.5	5
					21.5	10			19.5	9		
Spring	For Lang 2	3	2	History 220	3	1	History Option 2	3	1	History Option 5	3	1
	Chem 100	4	2	Regional/Socio Option	3	1	History Option 3	3	1	Humanities Option	3	1
	English 111	3	1	History 300/300S	3	1	History 400	3	1	Adv Open Option	3	1
	Math 142	3	1	P / C / B Option	4	2	Aero Engr 315	3	1	Adv Sociocultural Opt	3	1
	Physics 110	4	2	Mech Engr 220	3	1	ECE 315	3	1	Philos 210	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	5		16.25	7

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

HUMANITIES

THE HUMANITIES MAJOR AT A GLANCE: The Humanities major at USAF Academy provides cadets with the opportunities to explore the breadth of the humanities disciplines and to pursue interdisciplinary as well as individualized learning and research. The program is jointly administered by the Departments of English (including the Creative Arts faculty), Foreign Language, History, and Philosophy. There are two dimensions to the program. First, students take a set of courses that are foundational to the Humanities from across the contributing departments. Second, students select among a variety of electives in order to construct a multi-disciplinary educational pathway tailored to their specific interests and aspirations. Graduates with the Humanities major will provide the Air Force with officers with unique talent and experience in conceptual integration, lateral thinking, and strategic sensitivity.

USAF Academy graduates who major in Humanities will:

- Analyze, evaluate, and formulate conceptual thinking related to a variety of references in thought, literature, music, and art;
- Develop deeper understanding of and appreciation for the human condition, human cultures, and human societies;
- Develop sophisticated oral and written communication skills, ideally as well in a foreign language; and
- Develop higher-order critical reasoning and creative thought skills.

The Humanities major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. *93 Semester hours of Dean's academic core courses to include:*

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option	War Stories	English 411
Adv Open Option		Choose 1

B. *5 Semester hours of Director of Athletics core courses.*

C. *42 Semester hours of major's courses:*

1. Research Methods and Critical Enquiry requirement (choose one):
 - a. English 300

- b. History 200
 - c. Philosophy 200 or any 300- or 400-level Philosophy course other than Philos 370.
 - d. Cadets transferring to Humanities from other majors may substitute courses approved by the Humanities Division Chair. For example, Pol Sci 300 fulfills the Humanities RMCE requirement for former ForArStu majors.
2. – 3. Two Creative Arts courses (310 or higher)
4. – 6. Humanities distribution (one of each):
- a. Any 300- or 400-level English course (with the exception of English 411, 489, or 490)
 - b. Any 300- or 400-level non-core course offered by DFHI
 - c. Any non-core course offered by DFPY
7. – 14. Humanities options: 24 semester hours of courses offered by the Humanities Division and its departments (usually eight courses). Humanities major advisors are encouraged to use Hum 400S as a capstone unless circumstances such as a semester abroad preclude doing so.

Supplemental Information:

Proficiency in foreign language facilitates the study of many disciplines and provides a much-needed capability in the operational Air Force. To realize these benefits, Humanities majors may earn a foreign language minor by taking courses at the 200 level and above that double-count for the minor and Humanities options.

SUGGESTED COURSE SEQUENCE

Humanities Major

4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
For Lang 1	3	2	Creative Art 1	3	2	Hum Distro - English	3	1	Hum Option	3	1
Beh Sci 110	3	1	MSS 251	4.5	2	Hum Distro - History	3	1	Hum Option	3	1
History 100	3	1	Philos 210	3	1	Hum Distro - Philos	3	1	English 411	3	1
Math 141	3	1	History 300	3	1	ECE 315	3	1	Soc Sci 311	3	1
Comp Sci 110	3	1	Econ 201	3.5	2	Law 220	3	1	Adv Open Option	3	1
Phy Ed	0.5	2	Phy Ed	1	2	Adv STEM Option	3	1	Phy Ed	0.5	2
	15.5	8		18	10	Phy Ed	1	2		15.5	7
							19	8			

For Lang 2	3	2	Creative Art 2	3	1	Hum Option	3	1	Hum Option	3	1
Chem 100	4	2	Research Methods	3	1	Hum Option	3	1	Hum Option	3	1
English 111	3	1	Pol Sci 211	3	1	P / C / B Option	4	2	Hum Option	3	1
Math 142	3	1	P / C / B Option	4	2	Aero Engr 315	3	1	Hum Option	3	1
Physics 110	4	2	English 211	3	1	Math 300	3	1	Astr Engr 310	3	1
Ldrshp 100	0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Phy Ed	0.5	2
	18.25	10	Phy Ed	0.5	2		17.25	8		16.25	7
				20.25	7						

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

LEGAL STUDIES

THE LEGAL STUDIES MAJOR AT A GLANCE: Increasingly complex legal considerations permeate every aspect of modern life in both the civilian and military environments. Cadets who choose the Legal Studies major will build expertise in the study of law and its role and function in both American society and the international community. Cadets will also develop the critical thinking skills that will permit them to identify, understand, and begin to resolve the complex legal and other issues which they will encounter after graduation. The Legal Studies major is not a "pre-law" major; rather, it is designed to provide cadets an enhanced knowledge of the law and a respect for the rule of law, while intentionally developing critical thinking and clear communication skills that will serve our graduates well both in the Air and Space Forces and beyond.

Cadets who major in Legal Studies enjoy a nearly unmatched level of flexibility and choice in selecting courses. Cadets must complete fourteen courses in addition to the required academic core curriculum. Five courses are required for all Legal Studies majors; however, of the remaining nine courses, cadets select seven from a lengthy list of approved Law Options, with the final two courses providing even greater choice (refer to Section C on the next page). This flexible, choice-driven approach is a critical aspect of our major as it allows cadets to study specific areas in more depth, to expand their world view with broadening courses, and/or provide academic space toward earning a double major or academic minor.

Since the first graduating class of Legal Studies majors in 1990, graduates with the Legal Studies major have successfully entered Pilot and other rated career fields, as well as nearly every other non-technical career field in the United States Air and Space Forces, such as Intelligence, Contracting, Acquisitions, Public Affairs, Personnel, Office of Special Investigations, Security Forces, Maintenance, Logistics, Cyberspace Operations, and Space Operations, to name a few. Graduates have also attended law school and are now serving as Judge Advocates (JAGs) for the Air and Space Forces. In fact, pursuant to a program known as U-ELP, the Secretary of the Air Force may authorize graduates to attend an American Bar Association approved law school following graduation from USAF Academy. Full completion of this program ultimately leads to service as an Air Force JAG.

Finally, if you are a cadet who enjoys competition beyond the fields of friendly strife, the Department of Law and the Legal Studies major sponsor a variety of nationally and internationally respected competitive academic teams. Our Mock Trial, Moot Court, Cyber Policy, and three different International Humanitarian Law teams compete against other undergraduate, graduate, and even law school teams at competitions in the U.S. and overseas. Some of these competition teams are tied to required courses so interested cadets should work with their advisors to ensure they are enrolled in the proper courses.

Cadets interested in becoming a Legal Studies major should ideally take Law 220 during the fall of their third-class year (or even spring of their fourth-class year). While we have numerous cadets who declare during the spring and even summer of their 3rd year, the earlier the better so that cadets can maximize the developmental sequencing of our courses.

The Department of Law's curriculum is designed around the following Legal Studies Program Goals:

- 1) Develop officers who can solve legal problems and think critically;
- 2) Develop officers who can communicate clearly; and
- 3) Develop officers with knowledge of selected aspects of the law.

The Legal Studies major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

Required Major's Courses:

- | | |
|------------|----------------------------|
| 1. Law 221 | Legal Research and Writing |
| 2. Law 321 | Legal Advocacy |
| 3. Law 351 | U.S. Constitutional Law |
| 4. Law 421 | Law for Commanders |
| 5. Law 485 | Legal Studies Capstone |

6. – 12 Law Options - choose any seven of the following courses:

- | | |
|---------|----------------------------|
| Law 331 | Criminal Law and Procedure |
| Law 340 | Business Law |
| Law 360 | Law and Literature |
| Law 363 | International Law |
| Law 414 | Race, Sex, and Justice |
| Law 419 | Space Law |
| Law 440 | Cyber Law |
| Law 456 | National Security Law |
| Law 463 | Law of War |

Law 466	Advanced Law of War Topics
Law 480	Topics in Constitutional Law and Appellate Advocacy
Law 495	Special Topics (when offered)
Law 499	Independent Study
Philos 200	Introduction to Philosophy
Philos 395	Philosophy of Law
Soc Sci 420	Law and Economics
Soc Sci 483	Principles of Negotiation (See Supplemental Information 1)

13. Any Social Sciences/Humanities 300/400-level courses (≥ 3.0 sem hrs)

14. Academy Option any course taught for credit (≥ 3.0 sem hrs) under the supervision of the Dean of the Faculty, Commandant of Cadets, the Director of Athletics, or the 306 FTG.
(See Supplemental Information 2)

Supplemental Information:

1. Legal Studies majors who take Soc Sci 483 will receive credit for the Advanced Sociocultural Option. Soc Sci 483 is also a Law Option course for which a cadet could receive credit as a Law Option. As the course fulfills both requirements, any Legal Studies major taking Soc Sci 483 will then only need to take 6 Law Option courses; the seventh Law Option course could be any 200-400 level course taught under the supervision of the Dean of Faculty.
2. Cadets can use the Academy Option for a variety of purposes: to study specific areas in more depth, to expand their world view with broadening courses, to help meet requirements for an academic minor, or to accommodate instructor upgrade coursework or independent studies, to name a few.

SUGGESTED COURSE SEQUENCE

Legal Studies Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Econ 201	3.5	2	Law 321	3	1	Law 421	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Law Option	3	1	Law Option	3	1
	History 100	3	1	English 211	3	1	ECE 315	3	1	Law Option	3	1
	Math 141	3	1	Law 220	3	1	History 300	3	1	Astr Engr 310	3	1
	Comp Sci 110	3	1	P / C / B Option	4	2	Math 300	3	1	Adv Sociocultural Opt	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Philos 210	3	1	Adv STEM Option	3	1
		15.5	8		19	10	Phy Ed	1	2	Phy Ed	0.5	2
								19	8		18.5	8
Spring	For Lang 2	3	2	Law 221	3	1	Law 351	3	1	Law 485	3	1
	Chem 100	4	2	Pol Sci 211	3	1	Law Option	3	1	Law Option	3	1
	English 111	3	1	P / C / B Option	4	2	Law Option	3	1	Law Option	3	1
	Math 142	3	1	Soc Sci 311	3	1	Soc Sci / Hum Option	3	1	Academy Option	3	1
	Physics 110	4	2	Mech Engr 220	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	7		16.25	7

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

MANAGEMENT

THE MANAGEMENT MAJOR AT A GLANCE: The Management major prepares cadets for management and leadership roles in today's technologically complex, global Air and Space Forces. The curriculum is designed to develop cadets who can understand, analyze, and improve organizations through the efficient and effective use of systems. The courses in the major help students develop adaptive capacity and the organizational knowledge and skills vital for Air and Space Force officers as well as future national leaders. The Management Department is accredited by the AACSB (Association to Advance Collegiate Schools of Business), and the management major ranks among the most prestigious undergraduate management and business degrees in the nation. Our curriculum, together with USAF Academy's core courses, provides an excellent educational foundation for cadets interested in pursuing Air and Space Force careers such as 11XX (Pilot), 12XX (Combat Systems Officer), 13BX (Air Battle Manager), 13N1 (Nuclear and Missile Operations), 13S1 (Space Operations), 14N1 (Intelligence), 17D (Warfighter Comms Operations), 17S (Cyberspace Effects Operations), 21A1 (Aircraft Maintenance), 21R1 (Logistics Readiness), 31P1 (Security Forces), 38F (Force Support), 41AX (Health Services Administrator), 63A1 (Acquisition Manager), 64P1 (Contracting), 65F1 (Financial Management), 65W1 (Cost Analysis), and 71SX (Special Investigator). Additionally, the Management major prepares cadets interested in pursuing graduate degrees in Management, Management Science, and/or Business Administration.

The Management major is designed to produce critical thinkers who will lead organizations to quickly adapt and succeed in rapidly changing, highly technical, global environments. Management majors study traditional managerial and business topics such as organizational perspectives and theories, global organizations, complex human systems, financial and managerial accounting, managerial finance, human resource management, marketing, production and operations management, information systems, and strategic management. Related subjects, such as personal finance and investing, are also popular among our majors.

The Management Department's Program Goals, with underlying objectives, align directly with the department's stated mission. They focus on creating Air and Space Force managers who are:

- 1) Dynamic Managers
 - 1.1) Employ a strategic perspective to the management of organizations
 - 1.2) Promote, develop, and execute innovative practices to achieve continuous organizational improvement
 - 1.3) Understand and manage organizations as interconnected systems of people, resources, and technology
 - 1.4) Recognize the role of globalization in the management of organizations
- 2) Effective Problem Solvers
 - 2.1) Identify and diagnose problems in complex systems
 - 2.2) Generate and compare alternatives using appropriate analytical techniques along with financial, organizational, and market data

2.3) Propose and defend effective solutions while understanding their system-wide impacts

3) Ethical Leaders

3.1) Apply ethical reasoning and action in managerial decision making

3.2) Identify ethical dilemmas and apply an ethics framework to alternative solutions

4) Professional Communicators

4.1) Deliver effective oral presentations supported by appropriate techniques and technology

4.2) Write effective documents

The Management major contributes to both the development and assessment of the USAF Academy Institutional Outcomes for Leadership, Teamwork, and Organization Management; Critical Thinking; Ethics and Respect for Human Dignity; and Clear Communication.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option	Systems Analysis	Ops Rsch 310
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of additional major's courses.

- | | |
|--|---|
| 1. Mgt 303 | Managerial Perspectives |
| 2. Mgt 341 | Financial Accounting |
| 3. Mgt 342 | Managerial Accounting |
| 4. Mgt 345 | Organizational Behavior and Human Resource Management |
| 5. Mgt 337 | Managerial Finance |
| 6. Mgt 375 | Marketing Analysis |
| 7. Mgt 420 | Management Capstone Practicum |
| 8. Mgt 472 | Strategic Management Capstone |
| 9. Mgt 477 | Operations and Project Management |
| 10. - 13. Select four of the following Mgt Options | |
| Mgt 361 | Organization Development and Change |
| Mgt 372 | Introduction to Investments |

Mgt 382	Investments
Mgt 391	Business Data Analytics
Mgt 392	Organizational Networks in Cyberspace
Mgt 400	Leading Innovation
Mgt 411	Business Ethics
Mgt 440	Management Lessons in Literature
Mgt 448	Power and Influence in Organizations
Mgt 476	Logistics and Transportation Management
Mgt 478	Supply Chain Management
Mgt 495	Special Topics
Mgt 498	International Management

14. Select one additional course from the list above or one of the following:

Any foreign language 300-level course or above or foreign language 400/401, (if a cadet is not minoring in a foreign language)

Econ 423	Managerial Economics
Law 340	Business Law
Soc Sci 483	Principles of Negotiation

SUGGESTED COURSE SEQUENCE

Management Major

	4°			3°			2°			1°		
	hrs	per		hrs	per		hrs	per		hrs	per	
Fall	For Lang 1	3	2	Econ 201	3.5	2	Mgt 303	3	2	Mgt 472	3	2
	Beh Sci 110	3	1	MSS 251	4.5	2	Mgt 341	3	1	Mgt 477	3	1
	History 100	3	1	English 211	3	1	Mgt 345	3	2	Mgt Option	3	1
	Math 141	3	1	Pol Sci 211	3	1	Mgt Option	3	1	Astr Engr 310	3	1
	Comp Sci 110	3	1	P / C / B Option	4	2	ECE 315	3	1	Soc Sci 311	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Philos 210	3	1	Phy Ed	0.5	2
		15.5	8		19	10	Phy Ed	1	2		15.5	8
								19	10			
Spring	For Lang 2	3	2	History 300	3	1	Mgt 337	3	1	Mgt 420	3	2
	Chem 100	4	2	OpsRsch 310	3	1	Mgt 342	3	1	Mgt Option	3	1
	English 111	3	1	P / C / B Option	4	2	Mgt 375	3	1	Mgt Option	3	1
	Math 142	3	1	Law 220	3	1	Mgt Option	3	1	Adv Sociocultural Opt	3	1
	Physics 110	4	2	Mech Engr 220	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Math 300	3	1	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Ldrshp 300	0.75	0	Phy Ed	0.5	2
		18.25	10		17.25	8	Phy Ed	0.5	2		16.25	8
								19.25	8			

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

MATHEMATICS

THE MATHEMATICS MAJORS AT A GLANCE: The Department of Mathematical Sciences offers degrees in Mathematics and Applied Mathematics. The Mathematics track provides a broad overview of the foundational subjects of classical and modern mathematics while leaving considerable flexibility to tailor a program of study that meets individual interests. The degree stresses problem solving, logic, and abstract reasoning while also providing some exposure to various modern applications of mathematics to include programming. The Applied Mathematics track also provides a solid foundation in diverse mathematical topics, but applies that foundation to related subjects. The hallmark of the Applied Mathematics degree is a focused four-course interdisciplinary concentration coordinated with another department or departments. This blending of applied mathematics with another scientific discipline offers significant benefits in terms of career and graduate school choices.

The Mathematics and Applied Mathematics majors were created to offer a broad yet focused education in problem solving, analytic reasoning, critical thinking, and technical communication. These skills will allow each major to handle the complex operational, managerial, and technical problems that routinely challenge Air and Space Force officers. In addition, both majors provide a superior education that will facilitate success in a wide variety of graduate school programs. Cadets majoring in Mathematics or Applied Mathematics historically perform well in areas such as operations research, physics, engineering, business administration, economics, computer science, law, medicine, meteorology, and, of course, mathematics and applied mathematics.

Flexibility is a critical component of any modern, relevant degree program. The Mathematics and Applied Mathematics majors have been designed to allow you to choose a course of study that fits your interests, while also providing an education well-suited to the modern Air and Space Forces. As an officer with a background in math or applied math, you will be positioned to succeed across a diverse range of career fields ranging from operations research analyst or acquisitions to intelligence or pilot.

Our program's curriculum is designed such that, by completion of our program, our graduates shall demonstrate that they have attained the following departmental Student Learning Outcomes which are intentionally aligned with the institutional outcomes:

- 1) Develop strengths of character and intellect that enhance professional growth.
- 2) Solve problems using sound mathematical techniques.
- 3) Communicate mathematical ideas effectively in written and oral form.
- 4) Explore the utility and art of mathematics.

The Mathematics and Applied Mathematics majors contribute to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS (Mathematics): 141 Semester Hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics	Advanced Probability and Statistics	Math 377
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option	Differential Equations	Math 245

B. 5 Semester hours of Director of Athletics core courses.

C. 22 Semester hours of required major's courses:

1. Choose one of the following:
 - Comp Sci 210 Programming Fundamentals, or
 - Comp Sci 211 Programming for Scientists and Engineers, or
 - Comp Sci 212 Introduction to Programming for Analysts
2. Math 320 Foundations of Mathematics
3. Math 360 Linear Algebra
4. Math 366 Real Analysis
5. Math 378 Applied Statistical Modeling
6. Math 465 Modern Algebra
7. Math 420 Capstone I (1 sem hr)
8. Math 421 Capstone II (2 sem hrs)

D. 15 Semester hours from the list of courses below to include at least one course from the Proof-Based Mathematics Courses and at least one course from the Applied Mathematics Courses.

Math 346	Engineering Math
Math 359	Design and Analysis of Experiments
Math 443	Numerical Analysis of Differential Equations
Math 451	Complex Variables
Math 467	Real Analysis II
Math 470	Mathematical Physics
Ops Rsch 311	Deterministic Models
Ops Rsch 312	Probabilistic Models
Ops Rsch 417	Quick-Turn Analysis
Cyber Sci 431	Cryptography
Econ 411	Introduction to Game Theory
Philos 370	Introduction to Symbolic Logic

Proof-Based Mathematics Courses (choose at least one of the following courses):

Math 472	Introduction to Number Theory
Math 473	Introduction to Point-Set Topology

Math 474

Combinatorics and Graph Theory

Applied Mathematics Courses (choose at least one of the following courses):

Math 342

Numerical Analysis

Math 468

Dynamical Systems

Math 469

Partial Differential Equations

E. 6 semester hours of open electives to be coordinated with DFMS.

COURSE REQUIREMENTS (Applied Mathematics): 141 Semester Hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics	Advanced Probability and Statistics	Math 377
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option	Differential Equations	Math 245

B. 5 Semester hours of Director of Athletics core courses.

C. 22 Semester hours of required major's courses:

1. Choose one of the following:

Comp Sci 210

Programming Fundamentals, or

Comp Sci 211

Programming for Scientists and Engineers, or

Comp Sci 212

Introduction to Programming for Analysts

2. Math 320

Foundations of Mathematics

3. Math 342

Numerical Analysis

4. Math 360

Linear Algebra

5. Math 366

Real Analysis

6. Math 378

Applied Statistical Modeling

7. Math 420

Capstone I (1 sem hr)

8. Math 421

Capstone II (2 sem hrs)

D. 9 Semester hours from the courses listed below. At least one of the courses must be a 400-level mathematics course (Math 4XX):

Math 346

Engineering Math

Math 359

Design and Analysis of Experiments

Math 443

Numerical Analysis of Differential Equations

Math 451

Complex Variables

Math 465

Modern Algebra

Math 467	Real Analysis II
Math 468	Dynamical Systems
Math 469	Partial Differential Equations
Math 470	Mathematical Physics
Math 472	Introduction to Number Theory
Math 473	Introduction to Point-Set Topology
Math 474	Combinatorics and Graph Theory
Ops Rsch 311	Deterministic Models
Ops Rsch 312	Probabilistic Models
Ops Rsch 417	Quick-Turn Analysis
Cyber Sci 431	Cryptography
Econ 411	Introduction to Game Theory
Philos 370	Introduction to Symbolic Logic

E. 12 semester hours of interdisciplinary concentration courses. A cadet may work with DFMS to customize a 4-course concentration plan focused on depth of knowledge. All interdisciplinary concentration plans must be approved by DFMS. For additional information on interdisciplinary concentration plans or to discuss possible plans, contact the Advisor-In-Charge in DFMS.

SUGGESTED COURSE SEQUENCE

Mathematics Major

	4°			3°			2°			1°		
	hrs	per		hrs	per		hrs	per		hrs	per	
Fall	Beh Sci 110	3	1	Math 243	3	1	Math 360	3	1	Math Option (Applied)	3	1
	Comp Sci 110	3	1	Econ 201	3.5	2	Mech Engr 220	3	1	Math 420	1	1
	For Lang 1	3	2	English 211	3	1	ECE 315	3	1	Math 465	3	1
	History 100	3	1	MSS 251	4.5	2	Math 377	3	1	Math Option	3	1
	Math 141	3	1	P / C / B Option	4	2	History 300	3	1	Adv SocioCultural Option	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Phy Ed	1	2	Soc Sci 311	3	1
		15.5	8		19	10		16	7	Phy Ed	0.5	2
											16.5	8
Spring	Chem 100	4	2	Comp Sci 210/211/212	4	2	Math 366	3	1	Math Option	3	1
	English 111	3	1	Math 320	3	1	Math 378	3	1	Math 421	2	1
	For Lang 2	3	2	Math 245	3	1	Math Option	3	1	Math Open Elective	3	1
	Math 142	3	1	P / C / B Option	4	2	Philos 210	3	1	Math Option (Proof)	3	1
	Physics 110	4	2	Law 220	3	1	Aero Engr 315	3	1	Math Open Elective	3	1
	Ldrshp 100	0.75	0	Pol Sci 211	3	1	Ldrshp 300	0.75	0	Astr Engr 310	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2		16.25	7	Phy Ed	0.5	2
					21.25	10					18.25	8

Course Unit Summary	
Core (29)	
Major (15)	
Phy Ed (10)	

Semester Hour Summary	
Core =	93.0 Sem Hours
Major =	43.0 "
Phy Ed =	5.0 "
Total =	141.0 "

Applied Mathematics Major

	4°		hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	Beh Sci 110		3	1	Math 243	3	1	Math 360	3	1	Interdisciplinary 2	3	1
	Comp Sci 110		3	1	Econ 201	3.5	2	Interdisciplinary 1	3	1	Math 420	1	1
	For Lang 1		3	2	English 211	3	1	Mech Engr 220	3	1	Math Option	3	1
	History 100		3	1	MSS 251	4.5	2	ECE 315	3	1	Math 342	3	1
	Math 141		3	1	P / C / B Option	4	2	Math 377	3	1	Adv SocioCultural Opti	3	1
	Phy Ed		0.5	2	Phy Ed	1	2	Phy Ed	1	2	Soc Sci 311	3	1
			15.5	8		19	10		16	7	Phy Ed	0.5	2
												16.5	8

Spring	Chem 100	4	2	Comp Sci 211	4	2	Math 366	3	1	Math Option	3	1
	English 111	3	1	Math 320	3	1	Math 378	3	1	Math Option	3	1
	For Lang 2	3	2	Math 245	3	1	History 300	3	1	Math 421	2	1
	Math 142	3	1	P / C / B Option	4	2	Philos 210	3	1	Interdisciplinary 3	3	1
	Physics 110	4	2	Law 220	3	1	Aero Engr 315	3	1	Interdisciplinary 4	3	1
	Ldrshp 100	0.75	0	Pol Sci 211	3	1	Ldrshp 300	0.75	0	Astr Engr 310	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2		16.25	7	Phy Ed	0.5	2
					21.25	10					18.25	8

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 43.0 "
Phy Ed = 5.0 "
Total = 141.0 "

MECHANICAL ENGINEERING

THE MECHANICAL ENGINEERING MAJOR AT A GLANCE: Mechanical Engineering is essentially the engineering of systems—designing, building, and testing the coupled interactions of components, power, and information. There are incredible mechanical engineering systems in aerospace and automotive hardware, power generation facilities, and manufacturing. Because systems bring together the engineering of mechanics and motion, thermodynamics and fluids, materials and structures, and control, Mechanical Engineering is a broad discipline of design and analysis. If you aren't sure what engineering discipline to pursue right now and you want to keep your options open, this foundational major may be perfect for you. Mechanical Engineering is also flexible, enabling focus in a variety of areas: failure analysis, aerospace structures, dynamics, or thermal-fluid systems. If understanding, building, and utilizing state-of-the-art materials (e.g., composites and ceramics) and manufacturing processes (e.g., “3-D” printing) intrigues you, this challenging major may be right for you. The USAF Academy Mechanical Engineering major is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

The Vision of the Department of Mechanical Engineering, which administers the Mechanical Engineering Program, is to provide a World-Class Engineering Education for the Military Profession. To ensure the success of our graduates, we prepare them to attain Program Educational Objectives two to five years after graduation. These are:

- 1) Recognition as successful Air or Space Force officers through demonstration of their ability to:
 - a. Rapidly acquire required knowledge,
 - b. Lead others effectively,
 - c. Effectively apply ethical and moral standards,
 - d. Improve unit performance by application of organizational skills,
 - e. Make sound decisions based on critical thinking, and
 - f. Communicate effectively.
- 2) Selection for career training on, or ahead of, schedule, and for a progression of assignments of increasing responsibility.
- 3) A demonstrated ability to solve Air and Space Force technical problems.
- 4) Success in continuing education.

The foundation that prepares graduates for attaining the Program Educational Objectives is provided by Student Learning Outcomes. Student Learning Outcomes describe what students must attain prior to graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. These Student Learning Outcomes are:

- 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;
- 3) an ability to communicate effectively with a range of audiences;

- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economics, environmental, and societal contexts;
- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions; and
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Incorporated within these outcomes, Mechanical Engineering majors must apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes; and work professionally in both thermal and mechanical systems areas. In addition, graduates must demonstrate design competence that includes integration of mechanical engineering topics.

A degree in Mechanical Engineering, with few exceptions, qualifies you for most every Air Force operational and support occupation. Within engineering, you can get an assignment as a mechanical engineer, aeronautical engineer, civil engineer, astronautical engineer, or project engineer. The Mechanical Engineering major also satisfies the educational requirements for Air Force Test Pilot, Flight Test Navigator, and Flight Test Engineer duties. Additional specialties are Scientific Analyst and Acquisition Project Officer. As a STEM degree, mechanical engineering provides competitive advantage for selection into U.S. Space Force and avails all Space Force career fields.

If you are a top performer in the Mechanical Engineering major, graduate school can be an option as a first Air or Space Force assignment, either through direct departmental sponsorship or by winning a prestigious national scholarship (Draper, Hertz, Rhodes, etc.). The Mechanical Engineering major gives you the flexibility to pursue either a more specialized degree in graduate school or to continue your broad-based study in engineering. Whether you ultimately choose a graduate program in mechanical engineering, aeronautical engineering, astronautical engineering, or materials engineering, your decision will be an informed one.

The Mechanical Engineering major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 144 Semester hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200

	Or	Or
	Introductory Biology with Laboratory	Biology 215
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option	Differential Equations	Math 245

B. 5 Semester hours of Director of Athletics core courses.

C. 46 Semester hours of major's courses:

- | | |
|---|---|
| 1. Comp Sci 206/206X
or Comp Sci 211 | Fundamentals of Programming for Engineers
Introduction to Programming for Scientists and Engineers |
| 2. Advanced Math Option | Engr 346, Math 346, Math 342, or Math 344
(See Supplemental Information 1) |
| 3. Mech Engr 205 | Engineering Tools Seminar |
| 4. Mech Engr 306 | Advanced Manufacturing Methods Seminar |
| 4. Mech Engr 312 | Thermodynamics |
| 5. Mech Engr 320 | Dynamics |
| 6. Mech Engr 325 | Engineering System Dynamics |
| 7. Mech Engr 330 | Mechanics of Deformable Bodies |
| 8. Mech Engr 341 | Fluid Mechanics |
| 9. Mech Engr 350 | Mechanical Behavior of Materials |
| 10. Mech Engr 370 | Introduction to Machine Design |
| 11. Mech Engr 441 | Heat Transfer |
| 12. Mech Engr 460 | Experimental Mechanics (See Supplemental Information 2) |
| 13. Mech Engr 491 | Capstone Design Project I (See Supplemental Information 2) |
| 14. Mech Engr 492 | Capstone Design Project II (See Supplemental Information 2) |
| 15. Mech Engr Option I | (See Supplemental Information 3) |
| 16. Mech Engr Option II | (See Supplemental Information 3) |
| 17. Mech Engr Option III | (See Supplemental Information 4) |

Supplemental Information:

1. Engr 346 or Math 346 meets the prerequisites for all Mechanical Engineering electives listed in the Mechanical Engineering Electives Table. Math 342 and Math 344 may not meet all the prerequisites for electives listed in the Mechanical Engineering Electives Table. Additionally, Math 342 will require one additional course to be taken to meet the prerequisites. Careful consideration should be given when choosing a math elective.

2. If planning a focus in certain areas, cadets may petition DFME and other applicable departments for a waiver to substitute the capstone design sequence of another major, or an appropriate substitute for the Experimental Mechanics course.
 3. Mech Engr Option I & II are any 3-semester hour courses in the Mechanical Engineering curriculum from the Mechanical Engineering Electives Table (i.e., those with a "Mech Engr" prefix) that has not been used to satisfy another curriculum requirement. Students should carefully consider taking option courses in the same emphasis area to provide depth in a traditional Mechanical Engineering specialty.
 4. Mech Engr Option III may be one of the following:
 - a. Any 3-semester hour course in the Mechanical Engineering curriculum from the Mechanical Engineering Electives Table (i.e., those with a "Mech Engr" prefix) that has not been used to satisfy another curriculum requirement
 - b. A 3-semester hour Special Topics course, if offered (e.g., a Mech Engr 495)
 - c. An Independent Study of 2- or 3-semester hours (e.g., a Mech Engr 499)
 - d. Sys Engr 310 or Sys Engr 311
 5. In addition, Engr 402, Professional Engineering Development (NCEES Fundamentals of Engineering exam prep), is a recommended course for all Mechanical Engineering cadets to take during their first class year of study.
- * Other 300- or 400-level 3-semester hour courses in the Engineering Division that have not been used to satisfy another curriculum requirement may be considered on a case-by-case basis and are subject to Department Head approval

Mechanical Engineering Electives Table

Emphasis Area	Course	Information
Structures	Mech Engr 332 (F/S)	Aerospace Structures <i>Prereq:</i> Mech Engr 330 <i>Coreq:</i> Aero Engr 315, Mech Engr 320
	Mech Engr 421 (S) (even years only)	Vibrations <i>Prereq:</i> Mech Engr 320 or Physics 355 <i>Coreq:</i> Math 346 or Engr 346
	Mech Engr 431 (F)	Introduction to Finite Element Analysis <i>Prereq:</i> Mech Engr 330 and Math 342, Math 344, Math 346, or Engr 346
	Mech Engr 450 (S)	Aerospace Composite Materials <i>Prereq:</i> Mech Engr 330, Math 245
	Mech Engr 340 (S)	Materials Science for Engineers <i>Prereq:</i> Mech Engr 220
Materials	Mech Engr 440 (F)	Physical Metallurgy <i>Prereq:</i> Mech Engr 340
	Mech Engr 445 (S) (even years only)	Failure Analysis and Prevention <i>Prereq:</i> Mech Engr 350 <i>Recommended:</i> Mech Engr 340

	Mech Engr 450 (S)	Aerospace Composite Materials <i>Prereq:</i> Mech Engr 330, Math 245
Dynamic Systems	Engr 341 (F)	Linear Systems Analysis and Design <i>Prereq:</i> Math 245
	Mech Engr 396 (F)	Mechatronics <i>Prereq:</i> ECE 315 (\geq B-)
	Mech Engr 421 (S) (even years only)	Vibrations <i>Prereq:</i> Mech Engr 320 or Physics 355 <i>Coreq:</i> Math 346 or Engr 346
Thermal Fluid Science	Mech Engr 468 (F) (odd years only)	Sustainable Energy <i>Prereq:</i> Mech Engr 312 <i>Coreq:</i> Mech Engr 341 or dept approval
N/A	Mech Engr 490 (F) (even years only)	Automotive Systems Analysis for the Engineer <i>Coreq:</i> Mech Engr 320 or dept approval

SUGGESTED COURSE SEQUENCE

Beh Sci 110	3	1	Mech Engr 220	3	1	Mech Engr 312	3	1	Mech Engr 460	3	2
English 111	3	1	Physics 215	4	2	Mech Engr 350	3	1	Mech Engr Option II	3	1
Math 141	3	1	Pol Sci 211	3	1	Math 356	3	1	Mech Engr Option III	2	1
Comp Sci 110	3	1	Econ 201	3.5	2	ECE 315	3	1	History 300	3	1
Phy Ed	0.5	2	English 211	3	1	Law 220	3	1	Phy Ed	0.5	2
	15.5	8	Phy Ed	1	2	Soc Sci 311	3	1		14.5	9
				20.5	10	Phy Ed	1	2			
							20	9			
For Lang 2	3	2	Comp Sci 206	1	1	Mech Engr 325	3	1	Mech Engr 492	3	2
Chem 100	4	2	Mech Engr 320	3	1	Mech Engr 341	3	1	Engr 402	0.5	1
History 100	3	1	Mech Engr 330	3	1	Mech Engr Option I	3	1	Mech Engr 370	3	1
Math 142	3	1	Math 245	3	1	Adv Math Option	3	1	Mech Engr 441	3	1
Physics 110	4	2	Chem 200	4	2	Aero Engr 315	3	1	Astr Engr 310	3	1
Ldrshp 100	0.75	0	MSS 251	4.5	2	Philos 210	3	1	Adv Sociocultural Opt	3	1
Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	18.25	10	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
				19.75	10		19.25	8		16.75	9

Course Unit Summary
Core (29)
Major (17)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 46.5 "
PhyEd = 5.0 "
Total = 144.5 "

METEOROLOGY

THE METEOROLOGY MAJOR AT A GLANCE: From planning deployments and air strikes to scheduling space launches and issuing proper protective clothing, weather considerations influence a great many of the decisions made by Air and Space Force officers. Throughout history, weather has played a pivotal role in the outcome and execution of many important campaigns. The debacle of Napoleon's army in Russia, the scheduling of the Normandy invasion, and the destruction of Germany's counter attack in the Battle of the Bulge, are but a few examples. Knowledge of the weather is still important in the modern air, land, and space domains.

Meteorology is the study of the atmosphere and the weather that it generates. At USAF Academy, the Meteorology major uniquely focuses on the impact of weather on military operations. The growth of meteorology and weather forecasting is intimately linked with the emergence and rise of aviation and space power through the 20th and into the 21st century. The basic properties of the atmosphere and resulting weather phenomena are literally of life-and-death importance to the Air and Space Forces. According to Sun Tzu, "...know the ground, know the weather; your victory will then be total."

The Meteorology major provides the knowledge and understanding necessary to analyze and predict atmospheric behavior over a broad range of time and space scales. These phenomena include small features such as thunderstorms and tornadoes; medium-sized features such as squall lines, hurricanes and blizzards; and even larger features such as continental weather, waves in the jet stream, and climate change.

The Meteorology major requires a foundation in physics, mathematics, and an aptitude for problem solving. This major is administered by the Department of Physics and Meteorology (DFPM). While graduates with a Meteorology major are academically qualified for direct entry into the Weather and Environmental Sciences (WESO, 15W) career field, the majority of Meteorology graduates enter rated career fields. The knowledge and experience gained from a better understanding of the atmosphere benefits them greatly throughout their careers.

The Meteorology Major is designed to develop officers who can:

- 1) Formulate a three-dimensional picture of past and current states of the atmosphere by:
 - 1.1. gathering and interpreting in situ and remotely-sensed meteorological data from a wide array of sources,
 - 1.2. employing conceptual models developed for different regions on varying space and time scales, and
 - 1.3. demonstrating a thorough understanding of the physical and dynamical processes that govern weather and climate.
- 2) Employ sound reasoning to solve the full spectrum of meteorological problems faced in military and civilian operations by:
 - 2.1. effectively relating current and forecast meteorological conditions to operational mission and societal impacts,

- 2.2. selecting appropriate meteorological data, algorithms, and products to answer questions about the current state of the environment (nowcasting), and
- 2.3. employing appropriate operational tools designed to anticipate future states of the environment (forecasting).

- 3) Clearly communicate meteorological concepts through:
 - 3.1. written forecast discussions, forecast reviews, and/or reports,
 - 3.2. oral presentations and forecast discussions, and
 - 3.3. correct manipulation and/or coding of mathematical expressions representing the relevant physical laws governing meteorological processes.

The Meteorology major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

- | | |
|----------------|---|
| 1. Meteor 320 | Introduction to Meteorology and Aviation Weather |
| 2. Meteor 330 | Physical Meteorology I |
| 3. Meteor 331 | Physical Meteorology II |
| 4. Meteor 351 | Weather Data, Analysis, and Structure of Mid-latitude Weather Systems |
| 5. Meteor 352 | Climatology |
| 6. Meteor 370 | Meteorological Applications of Remote Sensing |
| 7. Meteor 430 | Atmospheric Dynamics I |
| 8. Meteor 431 | Atmospheric Dynamics II |
| 9. Meteor 432 | Boundary Layer Structure and Processes |
| 10. Meteor 450 | Tropical Meteorology |

11. Meteor 451 Development and Evolution of Extratropical Weather Systems
12. Meteor 452 Mesoscale Meteorology
13. – 14. Two Meteorology Elective courses from the following:
- Comp Sci 211 Introduction to Programming for Engineers and Scientists
 - Comp Sci 212 Introduction to Programming for Analysts
 - Geo 310 Map Design and Graphic Communication
 - Geo 351 Physical Geography
 - Geo 382 Remote Sensing and Imagery Analysis
 - Math 245 Differential Equations
 - Meteor 499 Independent Study (any combination totaling 3 hours)
 - Physics 370 Upper Atmospheric and Geo-Space Physics
 - Physics 375 Physics of Space Domain Awareness
- Any 3 semester hour course taught within the Dean of Faculty at the 300- or 400 level and approved by the Meteorology AIC
15. Meteor 490 Weather Forecasting and Impacts on Society

SUGGESTED COURSE SEQUENCE

Meteorology Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Meteor 320	3	1	Meteor 330	3	1	Meteor 431	3	1
	Beh Sci 110	3	1	Math 243	3	1	Meteor 351	3	1	Meteor 432	1.5	1
	English 111	3	1	Econ 201	3.5	2	Meteor 352	3	1	Meteor 450	1.5	1
	Math 141	3	1	Physics 215	4	2	Philos 210	3	1	Meteor 451	3	1
	Comp Sci 110	3	1	MSS 251	4.5	2	ECE 315	3	1	Astr Engr 310	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	History 300	3	1	Soc Sci 311	3	1
		15.5	8		19	10	Phy Ed	1	2	Phy Ed	0.5	2
								19	8		15.5	8
Spring	For Lang 2	3	2	Meteor Elective	3	1	Meteor 331	3	1	Meteor 452	3	1
	Chem 100	4	2	English 211	3	1	Meteor 370	3	1	Meteor 490	3	2
	History 100	3	1	Pol Sci 211	3	1	Meteor 430	3	1	Meteor Elective	3	1
	Math 142	3	1	Law 220	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
	Physics 110	4	2	Chem 200	4	2	Math 356	3	1	Adv Sociocultural Opt	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10	Phy Ed	0.5	2		16.25	7		16.25	8
					20.25	9						

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

MILITARY & STRATEGIC STUDIES

THE MILITARY & STRATEGIC STUDIES MAJOR AT A GLANCE: Understanding of strategy is an essential component in any competitive environment. From businesses to nation states, sports teams to militaries, if competition is a component of the operating environment, the ability to develop, implement, and assess strategy is what will enable success. The Military & Strategic Studies major is an interdisciplinary program that teaches cadets how to develop and employ strategy in a military context while giving the cadet the necessary skills to succeed in any competitive environment.

Five required major's courses provide all MSS cadets with a solid foundation in air, space, and cyber strategy in current and future conflicts, the ability to conduct scholarly research using the principles of quantitative and qualitative methods, as well as an understanding of the role of innovation in military and strategic contexts. MSS majors then select three courses that develop the ability to employ strategy in specific military applications. In the MSS 42X courses, cadets learn to take military capabilities and develop a strategy for operational contexts. Designed to be an immersive and summative experience in a cadet's last semester, the MSS 49X series brings together all of a cadet's previous MSS courses and challenges the cadet to develop a theater campaign plan for a notional conflict in a specific region of the globe.

Finally, a major in MSS allows the cadet to purposefully develop themselves according to their own academic, military, and career interests. Good strategists require a broad understanding of STEM, social science methods, as well as the humanities. Breadth electives are designed to provide MSS majors the opportunity to have greater latitude in their own development as strategists, while allowing interested cadets to pursue an academic minor with minimal impact on course loads.

Through this purposeful course of instruction that covers the entire depth and breadth of the theory, context, and application of military & strategic studies, the Department of Military & Strategic Studies develops these Student Learning Outcomes and Proficiencies:

- 1) Apply informed reasoning to solve a complex, contemporary military problem;
- 2) Explain the structure, functions, and responsibilities of the joint force;
- 3) Given a campaign plan, create a detailed supporting plan which synchronizes air, space, cyber, SOF, or surface capabilities; and
- 4) Effectively communicate a scholarly argument on a Strategic Studies topic.

The Military & Strategic Studies major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

1. - 5. 15 semester hours of Foundations of Strategy (five courses):

MSS 298	Research Methods
MSS 343	Foundations of Joint Air, Space, and Cyber Strategy
MSS 444	Space & Cyber Strategy for National Security
MSS 498	Capstone Course in Joint Strategy
and either	
MSS 302	Future Conflict and Disruptive Technologies
or	
MSS 353	Strategies of Military Innovation

6. - 8. 9 semester hours of Specialization in Employing Military Capabilities (three courses)

MSS 302	Future Conflict and Disruptive Technologies
MSS 353	Strategies of Military Innovation
MSS 363	ISR Analysis
MSS 369	The Spectrum of Conflict
MSS 371	Joint Targeting and Strategy
MSS 372	Wargaming Air, Space, and Cyber Power
MSS 377	Airpower for Combined Effects
MSS 381	Air Warfare Operations and Planning
Soc Sci 483	Principles of Negotiation

9. 3 semester hours of Contextualizing Military Strategy (one course)

MSS 421	Strategy of International Power Projection
MSS 422	Strategy of Special Operations
MSS 423	Nuclear Operations and Warfighting Strategy

10. 3 semester hours of Synthesizing National Strategy (one course)

MSS 490	Strategy in Asia and the Pacific
MSS 491	Strategy in the Americas

MSS 493	Strategy in Eurasia
MSS 494	Strategy in the Middle East and Africa

11. - 14. 12 semester hours of MSS Breadth Electives (four courses)
Any four MSS courses, or
Four courses to contribute to the Geospatial Intelligence Certificate, or
Four courses that contribute to a DF approved academic minor, or
Four courses approved by the academic advisor

SUGGESTED COURSE SEQUENCE

Military & Strategic Studies Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Econ 201	3.5	2	MSS 343	3	1	MSS 42X	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	MSS 302/MSS 353	3	1	MSS Option	3	1
	History 100	3	1	English 211	3	1	MSS 444	3	1	MSS Option	3	1
	Math 141	3	1	Law 220	3	1	History 300	3	1	MSS Option	3	1
	Comp Sci 110	3	1	P / C / B Option	4	2	ECE 315	3	1	Philos 210	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Phy Ed	1	2	Adv STEM Option	3	1
		15.5	8		19	10		16	7	Phy Ed	0.5	2
											18.5	8
Spring	For Lang 2	3	2	MSS 298	3	1	MSS Option	3	1	MSS 498	3	1
	Chem 100	4	2	Pol Sci 211	3	1	MSS Specialization	3	1	MSS 49X	3	1
	English 111	3	1	Math 300	3	1	MSS Specialization	3	1	Astr Engr 310	3	1
	Math 142	3	1	P / C / B Option	4	2	MSS Specialization	3	1	Adv Sociocultural Opt	3	1
	Physics 110	4	2	Soc Sci 311	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10	Phy Ed	0.5	2		16.25	7		16.25	7
					20.25	9						

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

MSS 251 must be taken NLT
the third-class fall to declare MSS
or ForArStu - MSS

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
PhyEd = 5.0 "
Total = 140.0 "

NUCLEAR WEAPONS AND STRATEGY MINOR

THE NUCLEAR WEAPONS AND STRATEGY MINOR AT A GLANCE: The Nuclear Weapons and Strategy minor provides a pathway for cadets from all majors to build the technical and strategic foundation to lead the USAF in the second nuclear age. Nuclear weapons play an essential role in the strategic deterrence of adversaries and the current limited nature of warfare. The Nuclear Weapons and Strategy minor focuses on the enduring fundamentals of the nuclear enterprise. This includes the origin of nuclear energy, strategic policy, proliferation, and the effects of radiation as a result of nuclear reactions. The skills and abilities developed in the Nuclear Weapons and Strategy minor are of high importance to the execution of the Air Force's nuclear mission, maintenance of the Air Force's nuclear arsenal, and may be applied in many Air Force career fields. Graduates who complete the Nuclear Weapons and Strategy minor will be prepared to lead the USAF in the second nuclear age and will be well prepared to support Air Force Global Strike Command, NNSA, USSTRATCOM, AFNWC, DTRA, AFTAC, and DIA.

COURSE REQUIREMENTS:

The Nuclear Weapons and Strategy minor requires a minimum of 146 hours and at least 2 non-core academic courses (6 semester hours) in residence in excess of the major's requirements (including the Academy Option). The student must complete these five courses (15 semester hours) with a grade of "C" or better. As this is an interdisciplinary minor, no more than 3 courses for the minor can be from any one department; therefore, the option course must be from a department other than DFPM.

1. Required Courses:

Physics 310	Principles of Nuclear Science
Physics 354	Nuclear Weapons Engineering
Physics 450	Nuclear Weapons Effects
Soc Sci 467	Nuclear Weapons Policy and Strategy

2. Choose one of the following:

Pol Sci 302	American Foreign and National Security Policy
MSS 423	Nuclear Operations and Warfighting Strategy
Chem 350	Chemistry of Weapons
History 320	Winged Defense: The History of Airpower
History 322	Conquest of the New Frontier: The History of Space Power

With the approval of DFPM, DFCH, DFHI, DFMI, or DFPS, cadets may substitute a 3.0 sem hrs (or greater) 495 Special Topic or 499 Independent Study course for this requirement. One option for the Independent Study is a summer internship at a location within the National Nuclear Enterprise, selected to provide the cadet an opportunity to work on special projects designed to give them an understanding of the dynamics and challenges within the Nuclear Enterprise. Cadets can follow-up in the fall semester with

an Independent Study that builds upon or finalizes the work done during the summer internship. Independent Study requirements are managed and overseen by the department administering the course. To participate in a summer internship, cadets must secure a Cadet Summer Research Program (CSRP) slot.

OPERATIONS RESEARCH

THE OPERATIONS RESEARCH MAJOR AT A GLANCE: Operations Research (OR) is the application of scientific and mathematical methods to the study and analysis of problems involving complex systems. More simply, OR is the science of problem solving and decision making. To gain an appreciation for the field, it is necessary to look at its origins.

OR, as a discipline, arose from the need to determine optimal resource allocation and assist decision makers during the Second World War. Groups of mathematicians, physical scientists, and economists were assembled during the war to perform studies that would provide quantitative input for commanders. The results of their efforts were impressive and, soon thereafter, the commercial sector realized the power of these new planning techniques.

The use of mathematics to model real world systems was nothing new; physicists and economists had been doing this for years. What defined this new field called OR was its focus on the operations of organizations. Not only were traditional mathematical modeling methods used, such as statistics and probability, but new modeling methods were created, such as mathematical programming and queuing theory.

This is an exciting field and one that attracts curious problem solvers who are strong in mathematics and computer science and are eager to solve real-world problems.

The description of OR provided above highlights OR's interdisciplinary nature. USAF Academy has captured the essence of the field by establishing a truly interdisciplinary major. The OR program is jointly administered by the Departments of Computer and Cyber Sciences, Economics and Geosciences, Management, and Mathematical Sciences. The required major's courses include courses from each of the four departments.

Our program's curriculum is designed such that, by completion of our program, our graduates shall demonstrate that they have attained the following Student Learning Outcomes:

- 1) Apply fundamental operations research techniques to frame and solve ill-defined technical, social, political, and economic problems;
- 2) Effectively form, lead, and work within multi-disciplinary teams;
- 3) Communicate ideas, concepts, and recommendations effectively; and
- 4) Learn independently.

The Operations Research major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 141 Semester hours

A. *93 Semester hours of Dean's academic core courses to include:*

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics	Advanced Probability and Statistics	Math 377
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1
Adv Open Option	Systems Analysis	Ops Rsch 310

B. 5 Semester hours of Director of Athletics core courses.

C. 43 Semester hours of major's courses:

1. Comp Sci 212	Intro to Programming for Analysts
2. Comp Sci 362	Computer Simulation
3. Econ 365	Econometrics I
4. Econ 465	Econometrics II
5. Math 344	Applied Linear Algebra
6. Math 378	Applied Statistical Modeling
7. Ops Rsch 311	Deterministic Models
8. Ops Rsch 312	Probabilistic Models
9. Ops Rsch 331	Economic Theory and Operations Analysis
10. Ops Rsch 421	Capstone in Operations Research I
11. Ops Rsch 422	Capstone in Operations Research II
12. Ops Rsch Option	(See Supplemental Information)
13. Ops Rsch Option	(See Supplemental Information)
14. Ops Rsch Option	(See Supplemental Information)
Seminar courses:	
Ops Rsch 405	Operations Research Seminar I
Ops Rsch 406	Operations Research Seminar II

Supplemental Information:

Cadets shall choose three of the following courses for the Ops Rsch Options:

Comp Sci 471	Artificial Intelligence
Data 364	Databases and Applications
Econ 377	Financial Markets
Econ 411	Introduction to Game Theory
Econ 422	Labor Economics
Econ 447	Quantitative Economic Methods
Econ 450	International Economics
Econ 466	Advanced Econometrics
Econ 473	Public Economics
Econ 476	Economics of Sports
Econ 340	Economics of Inequality

Geo 340	Introduction to Geographical Information Systems
Geo 440	Advanced Geospatial Analysis
Math 245	Differential Equations
Math 340	Discrete Mathematics
Math 342	Numerical Analysis
Math 359	Design and Analysis of Experiments
Mgt 382	Investments
Mgt 391	Business Data Analytics
Mgt 477	Operations & Project Management
Mgt 478	Supply Chain Management
Ops Rsch 417	Quick-Turn Analysis
Ops Rsch 476	Sports Analytics
Ops Rsch 495	Special Topics
Sys Engr 336	Engineering Economics and Financial Management
Other courses allowed by Ops Rsch AIC and Ops Rsch Working Group approval	

Air and Space Force Career Fields

The operations research major is a desired academic background for many career fields in the Air and Space Forces. Cadets should consult with their academic advisors about choosing core class options and Operations Research electives to improve their chances of selection into specific rated or non-rated career fields. The Hospital Services Administrator career field (41A) has separate application and screening process that require specific coursework.

Many Operations Research majors enter the Operations Research Analyst career field (15A). Those students that desire to become a 15A should maintain a major's GPA of 2.80 or higher to qualify for acceptance into the career field. For initial skills training following graduation, all selected 15As will attend graduate school at the Air Force Institute of Technology for an Operations Research master's, certificate, or gain approval to attend a civilian institution for a master's or PhD.

SUGGESTED COURSE SEQUENCE

Operations Research Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Math 243	3	1	Ops Rsch 311	3	1	Econ 465	3	1
	Beh Sci 110	3	1	English 211	3	1	Ops Rsch 331	3	1	Ops Rsch 421	3	2
	English 111	3	1	Econ 201	3.5	2	Math 377	3	1	Ops Rsch 405	0	1
	Math 141	3	1	P / C / B Option	4	2	Law 220	3	1	Ops Rsch Option	3	1
	Comp Sci 110	3	1	MSS 251	4.5	2	Astr Engr 310	3	1	AF Ops Rsch Option	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Adv Sociocultural Opt	3	1	Aero Engr 315	3	1
		15.5	8		19	10	Phy Ed	1	2	Phy Ed	0.5	2
								19	8		15.5	9
Spring	For Lang 2	3	2	Comp Sci 212	4	2	Comp Sci 362	3	1	Ops Rsch Option	3	1
	Chem 100	4	2	Math 344	3	1	Econ 365	3	1	Ops Rsch 422	3	2
	History 100	3	1	Ops Rsch 310	3	1	Math 378	3	1	Ops Rsch 406	0	1
	Math 142	3	1	Pol Sci 211	3	1	Ops Rsch 312	3	1	Philos 210	3	1
	Physics 110	4	2	P / C / B Option	4	2	ECE 315	3	1	Soc Sci 311	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	History 300	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2		16.25	7	Phy Ed	0.5	2
					21.25	10					16.25	9

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 43.0 "
Phy Ed = 5.0 "
Total = 141.0 "

PHILOSOPHY

THE PHILOSOPHY MAJOR AT A GLANCE: The word “philosophy” derives from a Greek work meaning the *love of wisdom*. In pursuit of wisdom, students of philosophy attempt to answer fundamental questions about the nature of reality, knowledge, and value. Since antiquity, however, philosophers have reminded us that academic study alone cannot make one wise; life experience must complement the knowledge gained by study. Further, many philosophers have insisted that wisdom as a cardinal virtue cannot exist independently of the other three cardinal virtues—courage, temperance, and justice. The spirit of philosophy is accordingly summed up well by Plato’s Socrates. On trial for his life and under pressure to desist from his philosophical investigations, Socrates instead proclaimed that “...for a human being the unexamined life is not worth living.” He went to his death apparently content that he had served his fellow citizens and lived the life most worth living. USAF Academy philosophy majors will undertake their study of philosophy as part of a life of energetic inquiry aimed at developing the virtues appropriate to a leader of character. They will read and discuss primary texts from ancient times up to the present day.

DFPY Student Learning Outcomes:

An undergraduate program in philosophy aims to cultivate skills in the methods of philosophy and to foster learning across a broad range of philosophical topics and philosophical history.

Philosophy at USAF Academy includes these aims, but with adjustments. All students are expected to defend the United States when they become part of the operational Air Force. At the same time, the explicit aim of the institution is to build officers of character. Together, these two institutional realities set our program apart. Our cadets should have an understanding of the ethics of war as well as the ethics of officership. Moreover, our program should provide opportunities for further study in other topics of special interest to future officers, including philosophy of law (given the importance of the laws of war), medical ethics (given the greater possibility of encountering injured people), and religion (given the international and interreligious nature of military service).

The difference between cadets who major in philosophy and those who minor in philosophy is a matter of the degree rather than kind. The learning objectives for both majors and minors are therefore the same. Graduates shall demonstrate:

- 1) Skills in the methods of philosophy. Graduates of our program will:
 - a. Read critically, recognizing the assumptions, context, and arguments, made by authors;
 - b. Write persuasively, following the best practices of the discipline;
 - c. Argue logically, employing both informal and formal systems of logic; and
 - d. Do all of this respectfully, displaying the virtues of charity, fairness, and humility.

- 2) Competence with respect to core philosophical subjects, grounded in the history of philosophy, together with special expertise in ethics as applied to the profession of arms.

Graduates of our program can:

- a. Describe a representative set of the central philosophical problems, questions, and theories, especially those associated with metaphysics, epistemology, language, ethics, and religion;
- b. Outline the general history of philosophy, with special attention to important philosophers such as Confucius, Zuangzi, Mencius, Plato, Aristotle, Augustine, Avicenna, Al Gazali, Maimonides, Aquinas, Descartes, Locke, Kant, Hume, and Mill;
- c. Apply moral theory to the problems that are unique to war and the military profession; and
- d. Recognize and respond to the challenges and opportunities posed by diverse cultural and religious practices as these impact war and the military profession.

The Philosophy major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option	War Stories	English 411
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics courses.

C. 42 Semester hours of major's courses:

1. Philos 311 War, Morality, and the Military Profession
2. Philos 370 Introduction to Symbolic Logic
3. Philos 391/2/3/4
4. Philos 401/402 Comparative Religion or Philosophy of Religion
5. Philos 423 Knowledge and Reality
6. Philos 495 Special Topics for Philosophy majors
7. - 13. Philosophy Options (See Supplemental Information 1 and 2)
14. Open Academic Option Any course (≥ 3.0 sem hrs) taught under the supervision of the Dean of Faculty

Supplemental Information:

- 1) Consistent with DF's emphasis on multiple purposeful pathways, each of these options can be filled in three ways:
 - a. "Neat": take any 3-semester hour course taught by DFPY.
 - b. "With a twist": take Law 463, Mgt 411, Pol Sci 301, Pol Sci 423, Pol Sci 451, and/or Econ 440; or with prior DFPY approval, take any 3-semester hour course taught by DF that focuses on "overlap" texts commonly read by another discipline as well as philosophy. In this case, DFPY advisors will probably look for a pairing (e.g., an English 495 on American Transcendentalism with Philos 382, American Philosophy, for 6 semester hours of Philosophy Option credit).
 - c. "With a splash": with prior DFPY approval, take any course taught by DF or academic course taught by AD (e.g., Phy Ed Aca 460) and pair it with a Philos 499 for 6 semester hours of Philosophy Option credit (e.g., Biology 459, Principles of Evolution, paired with a Philos 499 on philosophy of biology; History 352, The History of Modern America, paired with a Philos 499 on American Pragmatism).
- 2) Cadets majoring in philosophy who wish to take a foreign language minor may substitute the number of foreign language courses necessary to earn the minor, minus two courses totaling at least six semester hours, for philosophy options, one for one. (DF-wide policy governing academic minors requires that at least two courses count only toward the minor.) Additional foreign language courses beyond the minor can earn a similar offset with department approval.

SUGGESTED COURSE SEQUENCE

Philosophy Major

	4°		hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1		3	2	Philos Option	3	1	Philos 39X	3	1	Philos 423	3	1
	Beh Sci 110		3	1	MSS 251	4.5	2	Philos 370	3	1	Philos 401	3	1
	History 100		3	1	Philos 210	3	1	Law 220	3	1	Philos Option	3	1
	Math 141		3	1	Econ 201	3.5	2	ECE 315	3	1	Adv Open Option	3	1
	Comp Sci 110		3	1	P / C / B Option	4	2	Adv STEM Option	3	1	Soc Sci 311	3	1
	Phy Ed		0.5	2	Phy Ed	1	2	English 411	3	1	Phy Ed	0.5	2
			15.5	8		19	10	Phy Ed	19	8		15.5	7
Spring	For Lang 2		3	2	Philos Option	3	1	Philos 311	3	1	Philos Option	3	1
	Chem 100		4	2	Philos Option	3	1	Philos 495	3	1	Philos Option	3	1
	English 111		3	1	English 211	3	1	Philos Option	3	1	Open Academic Option	3	1
	Math 142		3	1	P / C / B Option	4	2	Aero Engr 315	3	1	History 300	3	1
	Physics 110		4	2	Pol Sci 211	3	1	Math 300	3	1	Astr Engr 310	3	1
	Ldrshp 100		0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed		0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Phy Ed	0.5	2
			18.25	10	Phy Ed	0.5	2		16.25	7		16.25	7
						20.25	9						

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

PHILOSOPHY MINOR

THE PHILOSOPHY MINOR AT A GLANCE: The Philosophy minor requires five philosophy courses in addition to Philos 210. "Philosophy" is not another discipline. Rather, it is rational inquiry into any discipline (e.g., philosophy of psychology, philosophy of history, philosophy of law). Philosophers seek answers to the basic, fundamental questions which underpin any field of study. In addition to the questions addressed in the core course about how we should live our lives, philosophers also study: principles of language and reasoning (logic); foundations of empirical discovery and other ways of knowing (epistemology); and the ultimate underpinnings and structure of the self and the world (metaphysics).

COURSE REQUIREMENTS:

In addition to the successful completion of Philos 210 ("C" or better), five courses (≥ 15 semester hours) in which the student earns a grade of "C" or better. Required courses include:

1. One course in the history and topics series:

Philos 391	Ancient Western Philosophy
Philos 392	Western Medieval Philosophy
Philos 393	Modern Western Philosophy
Philos 394	Contemporary Topics in Philosophy
2. One of the following logic courses:

Philos 200	Introduction to Philosophy
Philos 370	Introduction to Symbolic Logic
3. - 4. Any two Philos courses.
5. Any philosophy course or one of the following courses: Econ 440, Law 463, Mgt 411, Pol Sci 301, Pol Sci 423, or Pol Sci 451.

WHY STUDY PHILOSOPHY? Philosophy is an ancient and valuable sub district within the vast marketplace of ideas. It is concerned with the most interesting questions in life—the questions that are fundamental and the least easy to answer or avoid. All cadets are required to take a course in ethics, which is the discipline concerned with answering the questions: What is a good act? What sort of person is the best person? What is truly valuable? By what principles should life be led? Obviously, philosophy is not for everyone. It is not for those who want easy answers, nor is it for those who do not care about the deeper meanings of life or the purpose of their own lives. It is for those who wish to gain a more thorough understanding of themselves as rational, reflective beings inhabiting and working in a world that sometimes allows us to glimpse its deeper meanings.

PHYSICS

THE PHYSICS MAJOR AT A GLANCE: Newton, Maxwell, Einstein...some of history's most important and influential people focused their studies on physics. Our modern technological society owes its existence to great thinkers such as these. Tablets, smart phones, Xboxes—the laws and equations behind every one of our favorite devices were first discovered in a physics laboratory somewhere around the globe. And although the pace of scientific discovery has been nothing short of amazing over the past two centuries, there remains a plethora of fundamental "unknowns" for future physicists to conquer: dark energy, dark matter, quantum gravity, Grand Unification Theory...and many more.

On a more practical level, majoring in physics is the only path to becoming an Air Force physicist (61D Air Force Specialty Code (AFSC)). History proves it is also an excellent path to success in other career fields in both the Air and Space Forces, including acquisition management (AFSC/SFSC 63A), space operations (SFSC 13S), weather and environmental sciences (15W), and intelligence (AFSC/SFSC 14N), as well as the whole spectrum of rated AFSCs. For cadets seeking to pursue an advanced academic degree while on active duty, USAF Academy physics majors are highly competitive for graduate school due to the quality of our program and the wide variety of scholarships and sponsorships available. Got your sights set even higher? One USAF Academy Physics major—Dr. Ronald Sega, Class of 1974—flew two missions on the Space Shuttle as a NASA astronaut and later went on to become the Under Secretary of the Air Force for Space.

So what do AF physicists actually do? Over their first 5-10 years on active duty, most 61Ds are assigned to work cutting edge research, development, and test projects and next-generation weapon system acquisition programs under Air Force Materiel Command, Air Force Special Operations Command, Air Combat Command, the National Reconnaissance Office, and other major commands. These assignments may include experimental design and data analysis, launching new satellites, briefing members of Congress, and fielding state-of-the-art technologies. Bottom line: the Air Force depends critically on 61Ds for their scientific expertise, critical thinking skills, fresh perspectives and new ideas applied to the nation's toughest (and often highly classified) technical challenges in the pursuit of maintaining US air, space, and cyberspace dominance for decades to come.

For USAF Academy cadets choosing to major in physics, the journey typically begins spring semester of the sophomore year with Physics 264 (Modern Physics) and Physics 291 (Introduction to Optics and Lasers). The junior and senior years include courses like Classical Mechanics, Electromagnetic Theory, Laboratory Techniques, Computational Physics, Thermal & Statistical Physics, and Quantum Mechanics. Physics majors also choose three courses that constitute their "concentration." The available concentrations include Directed Energy and Optics, Nuclear Physics, and Space Physics. Another option is the Applied Physics concentration, which allows the cadet to choose essentially any coherent sequence of three technical courses offered in either the physics department or a combination of the physics department and another academic department. Physics majors interested in the Weather and Environmental Sciences Officer (15W)

career field should speak with their advisor about incorporating meteorology courses into their schedule as an applied physics concentration. There is also a well-established path to completing double-majors that include Physics. The most common is Physics/Applied Mathematics, but former physics students have also double-majored in Astronautical Engineering, Electrical Engineering and several others.

Beyond the classroom, physics majors have ample opportunity to participate in world-class scientific research and obtain academic credit through Capstone Physics Research (Physics 490) and one or more an Independent Study (Physics 499) courses. Physics 499 can be taken for 1 to 3 semester hours per semester. DFPM is home to 5 research centers with more than 40 faculty and full-time researchers executing dozens of diverse projects at any given time:

- Space and Atmospheric Research Center (SPARC): Designs, builds, calibrates, operates, and analyzes data from scientific payloads that fly in space; investigates the aurora and sprites in the middle atmosphere, and lightning in the lower atmosphere.
- Laser and Optics Research Center (LORC): Models, designs, and constructs new types of lasers and optics for potential use in future intelligence, surveillance, and reconnaissance platforms, non-kinetic weapon systems, and medical devices.
- Center for Space Situational Awareness Research (CSSAR): Operationalizes the Falcon Telescope Network (FTN), twelve robotic 20-inch telescopes around the globe from Colorado to Chile to Australia; schedules observations; analyzes satellite and astronomical data for space situational awareness research.
- Astronomical Research Group and Observatory (ARGO): Collects spectral and photometric images of stars using the 16-inch and 1-meter telescopes at the USAF Academy Observatory, in addition to the FTN; processes data to characterize orbital properties of previously unknown or unconfirmed exoplanets.
- Nuclear Enterprise Research Center (NERC): focuses on the engineering, science and policy issues that face the United States Air Force and the Department of Defense. NERC works closely with DIA, AFTAC, DTRA, AFNWC, and NNSA to respond to evolving threats and difficulties that face this nation and the world.

Over the multiple years completing the USAF Academy physics major, cadets develop a mastery of the most fundamental laws governing our universe—those same laws that dictate the F-35's radar cross-section, GPS's susceptibility to jamming, and the AIM-9's maximum kill range. Ultimately, the physics major is tailored to prepare cadets for their primary role as future officers: solving unforeseen, abstract, complex, and ill-defined problems. Regardless of AFSC, cadets graduating from USAF Academy with a bachelor's degree in physics enter active duty with great confidence in their abilities to conquer the many "unknowns" for which they will be responsible at their first assignment and beyond.

Learning Outcomes: Our program's curriculum is designed such that our graduates shall demonstrate that they have attained the following Student Learning Outcomes:

1. Demonstrate comprehensive quantitative and qualitative knowledge of the fundamental pillars of physics (classical physics, quantum theory, relativity, and thermodynamics) and

apply fundamental concepts to explain or predict physical phenomena. (**Physics Knowledge & Application**)

2. Frame and solve problems competently by identifying the essential parts of a problem and formulating a strategy for solving the problem. Estimate the numerical solution to a problem, to include uncertainty analysis. Employ appropriate mathematical and computational techniques to arrive at a solution, assess the reasonableness of the solution, and interpret the results. (**Problem Solving Skills**)
3. Design, conduct, and understand experiments or theoretical studies to include experimental design, data collection techniques, mathematical analyses, and uncertainties. Properly and safely use appropriate laboratory equipment, modern instrumentation, and sound techniques to carry out experiments. May include theoretical or computational studies and the appropriate analytical or numerical techniques. (**Experimental Skills**)
4. Effectively communicate physics concepts, problems, solutions, experiments, and their application to physical phenomena, both orally and in writing, to experts and non-experts. (**Communication Skills**)
5. Understand the processes for, and participate in, scientific research to investigate real-world problems, including literature review, application of fundamental physics concepts, experimental techniques, data collection and analysis, discrimination between relevant and irrelevant data, uncertainty analysis, and presentation of results. (**Research Skills**)
6. Explain the development and the current theoretical, experimental, and philosophical foundation underlying what we know, what we cannot know, and what we do not yet know about natural phenomena. Understand, evaluate, and critique recently developed or alternative scientific ideas presented in the media, experiments, and the scientific literature. (**Philosophical Basis of Science**)
7. Demonstrate character traits expected of an Air or Space Force officer educated in the basic sciences. These traits include: integrity, dedication to duty, commitment to excellence, teamwork, intellectual curiosity, innovation, and responsibility. (**Character Traits**)

The Physics major contributes to both the development and assessment of the USAF Academy Institutional Critical Thinking Outcome.

COURSE REQUIREMENTS: 145 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Physics II with Laboratory	Physics 215
P / C / B Option 2	General Chemistry II Lecture and Lab or Introductory Biology with Laboratory	Chem 200* or Biology 215
Statistics	Probability and Statistics for Scientists and Engineers	Math 356
Adv STEM Option	Calculus III	Math 243/253
Adv Sociocultural Option		Choose 1

Adv Open Option	Physics 310 or Physics 371
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*For P / C / B Option 2, Chem 200 is preferred for most concentrations

B. 5 Semester hours of Director of Athletics core courses.

C. 6 Semester hours in Applied Mathematics as follows:

- | | |
|-------------|-------------------------|
| 1. Math 245 | Differential Equations |
| 2. Math 346 | Engineering Mathematics |

D. 32 Semester hours in Physics:

- | | |
|-----------------|-----------------------------------|
| 1. Physics 264 | Modern Physics |
| 2. Physics 291 | Introduction to Optics and Lasers |
| 3. Physics 341 | Laboratory Techniques |
| 4. Physics 355 | Classical Mechanics |
| 5. Physics 356 | Computational Physics |
| 6. Physics 361 | Electromagnetic Theory I |
| 7. Physics 362 | Electromagnetic Theory II |
| 8. Physics 421 | Thermal and Statistical Physics |
| 9. Physics 465 | Quantum Mechanics |
| 10. Physics 490 | Capstone Physics Research |
| Seminar course: | |
| Physics 405 * | Physics Seminar |

* Physics 405 must be taken concurrently with Physics 490

E. 9 Semester hours in one of the following three concentrations listed in the table below: At least two of the selected courses must be 300-level or higher and one must be a 400-level course. At most one 3 semester hour Physics 499 may substitute as a 2/300-level concentration course; however, Physics 499 cannot fulfill the 400-level course requirement if there is only one 400-level course option. For the Space Physics sequence we recommend cadets take Physics 371 as their Advanced Open Option. For the Nuclear Physics sequence we recommend cadets take Physics 310 as their Advanced Open Option. Cadets majoring in physics and pursuing the nuclear minor must take at least 2 noncore academic courses (6 semester hours) in residence in excess of the major's requirements (including the Academy Option) to meet the minor requirements.

		Course	Title	Offered	Pre/Co-requisites
Concentration Sequences	Space Physics	Physics 370	Upper Atmospheric & Geo-Space Physics	Fall odd years	Prereq: Physics 215 or dept approval
		Physics 375	Physics of Space Domain Awareness	Fall even years	Prereq: Physics 215 or dept approval
		Physics 486	Astrophysics	Spring even years	Prereq: Physics 264 & Physics 371 or dept approval Coreq: Physics 362 or dept approval
	Nuclear Physics	Physics 354	Nuclear Weapons Engineering	Spring	Prereq: C or better in Physics 310
		Physics 450	Nuclear Weapons Effects	Fall	Prereq: C or better in Physics 354
		Physics 468	Atomic & Nuclear Physics	Spring	Prereq: Physics 465 or dept approval
	Directed Energy & Optics	Physics 242	Quantum Information	Fall	Prereq: Physics 110 & Math 142 or dept approval
		Physics 468	Atomic & Nuclear Physics	Spring	Prereq: Physics 465 or dept approval
		Physics 482	Lasers & Modern Optics	Spring odd years	Coreq: Physics 362, ECE 444, or dept approval
	Additional Courses	Physics 451	Plasma Physics	Offered infrequently	Prereq: Physics 370 recommended Coreq: Physics 362 & Math 346 or dept approval
		Physics 473	Solid State Physics	Offered infrequently	Prereq: Physics 215 Coreq: Physics 465 & Math 245 or dept approval
		Physics 495	Special Topics	Offered infrequently	Department approval
		Physics 499	Independent Research		Department approval

Applied Physics Option:

Working with your academic advisor, you may also propose a sequence of your own by selecting at least three courses (9 semester hours) from the Department of Physics and Meteorology or other USAF Academy academic departments. It is *your* responsibility to have thorough discussions with your academic advisor to identify and justify a coherent three-course sequence in an area related to basic sciences and engineering. You may take more than three courses if your schedule permits in order to delve more deeply into a subject of interest. At least two of the selected courses must be 300-level or higher and one must be a 400-level course. At most, one 3 semester hour Physics 499 may substitute as a 2/300 -level concentration course; however, Physics 499 cannot fulfill the 400-level course requirement if there is only one 400-level course option. All applied physics option sequences must be approved by the Physics Major AIC, the department's Director of Advanced Programs, and the Department Head.

Some illustrative possible sequences:

Aircraft Propulsion Design: Aero Engr 241/Aero Engr 361/Aero Engr 466

Atmospheric Physics: Meteor 330/Meteor 331/Meteor 430

Materials Physics: Physics 473/Mech Engr 340/Mech Engr 440

Mathematical Physics: three of Math 344/Math 451/Math 468/Math 469/Math 470
Medical Physics (pre-med):* Chem 233/Chem 234/Chem 243/Biology 431
Space Vehicle Design: Physics 370 or Astr Engr 331/Astr Engr 436/Astr Engr 437

* Four concentration courses are required for pre-med students and should be taken by the end of the 2^o year.

SUGGESTED COURSE SEQUENCE

Physics Major

	4 ^o	hrs	per	3 ^o	hrs	per	2 ^o	hrs	per	1 ^o	hrs	per
Fall	For Lang 1	3	2	Math 243	3	1	Math 346	3	1	Physics 421	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Physics 355	3	1	Physics 465	3	1
	History 100	3	1	P/C/B Option	4	1	Physics 361	3	1	Physics Conc 1	3	1
	Math 141	3	1	Econ 201	3.5	2	Law 220	3	1	Soc Sci 311	3	1
	Comp Sci 110	3	1	Physics 215	4	2	History 300	3	1	Adv Sociocultural Opt	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Adv Open Option	3	1	Phy Ed	0.5	2
		15.5	8		20	10	Phy Ed	1	2		15.5	7
								19	8			
Spring	For Lang 2	3	2	Physics 264	3	1	Physics 341	4	2	Physics 405	0	1
	Chem 100	4	2	Physics 291	3	1	Physics 356	3	1	Physics 490	4	2
	Physics 110	4	2	Math 245	3	1	Physics 362	3	1	Physics Conc 2	3	1
	English 111	3	1	Pol Sci 211	3	1	Aero Engr 315	3	1	Physics Conc 3	3	1
	Math 142	3	1	English 211	3	1	Math 356	3	1	Philos 210	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	ECE 315	3	1	Astr Engr 310	3	1
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
		18.25	10	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
					19.25	8		20.25	9		17.3	9

Course Unit Summary
Core (29)
Major (16)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 47.0 "
PhyEd = 5.0 "
Total = 145.0 "

POLITICAL SCIENCE

THE POLITICAL SCIENCE MAJOR AT A GLANCE: The Political Science major offers a course of studies tailored to the needs of prospective Air Force officers by providing a comprehensive understanding of both the substance and process of politics and public policy. The major is uniquely capable of preparing cadets to comprehend the political events, both domestic and international, that will shape their careers. It accomplishes this by examining topics such as political theory, research methods, comparative politics, international relations, American politics, security studies, defense decision-making, political economy, and organizational behavior.

The Political Science major is flexible. The major allows cadets to study a subfield in-depth or to examine a variety of political topics. The wide option of electives offers an advantage for cadets who pursue a minor in a foreign language, philosophy, religion studies, or nuclear weapons and strategy. The major offers four areas of concentration: American politics, international relations, comparative politics and area studies, and national security policy. Academic advisors enthusiastically assist cadets in tailoring an academic program to meet their individual interests.

Our program's curriculum is designed such that, by completion of our program, our graduates shall demonstrate that they have attained the following ***Student Learning Outcomes***:

- Explain the history, underlying theories, and operation of political systems and the American political system under the Constitution.
- Evaluate fundamental similarities and differences among various political systems around the world.
- Explain fundamental drivers of cooperation, conflict, and war in the international system.
- Analyze national security institutions, process, and strategy.
- Demonstrate proficiency in ethical, qualitative, and quantitative reasoning.

The Political Science major contributes to both the development and assessment of the USAF Academy Critical Thinking and National Security of the American Republic Outcomes.

COURSE REQUIREMENTS: 140 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 2		Choose 1
P / C / B Option 1		Choose 1
Statistics		Choose 1
Soc Sci 311	International Security	Soc Sci 212
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 42 Semester hours of major's courses:

- | | |
|----------------|--|
| 1. Pol Sci 300 | Quantitative Methods and Research Design |
| 2. Pol Sci 301 | Political Theory |
| 3. Pol Sci 302 | American Foreign and National Security Policy
(See Supplemental Information 1) |
| 4. Pol Sci 394 | Comparative Politics |
| 5. Pol Sci 491 | Capstone Seminar in Political Science: National Security
and Political Analysis |
6. - 8. Select one course from each of the following three baskets:
- | | |
|----------------------------|--|
| a) American Government | Pol Sci 392, Pol Sci 451, Pol Sci 481, Pol Sci 482,
Pol Sci 483, Pol Sci 484 |
| b) Comparative Politics | Pol Sci 464, Pol Sci 469, Pol Sci 471, Pol Sci 473,
Pol Sci 475, Pol Sci 477, Pol Sci 479 |
| c) International Relations | Pol Sci 390, Pol Sci 421, Pol Sci 445, Pol Sci 496, Soc
Sci 444 |
9. - 10. Pol Sci Options 1 & 2 Any Pol Sci course (See Supplemental Information 2)
11. Pol Sci Option 3 Any Pol Sci course, ForArStu course, Soc Sci 444, or
Soc Sci 467
12. - 13. Pol Sci Options 4 & 5 Any Pol Sci course, any ForArStu course, and any of the
following that contribute to a cadet's substantive or
methodological course of study as coordinated with an
academic advisor: any For Lang course at the 200-level or
above, any non-core History course, any non-core Econ
course, any non-core Law course, any non-core Philos
course, any non-core English course, Beh Sci 352, Beh Sci
360, Beh Sci 362, Beh Sci 364, Beh Sci 366, Beh Sci 358,
Geo 250, Geo 412, Geo 470, Geo 471, Geo 475, Geo 480,
Hum 430, Hum 461, Hum 463, MSS 353, MSS 369, MSS
421, MSS 422, MSS 423, MSS 444 MSS 490, MSS 491,
MSS 493, MSS 494, Soc Sci 420, Soc Sci 444, Soc Sci 467
14. DF Option Any course (≥ 3.0 sem hrs) taught under the supervision
of the Dean of Faculty

Supplemental Information:

1. Pol Sci 211, Soc Sci 212, and Pol Sci 302 support the National Security of the American Republic in a Complex Global Environment outcome.
2. Pol Sci 300, Pol Sci 301, and Pol Sci 394 support the Critical Thinking outcome.

SUGGESTED COURSE SEQUENCE

Political Science Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Econ 201	3.5	2	Pol Sci 394	3	1	Pol Sci Option	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Pol Sci 301	3	1	Pol Sci Option	3	1
	History 100	3	1	Pol Sci 211	3	1	Pol Sci Basket 1	3	1	Pol Sci 491	3	1
	Math 141	3	1	Law 220	3	1	Philos 210	3	1	Adv Sociocultural Opt	3	1
	Comp Sci 110	3	1	P / C / B Option	4	2	History 300	3	1	Astr Engr 310	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	ECE 315	3	1	Phy Ed	0.5	2
		15.5	8		19	10	Phy Ed	1	2		15.5	7
								19	8			
Spring	For Lang 2	3	2	Adv STEM Option	3	1	Pol Sci 302	3	1	Pol Sci Option	3	1
	Chem 100	4	2	English 211	3	1	Pol Sci 300	3	1	Pol Sci Option	3	1
	English 111	3	1	Math 300	3	1	Pol Sci Basket 2	3	1	Pol Sci Option	3	1
	Math 142	3	1	P / C / B Option	4	2	Pol Sci Basket 3	3	1	DF Option	3	1
	Physics 110	4	2	Soc Sci 212	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10	Phy Ed	0.5	2		16.25	7		16.25	7
					20.25	9						

Course Unit Summary
Core (29)
Major (14)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 42.0 "
Phy Ed = 5.0 "
Total = 140.0 "

PRE-HEALTH PROFESSIONS MINOR

THE PRE-HEALTH PROFESSIONS MINOR AT A GLANCE: The Pre-Health Professions Minor prepares cadets to apply for careers in medical, dental, nursing, physician assistant, and physical therapy graduate programs that are necessary to get selected into those career fields. These professions support the Air Force Medical Command, which provides operational medical capability integrated within warfighting force elements. Per the USAF Surgeon General, this alignment improves the Air Force's ability to generate medically ready forces, provide installation support to Airman and Guardians, and partner with the Defense Health Agency to optimize health care delivery. Health professionals of the USAF provide a critical component of readiness by ensuring USAF and USSF commanders have the medical support for their warfighting capabilities. Cadets who complete this minor will meet mandatory coursework requirements necessary for application to health professions. They will also be prepared for the rigors of highly selective graduate school programs and standardized admissions tests that are required for selection as a USAF health professional.

COURSE REQUIREMENTS:

The Pre-Health Professions Minor requires 15-21 semester hours, and a minimum of 6 semester hours in excess of the major's requirements. The course requirements are designed to satisfy the pre-requisite requirements for most health profession graduate programs and to prepare cadets to excel as future Air Force health professionals. Each of the four tracks is designed to satisfy the pre-requisites for a specific health professions graduate program and should be carefully chosen by the cadet in consultation with their major advisor and an HPAC advisor; consult an HPAC advisor if any courses are validated. Completion of the Pre-Health Professions academic minor is NOT sufficient to compete for accession into Air Force health professions. If cadets intend to compete for accession into health professions (medical, dental, nursing, physical therapy, physician assistant), deliberate coordination with the USAF Academy Health Professions Advising Committee (HPAC) is required to meet all preparation and competitive release requirements. All courses must be completed with a grade of "C" or better.

PRE-MEDICAL and PRE-DENTAL TRACK

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutions	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 21 Semester hours of minor's courses:

1. Bio 215 Introductory Biology with Laboratory (4)
2. Chem 233 Organic Chemistry I (3)
3. Chem 234 Organic Chemistry II (3)
4. Chem 243 Organic Chemistry Laboratory (4)
5. Bio 360 Cell and Molecular Biology (3)
6. Bio 363 Genetics (4)

PRE-NURSING TRACK

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutions	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	Introductory Biology with Laboratory	Biology 215
Statistics		Choose 1
Adv STEM Option	Human Nutrition	Biology 370
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 15 Semester hours of minor's courses:

1. Biology 332 Microbial Diversity (3)
2. Biology 410 Anatomy and Physiology: Sensory and Motor Integration (3)
3. Biology 431 Microbiology (3)
4. Biology 440 Anatomy and Physiology: Visceral Systems Integration (3)
5. Beh Sci 440 Lifespan Development (3)

PRE-PHYSICIAN ASSISTANT TRACK

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutions	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	Introductory Biology with Laboratory	Biology 215
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 18 Semester hours of minor's courses:

1. Chem 230 Introductory Organic Chemistry (3)
2. Biology 332 Microbial Diversity (3)

3. Biology 410 Anatomy and Physiology: Sensory and Motor Integration (3)
4. Biology 431 Microbiology (3)
5. Biology 440 Anatomy and Physiology: Visceral Systems Integration (3)
6. Chem 481 Biochemistry I (3)

PRE-PHYSICAL THERAPY TRACK

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutions	
P / C / B Option 1	General Chemistry II Lecture and Lab	Chem 200
P / C / B Option 2	General Physics II with Laboratory	Physics 215
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option	Sociology	Beh Sci 360
Adv Open Option		Choose 1

B. 16 Semester hours of minor's courses:

1. Biology 215 Introductory Biology with Laboratory (4)
2. Biology 320 Biomechanics (3) (Offered Spring, even numbered years only)
3. Biology 410 Anatomy and Physiology: Sensory and Motor Integration (3)
4. Biology 440 Anatomy and Physiology: Visceral Systems Integration (3)
5. Beh Sci 440 Lifespan Development (3)

RELIGION STUDIES MINOR

THE RELIGION STUDIES MINOR AT A GLANCE: This minor provides cadets the knowledge and skills they need to serve and lead effectively in other parts of the world as they engage persons of different cultures and religions, both in times of peace and in times of war. A central goal of the academic study of religion at the Academy is increasing cadets' religious literacy, i.e., their understanding of different world religions, and how religion, as variously conceived and practiced, decisively informs the way people across the globe view themselves, the world, and their place within the world. Furthermore, it is by studying religion that cadets become better able to relate to and work with those who possess religious worldviews, and lead religious lives, that differ from their own. The study of religion therefore provides cadets the knowledge and skills they need to serve and lead effectively in a pluralistically religious (and non-religious) military, as well as a better understanding of the cultural background in expeditionary settings.

COURSE REQUIREMENTS:

Cadets will earn the minor by completing five courses (15 semester hours):

1. Three required courses (nine semester hours) that provide a basic understanding of the concept of religion and of faith traditions around the world:

Philos 401	Comparative Religion (or another course approved by Humanities and Social Science Division Chairs)
Philos 402	Philosophy of Religion (or another course approved by Humanities and Social Science Division Chairs)
Philos 420	Religion Studies Capstone (to be completed last)

2. Two elective courses (six semester hours) that broaden students' understanding of religion in the context of their academic majors. Courses offered in the current curriculum will count if the owning department head, Humanities Division Chair, and Social Sciences Division Chair concur that they offer substantial insight into the nature and practice of religion:

Behavioral Science	sociology, personality, social psychology, biopsychology-- depending on section and syllabus
English	literature courses, depending on the syllabus in a given semester
History	any course might count depending on the syllabus that semester:
History 220	Let Freedom Ring?: American History since Reconstruction
History 230	Bastille to Brexit: Introduction to Modern European History
History 240	Steppes, Stalin, and Sputnik: Introduction to Russia and Eurasia
History 250	Introduction to the History of the Middle East and North Africa
History 260	Historia Pasada y Presente: Introduction to Modern Latin American History
History 270	Modern East Asian History

History 280	Africa South of the Sahara
History 290	Global Contact and Local Responses in South and Southeast Asia
History 360	Topics in Regional History: Eastern/Western Europe; Russia; Latin America
History 361	Topics in Regional History: Eastern, Central, or Western Asia; Africa
History 368	Big Ideas: Intellectual Trends in World History
Hum 430	The Holocaust
Hum 461	Russian Literature
Hum 463	Far Eastern Literature
Law 351	U.S. Constitutional Law
Law 360	Law and Literature
Mgt 440	Managerial Lessons in Literature
Philos 350	Philosophy and Christian Thought
Philos 365	C.S. Lewis and Philosophy
Philos 382	American Philosophy
Philos 392	Medieval Philosophy
Pol Sci 477	Politics of the Middle East

ROBOTICS AND AUTONOMOUS SYSTEMS MINOR

THE ROBOTICS AND AUTONOMOUS SYSTEMS MINOR AT A GLANCE: The newest US Air Force mission statement is "To fly, fight, and win...airpower anytime, anywhere," and official USAF doctrine defines airpower as: "the ability to project military power through control and exploitation in, from and through the air." Recognizing this fact, the robotics and autonomous systems minor focuses on how war in the air domain will be changed through increased use of robotics. Up until now, robotics have primarily served in roles where repetitive functions could be automated. However, as cost, computing power and algorithmic development simultaneously enable newer classes of low-cost attritable assets, robotic systems are taking a prominent role in defense and projection of power. The Robotics and Autonomous Systems Minor is for those cadets who want to go beyond the basic understanding of technology in the DoD via the USAF Academy Core, and will focus explicitly on capability, need and employment of robotic systems. It provides cadets exposure to tactical, operational, strategic considerations as well as technological capabilities and limits of robotic systems. It adds to the core curriculum's foundation with greater depth in the specific application of robotic systems relevant to any Air Force operational specialty. This minor is compatible with any academic major.

COURSE REQUIREMENTS FOR THE ROBOTICS AND AUTONOMOUS SYSTEMS MINOR:

The Robotics and Autonomous Systems Minor requires a minimum of 15 semester hours. The student must complete these five courses (15 semester hours) with a grade of "C" or better. Up to 9 semester hours may "multiple count" (double, triple, etc., as the case may be) toward this minor and a cadet's advanced core options and/or major's requirements. In the event that more than 9 semester hours satisfy requirements for this minor and a cadet's major, second minor, or core classes, additional courses must be taken from the list of courses below. A cadet must take a minimum of 6 semester hours solely counted for the Robotics and Autonomous Systems Minor. This is an interdisciplinary minor. No more than 2 courses for the minor can be from any one department, unless a specific special topic is proposed and approved via an ECE 499 or Mech Engr 499 (in this case, it is possible that 3 courses could come from either ECE or Mech Engr).

1-3. Three required foundational courses:

ECE 387	Introduction to Robotic Systems
Mech Engr 396	Mechatronics
Pol Sci 466	Cyber Security Policy and Politics

4-5. Choose two of the following depth options (Reminder, cadets may not choose more than a total of two courses from the same discipline):

Astr Engr 331	Space Systems Engineering
Mech Engr 320	Dynamics
Comp Sci 471	Artificial Intelligence

Comp Sci 472	Autonomous Systems Integration
ECE 487	Advanced Robotics
Econ 367	Industrial Organization
Engr 341	Linear Systems Analysis and Design
Engr 342	Linear Control System Analysis and Design
History 321	STEM at War: History of Technology and Warfare
Law 440	Cyber Law
Math 344 or 360	Applied Linear Algebra or Linear Algebra (you may not count both towards requirements for this minor)
Mgt 400	Management and Command
Philos 320	Ethics and Technology

With the approval of the minor AIC and the Department Head of an instructor offering a 499, cadets may substitute a robotics related 499 course.

SOCIAL SCIENCES

THE SOCIAL SCIENCES MAJOR AT A GLANCE: Social Sciences deal with human behavior in its social and cultural aspects. At USAF Academy, the following disciplines are within the social sciences: Economics, Geospatial Science, Management, Law, Political Science, Behavioral Science, and Military & Strategic Studies.

The major in Social Sciences is designed for the cadet whose interests and abilities lie in a broader program of study than a single disciplinary major would provide. The Social Sciences major requires completion of at least one course, as indicated below, taught in five of the seven disciplines included in the Social Sciences division. More concentrated study in one discipline is possible through the use of the Social Science Divisional Options (any course(s) from the social science disciplines).

Flexibility in course selection is one advantage of this major. A specialized graduate degree in a particular discipline would be an option after graduation. The Social Sciences Major must be recommended by the Academic Advisor, endorsed by the Department Head, and approved by the Division Chair. Alternatively, the Social Sciences Major may be directed by the Academic Review Committee and coordinated with the Division Chair.

COURSE REQUIREMENTS: 134 Semester hours

A. 93 Semester hours of Dean's academic core courses to include:

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. 5 Semester hours of Director of Athletics core courses.

C. 36 Semester hours of major's courses:

1. Social Sciences Breadth Elective #1
2. Social Sciences Breadth Elective #2
3. Social Sciences Breadth Elective #3
4. Social Sciences Breadth Elective #4
5. Social Sciences Breadth Elective #5
6. Social Sciences Depth Elective #1
7. Social Sciences Depth Elective #2

8. Social Sciences Depth Elective #3
9. Social Sciences Depth Elective #4
10. Social Sciences Depth Elective #5
11. Social Sciences or Humanities Division Option
12. Academy Option

Supplemental Information:

1. Econ 423 (Managerial Economics) may satisfy a Mgt or Econ requirement.
2. Soc Sci 420 (Law and Economics), taught by DFEG and DFLA, may satisfy a Law or Econ requirement.
3. Soc Sci 483 (Principles of Negotiation), taught by DFLA and DFMI, may satisfy a Beh Sci, Law, or Mgt requirement. Also may satisfy Adv Sociocultural Option.
4. Pol Sci 423 (Genocide and Mass Atrocity), taught by DFPS, may satisfy a Pol Sci or Law requirement.
5. Any ForArStu course may satisfy one Social Sciences depth elective.
6. Breadth Electives: Select five courses not used to fill a core requirement, each from a different discipline offered by the Social Sciences division (Behavioral Sciences, Economics, Geosciences, Legal Studies, Management, Military & Strategic Studies, and Political Science).
7. Depth Electives: Select any five courses from any department within the Social Sciences division in any combination or concentration.
8. Social Sciences or Humanities Divisions Option: Any three semester hour graded course taught within either the Social Sciences Division or the Humanities Division.
9. Academy Option: Any course taught for credit under the supervision of the Dean of the Faculty, Commandant of Cadets, the Director of Athletics, or the 306 FTG. Courses must carry at least three semester hours of credit. Academy Options may include EAP 109, Armnshp 461, Armnshp 491, or any non-core course worth at least 3.0 semester hours.

SUGGESTED COURSE SEQUENCE

Social Sciences Major

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Econ 201	3.5	2	Social Sciences Option	3	1	Social Sciences Option	3	1
	Beh Sci 110	3	1	MSS 251	4.5	2	Social Sciences Option	3	1	Soc Sci/Hum Div Option	3	1
	History 100	3	1	English 211	3	1	Academy Option	3	1	Adv Sociocultural Opt	3	1
	Math 141	3	1	P / C / B Option	4	2	ECE 315	3	1	Soc Sci 311	3	1
	Comp Sci 110	3	1	Phy Ed	1	2	History 300	3	1	Adv STEM Option	3	1
	Phy Ed	0.5	2		16	9	Philos 210	3	1	Phy Ed	0.5	2
		15.5	8				Phy Ed	1	2		15.5	7
								19	8			
Spring	For Lang 2	3	2	Social Sciences Option	3	1	Social Sciences Option	3	1	Social Sciences Option	3	1
	Chem 100	4	2	Pol Sci 211	3	1	Social Sciences Option	3	1	Social Sciences Option	3	1
	English 111	3	1	P / C / B Option	4	2	Social Sciences Option	3	1	Social Sciences Option	3	1
	Math 142	3	1	Law 220	3	1	Aero Engr 315	3	1	Adv Open Option	3	1
	Physics 110	4	2	Mech Engr 220	3	1	Math 356	3	1	Astr Engr 310	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Ldrshp 300	0.75	0	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2
		18.25	10		17.25	8		16.25	7		16.25	7

Course Unit Summary
Core (29)
Major (12)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 36.0 "
Phy Ed = 5.0 "
Total = 134.0 "

SPACE WARFIGHTING MINOR

SPACE WARFIGHTING MINOR AT A GLANCE: This minor is designed to broaden understanding of the space warfighting domain through both discipline-specific knowledge and a greater socio-cultural understanding of the principal spacefaring nations. This minor supplements the attainment of a Bachelor of Science Degree by providing greater space domain awareness. Four separate tracks enhance understanding within any major about the role of the space domain in modern warfare through the perspectives of the primary careers contributing to the U.S. Space Force missions. The Operator track provides an educational background for anyone interested in the execution of space domain effects within the space operations field. The Intel track prepares cadets interested in how space based intelligence enhances the execution of modern warfare, and provides a diverse educational background on the major international actors in this domain. The Digital track provides in-depth education on the cyber domain through which most space effects are delivered. Finally, the Acquisition track provides a greater understanding of the design, development and the unique nature of acquiring space warfighting effects. The Space Warfighting Minor provides an educational background designed to enhance the greater understanding of the role of the space domain within any field of study.

COURSE REQUIREMENTS:

The Space Warfighting Minor requires a minimum of 15 semester hours. The course requirements for the minor are designed to provide both a technical understanding of the space domain and a socio-cultural understanding of this future battlespace. Each track listed below specifies the required core options, required classes, and a list of additional classes from which a cadet may choose.

SPACE WARFIGHTING OPERATOR TRACK

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Physics II with Laboratory	Physics 215
P / C / B Option 2		Choose 1*
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option	Space and Cyber Strategy for National Security	MSS 444
Adv Open Option		Choose 1

*For P / C / B Option 2, Chem 200 is preferred.

B. Required courses:

Astr Engr 321

Intermediate Astrodynamics

Astr Engr 431
Law 419
Pol Sci 465

Space Warfighting Payload Design
Space Law
US National Space Policy

C. Choose at least one of the following:

Astr Engr 331
Astr Engr 332
Astr Engr 423
Chem 325
Econ 374
Geo 340
Geo 382
Geo 482
History 240

History 270
History 332
MSS 490
MSS 493
Physics 375
Physics 291
Pol Sci 469
Pol Sci 473

Space Systems Engineering
Satellite Communications
Space Mission Design
Space Chemistry
Survey of International Economics
Introduction to Geographic Information Systems
Remote Sensing and Imagery Analysis
Advanced Remote Sensing
Steppes, Stalin, and Sputnik: Introduction to Russia and Eurasia
Modern East Asian History
Conquest of the New Frontier: A History of Space Power
Strategy in Asia and the Pacific
Strategy in Eurasia
Physics of Space Domain Awareness
Introduction to Optics and Lasers
Politics of Russia, Eastern Europe, and Eurasia
Politics of Asia

SPACE WARFIGHTING INTEL TRACK

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Physics II with Laboratory	Physics 215
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option	Space and Cyber Strategy for National Security	MSS 444
Adv Open Option		Choose 1

B. Required courses:

Astr Engr 431
Geo 340

Space Warfighting Payload Design
Introduction to Geographic Information Systems

Pol Sci 465

US National Space Policy

C. Choose at least two of the following. Must take at least one Russia or China focused class.

Astr Engr 332	Satellite Communications
Econ 374	Survey of International Economics
Geo 382	Remote Sensing and Imagery Analysis
Geo 482	Advanced Remote Sensing
History 240	Steppes, Stalin, and Sputnik: Introduction to Russia and Eurasia
History 270	Modern East Asian History
History 322	Conquest of the New Frontier: A History of Space Power
MSS 490	Strategy in Asia and the Pacific
MSS 493	Strategy in Eurasia
Physics 375	Physics of Space Domain Awareness
Physics 291	Introduction to Optics and Lasers
Pol Sci 462	Politics and Intelligence
Pol Sci 469	Politics of Russia, Eastern Europe, and Eurasia
Pol Sci 473	Politics of Asia

SPACE WARFIGHTING DIGITAL TRACK

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Physics II with Laboratory	Physics 215
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option	Space and Cyber Strategy for National Security	MSS 444
Adv Open Option		Choose 1

B. Required courses:

Astr Engr 431	Space Warfighting Payload Design
Law 440 or Law 419	Cyber Law or Space Law
Pol Sci 466 or Pol Sci 465	Cyber Security Policy and Politics or US National Space Policy

C. Choose at least one of the following:

Astr Engr 332	Satellite Communications
Comp Sci 364	Databases and Applications

Comp Sci 380	Design and Analysis of Algorithms
Comp Sci 467	Computer Networks
Cyber Sci 333	Cyber Warfare
Cyber Sci 334	Cyber Defense
ECE 281	Digital Design and Computer Architecture
ECE 348	Telecommunication Principles
ECE 382	Embedded Computer Systems I
Math 378	Applied Statistical Modeling
Ops Rsch 312	Probabilistic Models

D. Choose at least one of the following:

History 240	Steppes, Stalin, and Sputnik: Introduction to Russia and Eurasia
History 270	Modern East Asian History
History 322	Conquest of the New Frontier: History of Space Power
MSS 490	Strategy in Asia and the Pacific
MSS 493	Strategy in Eurasia
Pol Sci 469	Politics of Russia, Eastern Europe, and Eurasia
Pol Sci 473	Politics of Asia

SPACE WARFIGHTING ACQUISITION TRACK

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1	General Physics II with Laboratory	Physics 215
P / C / B Option 2		Choose 1*
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option	Space and Cyber Strategy for National Security	MSS 444
Adv Open Option		Choose 1

*For P / C / B Option 2, Chem 200 is preferred.

B. Required courses:

Astr Engr 331	Space Systems Engineering
Astr Engr 431	Space Warfighting Payload Design
Pol Sci 465	US National Space Policy
Sys Engr 310/Mgt 477	Introduction to Systems Engineering/Operations and Project Management

C. Choose at least one of the following:

Astr Engr 332	Satellite Communications
Astr Engr 423	Space Mission Design
Chem 325	Space Chemistry
ECE 343	Electromagnetics
ECE 348	Telecommunication Principles
ECE 434	Digital Signal Processing
ECE 446	Applied Communication Systems
Geo 340	Introduction to Geographic Information Systems
Geo 382	Remote Sensing and Imagery Analysis
History 240	Steppes, Stalin, and Sputnik: Introduction to Russia and Eurasia
History 270	Modern East Asian History
History 322	Conquest of the New Frontier: A History of Space Power
Law 419	Space Law
MSS 490	Strategy in Asia and the Pacific
MSS 493	Strategy in Eurasia
Physics 375	Physics of Space Domain Awareness
Physics 291	Introduction to Optics and Lasers
Pol Sci 469	Politics of Russia, Eastern Europe, and Eurasia
Pol Sci 473	Politics of Asia

SUSTAINABILITY MINOR

SUSTAINABILITY MINOR AT A GLANCE: The Sustainability Minor develops critical thinkers who understand how resource optimization and infrastructure resiliency translate into a decisive warfighting advantage to support the Department of the Air Force and the joint force. Cadets in any major will learn to analyze and implement sustainable solutions that enhance mission effectiveness and operational efficiency by minimizing unnecessary use of resources and increasing infrastructure resiliency. They will explore the economic, environmental, and social principles of sustainability through required and elective courses that complement cadet pursuits in research, writing, and hands-on involvement. Cadets can tailor electives to best complement sustainability topics in their academic major and/or prospective Air or Space Force careers. The coursework in the Sustainability Minor emphasizes the critical linkages between resource stewardship, infrastructure resiliency, and national security, preparing future leaders to make data-informed decisions leading to mission assurance.

EDUCATIONAL OUTCOMES: Cadets completing the course sequence for a Sustainability Minor will

- A. examine the theories, principles, and practices of sustainability.
- B. learn technical and social approaches to historic and emergent sustainability problems and learn to integrate environmental, economic, and social considerations across disciplines.
- C. examine how human activities affect sustainability through real-world case studies, including measurements of impacts.
- D. develop skills for quantitative problem solving through independent research and/or interdisciplinary teamwork that addresses a specific aspect of sustainability.

COURSE REQUIREMENTS:

The Sustainability Minor requires a minimum of 15-semester hours. At least six-semester hours must count exclusively towards this minor and be taken in residence. No more than three academic courses can be completed within the same discipline as a cadet's major. The course requirements for the minor are designed to provide both technical understanding of sustainable application and a sociocultural understanding of the importance of sustainability.

1. Required courses:

Civ Engr 356	Introduction to Sustainability
Civ Engr 456	Sustainability Capstone

2. Cadets should choose three electives from one principal concentration (Sociocultural; Environmental; or Global Economy and Data Management); deviations require the minor's AIC approval.

SOCIOCULTURAL CONCENTRATION

The sociocultural concentration focuses on the societal impacts of an organization and approaches towards creating value for all stakeholders such as communities, employees, or individuals.

Cadets who elect to pursue the sociocultural concentration will select two breadth options and one depth option from the lists below.

1. Breadth Options (Pick one):

Beh Sci 366 ^B	Environmental Sociology
English 375	Literature, Language, and Science
History 369	Globalization: The history of People, Products, Ideas, and Systems in Motion
Mgt 478	Supply Chain Management
Philos 320	Ethics and Technology
B – Beh Sci 360 recommended	

2. Depth Track (Pick two courses within one track):

- Geopolitics
 - Geo 375 Geography of International Conflict
 - Pol Sci 445 Global Governance and International Institutions
- Sociocultural Patterns
 - Geo 250 Human Geography: A Global Cultural Awareness
 - Geo 412 World Cultural Geography

ENVIRONMENTAL CONCENTRATION

The environmental concentration focuses on planetary impacts. This concentration will focus on how an organization's actions can affect environmental health, ecosystems, and global climate. Cadets who elect to pursue the environmental concentration will select one breadth option and one depth track from the lists below.

1. Breadth Options (Pick one):

Beh Sci 366 ^B	Environmental Sociology
Chem 381 ^C	Chemistry of the Environment
Civ Engr 362 ^C	Introduction to Environmental Engineering
Civ Engr 363	Humanitarian Engineering
Geo 365	Sustainable Development
Geo 375	Geography of International Conflict
Philos 320	Ethics and Technology
B – Beh Sci 360 recommended	
C – Requires Chem 200	

2. Depth Track (Pick two courses within one track):

Ecology*	Climate	Environmental Geography	Geomorphology*	Energy*
Bio 380 ^B	Meteor 320	Geo 382 ^P	Geo 351	Mech Engr 312
Biology	Meteor 352	Geo 366	Geo 353	Mech Engr 468

481

* – Courses must be taken in listed order (first course is a pre-requisite for the second)

B – Requires Bio 215

P – Physics 215 recommended

GLOBAL ECONOMY AND DATA MANAGEMENT CONCENTRATION

Economic sustainability shifts the focus from traditional bottom-line to a measure of impact on the economic environment. This track will focus on the money and supply chain aspects of sustainability. Cadets who elect to pursue the global economy and data management concentration will select one breadth option and one depth track from the lists below.

1. Breadth Options (Pick one):

Econ 374	Survey of International Economics
Geo 375	Geography of International Conflict
Mgt 478	Supply Chain Management
Philos 320	Ethics and Technology
Pol Sci 445	Global Governance and International Institutions

2. Depth Options (Pick one track comprised of two courses):

Database		Geographic		Geospatial
Management*	Economics	Economy*	Data	Statistics*
Comp Sci 211	Econ 340	Geo 250	Geo 310	Math 377
Data Sci 364	Econ 454 ^E	Geo 360	Geo 340	Math 378

* – Courses must be taken in listed order (first course is a pre-requisite for the second)

E – Requires Econ 355 or Econ 374

COURSE SUBSTITUTIONS:

From time to time, departments may offer special topics courses that meet the significant Educational Outcomes of the minor. Courses not listed above that meet significant Educational Outcomes of the minor may be considered for substitution for any of the courses listed above. To request a course substitute, advisors must submit an Academic Waiver Request to the minor's AIC, which will include a description of the Educational Outcomes that are met and assessed by the course, as well as a copy of the course syllabus.

SYSTEMS ENGINEERING

THE SYSTEMS ENGINEERING MAJOR AT A GLANCE: Systems Engineering crosses many disciplinary boundaries to create a holistic, integrative approach to enable the successful realization of complex engineered systems used by our U.S. Air and Space Forces in defense of our nation. The Systems Engineer implements systems principles and concepts, as well as scientific, technological and management methods to:

- Surmount and tame the unwieldy complexity of modern warfighting systems development.
- Reduce the paralyzing uncertainty among engineering design alternatives and acquisitions decision making.
- Optimize systems designs with consideration of the entire system lifecycle, from concept development, to test and evaluation, to production and operations, to phase out, to maximize value to a diverse set of stakeholders.

SYSTEMS ENGINEERS IN THE AIR AND SPACE FORCES:

- Create innovative solutions to defense problems
- Help to design critical new technical systems
- Establish new defense system requirements
- Work closely with industry engineering partners
- Conduct technical tests and evaluations
- Analyze experimental data and test results
- And much, much more!

Cadets in the Systems Engineering major specialize in an engineering depth area of their choosing, or a blended depth approach, selected among courses from Aeronautical Engineering, Astronautical Engineering, Behavioral Sciences (Human Factors Engineering), Computer Science, Electrical and Computer Engineering, Mechanical Engineering, and other approved disciplines. Depth tracks provide deeper knowledge and skills in a domain relevant to Systems Engineers. Systems Engineering cadets apply their disciplined engineering approach by teaming up with engineering cadets from other disciplines in a senior Capstone Design project, often working on real-world Air and Space Force challenges and innovating new system solutions. The Systems Engineering major is an excellent choice for those who seek to become weapon system operators with a comprehensive understanding of our integrated and complex modern warfighting systems.

Systems Engineering graduates are prepared to attain the following Program Educational Objectives (PEOs) two to five years after graduation:

- 1) Recognition as successful Air or Space Force officers through demonstration of their ability to:
 - a. Rapidly acquire required knowledge,
 - b. Lead others effectively,
 - c. Effectively apply ethical and moral standards,

- d. Improve unit performance by application of organizational skills,
 - e. Make sound decisions based on critical thinking, and
 - f. Communicate effectively.
- 2) Selection for career training on, or ahead of, schedule and for a progression of assignments of increasing responsibility.
 - 3) A demonstrated ability to solve Air and Space Force technical problems.
 - 4) Success in continuing education.

To support these goals, the Systems Engineering program's curriculum is designed such that, by completion of the program, graduates shall demonstrate that they have attained the following Student Outcomes (SOs):

- 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;
- 3) an ability to communicate effectively with a range of audiences;
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;
- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions; and
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The Systems Engineering major contributes to the development of the USAF Academy Institutional Critical Thinking Outcome. USAF Academy's Systems Engineering major is accredited by the Engineering Accreditation Commission of ABET.

COURSE REQUIREMENTS: 144 Semester hours

A. 93 Semester hours of Dean's academic core courses.

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics	Probability and Statistics for Engineers and Scientists	Math 300/356/377 or Beh Sci 332
Adv STEM Option	Calculus III	Math 243/253

Adv Sociocultural Option		Choose 1
Adv Open Option	Systems Analysis	Ops Rsch 310

*For P / C / B Options, Physics 215 and Biology 215 are preferred, but other course combinations are possible with approval of the SE Program Director.

B. 5 Semester hours of Director of Athletics core courses.

C. 46 Semester hours of major's courses:

- | | |
|---------------------------|--|
| 1. Sys Engr 310 | Introduction to Systems Engineering |
| 2. Sys Engr Math Option | (See <i>Supplemental Information 1</i>) |
| 3. Comp Sci 211 | Introduction to Programming for Scientists and Engineers |
| 4. Sys Engr 301 | Project Engineering |
| 5. Ops Rsch 312 | Probabilistic Models |
| 6. Sys Engr 320 | Optimization Theory with Design Applications |
| 7. Beh Sci 373 | Human Factors Engineering |
| 8. Sys Engr 311 | Intermediate Systems Engineering Methods |
| 9. Sys Engr 336 | Engineering Economics and Financial Management |
| 10. Depth Option Course 1 | (See <i>Supplemental Information 2</i>) |
| 11. Depth Option Course 2 | (See <i>Supplemental Information 2</i>) |
| 12. Depth Option Course 3 | (See <i>Supplemental Information 2</i>) |
| 13. Depth Option Course 4 | (See <i>Supplemental Information 2</i>) |
| 14. Sys Engr 491 | Systems Engineering Capstone Design I
(See <i>Supplemental Information 3</i>) |
| 15. Sys Engr 492 | Systems Engineering Capstone Design II
(See <i>Supplemental Information 3</i>) |
| Sys Engr 405 | Systems Engineering Colloquium I |
| Sys Engr 406 | Systems Engineering Colloquium II |

* In addition, Sys Engr 402, Professional Systems Engineering Development (Associate Systems Engineering Professional exam), and/or Engr 402, Professional Engineering Development (NCEES Fundamentals of Engineering in Industrial and Systems exam prep), is a recommended course for all Systems Engineering cadets to take concurrently with Sys Engr 406.

Supplemental Information:

1. Sys Engr Math Option (depth area and prereq driven). Based on the depth area chosen, cadets will choose one of the following math courses:

- | | |
|----------|--|
| Math 245 | Differential Equations (Electronics [ECE] depth majors should take the ECE 245/ECE 332 sequence to meet this requirement. Note that ECE 245 does NOT fulfill a depth option requirement but ECE 332 does.) |
| Math 340 | Discrete Mathematics |
| Math 344 | Applied Linear Algebra |
| Math 359 | Design and Analysis of Experiments |

2. Depth option areas (cadet choice). The available course list for each depth option is managed and vetted by the respective host departments. Cadets will take a set of four courses from any one named depth area or a coherent set of four courses from the below options with approval of the Systems Engineering Program Director. Examples of alternative depth area sequences include multi-discipline domains such as Energy, Weapons, Sustainable Engineering, and Transportation. The four courses shall include a minimum of 8 engineering semester credits, as defined by the Engineering Accreditation Commission of ABET. A superscript "M" denotes a course that is mandatory for any cadet taking courses in the respective named depth option area:

Aeronautical:

Mech Engr 320	Dynamics
Aero Engr 241	Aero-Thermodynamics ^M
Aero Engr 341	Aeronautical Fluid Dynamics
Aero Engr 342	Computational Aerodynamics
Aero Engr 351	Aircraft Performance and Static Stability
Aero Engr 352	Aircraft Dynamic Stability and Control
Aero Engr 361	Propulsion I
Aero Engr 446	Introduction to Hypersonics
Aero Engr 456	Flight Test Techniques

Astronautical:

Mech Engr 320	Dynamics ^M
Aero Engr 241	Aero-Thermodynamics
Astr Engr 321	Intermediate Astrodynamics
Astr Engr 331	Space Systems Engineering
Astr Engr 332	Satellite Communications
Astr Engr 351	Rocket Propulsion
Astr Engr 422	Advanced Astrodynamics
Astr Engr 423	Space Mission Design
Astr Engr 431	Space Warfighting Payload Design

Computer Science:

Comp Sci 210	Programming Fundamentals
Comp Sci 220	Data Structures and Systems Programming
Comp Sci 330	Software Design and Development
Comp Sci 350	Software Engineering
Comp Sci 351	Computer Organization and Architecture

Electrical:

ECE 281	Digital Design and Computer Architecture ^M
ECE 332	Differential Equations with Circuit Applications II ^M
ECE 311	Electric Power (Power Track)
ECE 321	Electronics I (Electronics Track)

ECE 333	Signals and Systems (Digital Track)
ECE 346	Engineering Mathematics with ECE Applications
ECE 348	Telecommunication Principles
ECE 382	Embedded Computer Systems I (Computer Engineering Track or Robotics Track)
ECE 383	Embedded Computer Systems II (Computer Engineering Track)
ECE 387	Introduction to Robotic Systems (Robotics Track)
ECE 423	Power Electronics (Power Track)
ECE 434	Digital Signal Processing (Digital Track)
ECE 485	Advanced Computer Architecture (Computer Engineering Track)

Recommended in addition to the four-course depth sequence:

ECE 210 (1 sem hr)	Introduction to Electrical and Computer Engineering
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Environmental Engineering:

Required Depth Courses:

Civ Engr 361	Fundamental Hydraulics ^{M, 1}
Civ Engr 362	Introduction to Environmental Engineering ^M

Elective Depth Options:

Select at least one course from the following:

Civ Engr 351	Civil Engineering Practices - Field Engineering
Civ Engr 356	Introduction to Sustainability
Civ Engr 363	Humanitarian Engineering

Select at least one course from the following:

Civ Engr 461	Hydraulic Design
Civ Engr 462	Site Assessment & Remediation ²
Civ Engr 463	Wastewater Treatment Plant Design

Additionally, Math 245 (Differential Equations) is recommended.

Students enrolled in Sys Engr 491/492 who wish to pursue an environmental engineering design focus will be embedded in the capstone sequence: Civ Engr 451/452.

Notes:

¹Civ Engr 351 is a prerequisite for Civ Engr 361. Systems Engineers will have this prerequisite waived.

²Civ Engr 390 is a prerequisite for Civ Engr 462. Systems Engineers will have this prerequisite waived.

Human Factors:

Beh Sci 375	Aviation Psychology and Human Factors
Sys Engr 470	Human Systems Integration
Beh Sci 471	Engineering Psychology
Beh Sci 473	Human Factors Engineering in Systems Design

Mechanical:

Mech Engr 330	Mechanics of Deformable Bodies ^M
Three (3) additional, 3 semester hour 300- or 400-level Mech Engr courses.	

3. Systems Engineering Capstone Design Sequence:

Sys Engr 491	Systems Engineering Capstone Design I
Sys Engr 492	Systems Engineering Capstone Design II

To satisfy the Systems Engineering Capstone Design sequence requirement, cadets will enroll in Sys Engr 491 and Sys Engr 492 and be assigned to one of the following two-semester capstone design options based on interest, depth option selection, and capstone needs. Semester hour credit will be equivalent to that capstone course which the SE cadet supports.

SE Capstone	Design Focus	Embedded within Domain Capstone	Host Department	Semester
Sys Engr 491A	Aircraft & Jet Engines	Aero Engr 481	DFAN	Fall
Sys Engr 491B	Spacecraft	Astr Engr 436	DFAS	Fall
Sys Engr 491BL	Human Systems	Sys Engr 491BL	DFBL	Fall
Sys Engr 491C	Software	Comp Sci 453	DFCS	Fall
Sys Engr 491E	Electronic/Computer	ECE 463	DFEC	Fall
Sys Engr 491H	Mechanical	Mech Engr 491	DFME	Fall
Sys Engr 491S	Various Systems	Sys Engr 491S	DFSE	Fall
Sys Engr 492A	Aircraft	Aero Engr 482	DFAN	Spring
Sys Engr 492A1	Jet Engines	Aero Engr 483	DFAN	Spring
Sys Engr 492B	Spacecraft	Astr Engr 437	DFAS	Spring
Sys Engr 492BL	Human Systems	Sys Engr 492BL	DFBL	Spring
Sys Engr 492C	Software	Comp Sci 454	DFCS	Spring
Sys Engr 492E	Electronic/Computer	ECE 464	DFEC	Spring
Sys Engr 492H	Mechanical	Mech Engr 492	DFME	Spring
Sys Engr 492M	Tech Innovation	Mgt 420	DFMA	Spring
Sys Engr 492S	Various Systems	Sys Engr 492S	DFSE	Spring

4. Additional recommended courses. In addition to the curriculum listed above, if a cadet has additional room in their schedule, the following courses are recommended for further exploration of systems engineering topics.

Remaining P / C / B Option course: Physics 215, Biology 215, or Chem 200

Intermediate Math courses appropriate to the chosen depth area

Biology 345

Aerospace Physiology

Engr 341

Linear Systems Analysis and Design

Engr 402

Professional Engineering Development

ECE 210 (1 sem hr)

Introduction to Electrical and Computer Engineering

Mech Engr 205 (1 sem hr)

Engineering Tools Seminar

Mgt 477

Operations & Project Management

Mgt 419

Technological Innovation Management

Physics 354

Nuclear Weapons Engineering

Sys Engr 402

Professional Systems Engineering Development

Sys Engr 460

UAV-RPA Systems

SUGGESTED COURSE SEQUENCE

Systems Engineering Major

	4°			3°			2°			1°					
	hrs	per		hrs	per		hrs	per		hrs	per		hrs	per	
Fall	Math 141	3	1	Law 220	3	1	Sys Engr 311	3	1	History 300	3	1			
	Beh Sci 110	3	1	English 211	3	1	SE Depth Option 1	3	1	SE Depth Option 2	3	1			
	Comp Sci 110	3	1	Econ 201	3.5	2	Math 356	3	1	SE Depth Option 3	3	1			
	English 111	3	1	Mech Engr 220	3	1	ECE 315	3	1	Sys Engr 491	3	2			
	For Lang 1	3	2	Physics 215	4	2	Soc Sci 311	3	1	Sys Engr 405	0	1			
	Phy Ed	0.5	2	Math 243	3	1	Biology 215	4	2	Aero Engr 315	3	1			
	15.5	8	Phy Ed	1	2	Phy Ed	1	2	Phy Ed	0.5	2				
				20.5	10			20	9			15.5	9		
Spring	Math 142	3	1	Sys Engr 310	3	1	Sys Engr 320	3	1	Depth Option 4	3	1			
	Physics 110	4	2	Comp Sci 211	4	2	Sys Engr 336	3	1	Sys Engr 492	3	2			
	History 100	3	1	SE Math Option	3	1	Sys Engr 301	3	1	Sys Engr 406	0	1			
	Chem 100	4	2	MSS 251	4.5	2	Ops Rsch 312	3	1	Astr Engr 310	3	1			
	For Lang 2	3	2	Pol Sci 211	3	1	Beh Sci 373	3	1	Adv SocioCultural Option	3	1			
	Ldrshp 100	0.75	0	Ops Rsch 310	3	1	Ldrshp 300	0.75	0	Philos 210	3	1			
Phy Ed	0.5	2	Ldrshp 200	0.75	0	Phy Ed	0.5	2	Ldrshp 400	0.75	0				
	18.25	10	Phy Ed	0.5	2			16.25	7	Phy Ed	0.5	2			
				21.75	10							16.25	9		

Course Unit Summary
Core (29)
Major (15)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 46.0 "
PhyEd = 5.0 "
Total = 144.0 "

SECTION 2-9 THE BACHELOR OF SCIENCE PROGRAM

THE BACHELOR OF SCIENCE PROGRAM AT A GLANCE: The Bachelor of Science Program (BSP) provides a broad educational foundation for graduation and subsequent service as a professional Air and Space Force officer, without specialization in a particular academic discipline. The BSP provides for maximum flexibility in selecting advanced courses for depth and/or breadth beyond core requirements. Successful completion of this program results in a Bachelor of Science degree. The Bachelor of Science Program is not a major. The BSP can only be declared through DFVR or ARC Chair recommendation, with DFV approval, no earlier than a cadet's third semester. The Office of Student Academic Affairs administers the BSP.

COURSE REQUIREMENTS: 128 Semester Hours

A. *93 Semester hours of Dean's academic core courses.*

Core Requirement	Required Core Options / Substitutes	
P / C / B Option 1		Choose 1
P / C / B Option 2		Choose 1
Statistics		Choose 1
Adv STEM Option		Choose 1
Adv Sociocultural Option		Choose 1
Adv Open Option		Choose 1

B. *5 Semester hours of Director of Athletics core courses.*

C. *3 Semester hours of Academy Option.*

D. *27 Semester Hours of additional coursework*

1. – 8. Academic Division Option
9. Academic Division/Open Option

SUGGESTED COURSE SEQUENCE

Bachelor of Science Program

	4°	hrs	per	3°	hrs	per	2°	hrs	per	1°	hrs	per
Fall	For Lang 1	3	2	Academic Div Option	3	1	Academic Div Option	3	1	Academic Div Option	3	1
	Beh Sci 110	3	1	Physics 110	4	2	Academic Div Option	3	1	Academic Div Option	3	1
	History 100	3	1	English 211	3	1	Philos 210	3	1	Adv STEM Opt	3	1
	Math 141	3	1	MSS 251	4.5	2	ECE 315	3	1	Adv Sociocultural Opt	3	1
	Comp Sci 110	3	1	Phy Ed	1	2	P / C / B Option	4	2	Soc Sci 311	3	1
	Phy Ed	0.5	2		15.5	8	Phy Ed	0.5	2	Phy Ed	0.5	2
		15	6					16.5	8		15.5	7

Spring	For Lang 2	3	2	Academic Div Option	3	1	Academic Div Option	3	1	Academic Div Option	3	1
	Chem 100	4	2	Pol Sci 211	3	1	Aero Engr 315	3	1	Acad Div/Open Option	3	1
	English 111	3	1	Law 220	3	1	Math 300	3	1	Academy Option	3	1
	Math 142	3	1	History 300	3	1	P / C / B Option	4	2	Astr Engr 310	3	1
	Econ 201	3.5	2	Mech Engr 220	3	1	Ldrshp 300	0.75	0	Adv Open Option	3	1
	Ldrshp 100	0.75	0	Ldrshp 200	0.75	0	Phy Ed	1	2	Ldrshp 400	0.75	0
	Phy Ed	0.5	2	Phy Ed	0.5	2		14.75	7	Phy Ed	0.5	2
		17.75	10		16.25	7					15.5	7

Course Unit Summary
Core (29)
Bach Sci (9)
Academy Option (1)
Phy Ed (10)

Semester Hour Summary
Core = 93.0 Sem Hours
Major = 27.0 "
Academy Option = 3.0 "
Phy Ed = 5.0 "
Total = 128.0 "

APPENDIX 1: USAF ACADEMY INSTITUTIONAL OUTCOME WHITE PAPERS

CRITICAL THINKING

Outcome Team Lead: Professor Jill Harris (DFEG)

Upon graduation, our graduates will be required to identify and solve complex problems and effectively respond to situations they have not previously confronted. Acting responsibly in an ever-changing world of ill-defined problems requires critical thinking. At USAF Academy, critical thinking is defined as: the process of self-aware, informed, and reflective reasoning for problem-solving and decision-making even in the absence of ideal conditions. Cadets' critical thinking is developed in an intentional manner across the USAF Academy experience, promoting the use of appropriate critical thinking processes within a discipline or context.

USAF ACADEMY GRADUATES WILL BE ABLE TO¹:

Self-aware Reasoning

Proficiency 1: Describe their own assumptions and contexts.

Proficiency 2: Explain how their own assumptions and contexts influence approaches to problem solving and decision making.

Informed Reasoning

Proficiency 3: Identify relevant information that is needed to solve a problem or make an effective decision.

Reflective Reasoning

Proficiency 4: Identify the assumptions and contexts that underlie an argument.

Proficiency 5: Evaluate the strength of an argument in support of an idea or interpretation.

Proficiency 6: Propose alternative interpretations of information or observations.

Problem-solving and Decision Making

Proficiency 7: Identify issue(s) in need of solving.

Proficiency 8: Intentionally apply an appropriate process to develop solutions to an issue.

Proficiency 9: Assess the merit of multiple options in order to identify the best solution.

Proficiency 10: Explain how changes to assumptions or contexts alter the recommended solution.

¹These proficiencies were modelled after the American Association of Colleges and Universities Essential Learning Outcomes www.aacu.org/leap/essential-learning-outcomes, the Foundation for Critical Thinking: <http://www.criticalthinking.org/>, and Facione, PA (2015). *Critical Thinking: What it is and why it counts*. San Jose, CA: California Academic Press, <http://www.insightassessment.com/Resources/Critical-Thinking-What-It-Is-and-Why-It-Counts>

CLEAR COMMUNICATION

Outcome Team Leads: Lt Col Regina Purnell-Adams (DFM) and Lt Col Timothy Frank (DFCE)

Clear communication is a multi-faceted, nuanced and teachable practice essential for successful officers and leaders of character. Officers must effectively convey information through communication acts, which may include staff correspondence, operational orders, strategic documents and civilian and military stakeholder briefings. Clear communication signifies the professional competence and knowledge expected in a leader while engendering the trust of others. At USAFA, cadets are commonly taught and assessed on written and oral forms of communication. Written communication ranges from short, less formal communication acts on digital media to lengthy, scholarly works. Oral communication ranges from talking to small groups to large public audiences and includes visual aids, vocal dynamics and body language. USAFA develops cadets' communication skills, experience, and confidence in four areas. First, clear communication begins by analyzing the communication situation, where planning takes place prior to the communicative act. Second, content is developed in a compelling way appropriate with the context. Third, content delivery is enhanced through inclusion of professional conventions. Fourth, revision and clarification ensures the communication act meets the communication objectives. USAFA strives to develop cadets who will successfully employ clear communication skills throughout their Air Force and Space Force careers.

USAF ACADEMY GRADUATES WILL BE ABLE TO¹:

Analyze the Communication Situation

(Includes the Air Force CELOs listed under sub-competency A2.6.4: Strategic Communication)

Proficiency 1: Demonstrate a thorough understanding of the rhetorical situation for a communication task.

Proficiency 2: Defines the means, method, and format required to effectively complete a communication task.

Build Content/Tell Compelling Stories

Proficiency 3: Articulate a compelling, authoritative, and precisely stated central message that is responsive to the communication situation.

Proficiency 4: Exhibit skillful and ethical use of credible, relevant sources to develop ideas that are appropriate for the discipline and communication mode.

Employ Professional Conventions for Language, Syntax, and Mechanics

Proficiency 5: Apply contextually and disciplinary appropriate stylistic conventions and terminology.

Proficiency 6: Incorporate effective delivery techniques to make a compelling communicative act.

Engage in Revision and Clarification Processes

Proficiency 7: Participate in feedback processes in ways that lead to improved communication.

APPLICATION OF ENGINEERING PROBLEM-SOLVING METHODS

Outcome Team Lead: Lt Col Daniel Showalter (DFAS)

Graduating cadets will recognize the engineering and technical challenges of the Air Force mission and the physical capabilities and limits within their assigned career fields and weapon systems. These officers need to not only be "operators," but to become problem solvers that use engineering principles to devise enhanced capabilities essential to achieving and maintaining Air Force dominance in air, space, and cyberspace. Proficiencies are organized into two broad categories:

- Fundamental Domain Knowledge (i.e., knowledge of basic engineering principles across a variety of physical domains relevant to Air Force missions in air, space, and cyberspace, and the infrastructure within which they operate).
- Problem Solving Process (i.e., using a top-down, systematic problem solving method, shown via italicized steps, to address the kind of ill-defined problems they will encounter across domains in their USAF careers).

USAF ACADEMY GRADUATES WILL BE ABLE TO:

Fundamental Domain Knowledge

Proficiency 1: Describe and apply the principles governing the performance and capabilities of aerospace vehicles and cyber systems, and their possible effects.

Proficiency 2: Describe and apply principles governing the performance, capabilities, and defense of USAF's and USSF's critical communication, sensing, control, and physical infrastructure.

Problem Solving Process

Proficiency 3: Formulate a *problem definition* from an incongruous set of requirements and constraints.

Proficiency 4: Create a viable *design* using robust and accepted engineering principles that considers the entire product life cycle including CONOPS, operations, sustainment, and disposal.

Proficiency 5: Apply *decision-making* skills in time-critical situations to help lead to problem resolution and objectively determine a design solution from a set of design solutions which best meets a given set of requirements. (Includes Air Force CELO A2.7.2.1.1 listed under sub-competency A2.7.2: Decision Making).

Proficiency 6: Develop physical and/or virtual *prototypes* using engineering tools which are tested to evaluate candidate designs, then apply the results back into the design process to

develop improved design solutions, inform the decision making process, and improve the final product.

Proficiency 7: *Evaluate* test results and determine if a solution meets given requirements and draw conclusions.

Proficiency 8: After solving a problem, cadets will *reflect* to comprehend systematic problem solving processes and the relationship to continuous process improvement. (Includes Air Force CELO A2.7.2.1.2 listed under sub-competency A2.7.2: Decision Making).

SCIENTIFIC REASONING AND THE PRINCIPLES OF SCIENCE

Outcome Team Lead: Dr. Joe Eichholz (DFMS)

Science, at its essence, is a process of discovery relying on testable ideas to produce explanations of the natural world. This process, grounded in the Nature of Science and Scientific Reasoning, has resulted in fundamental Scientific Principles allowing us to explain natural phenomena and make informed decisions. Scientific explanations, in turn, often rely on mathematics as the language that describes the natural world.

The Air Force needs science-proficient officers who can make decisions in a world increasingly influenced by scientific and quantitative data. Therefore, the goal of this outcome is to develop science-proficient officers, officers who exercise *scientific habits of mind*¹. This means cadets will be capable in the concepts, practices, and evaluation of the natural and mathematical sciences. Or, put simply, *know, do, and apply*.

The three proficiencies listed below provide the basis for teaching and assessing the goal. The bullets provide a description of the kinds of performance expected to display that proficiency. The descriptions, framed as actions, are intended to convey the idea that the scientifically literate person both understands and is capable of undertaking a basic set of practices².

These proficiencies are not discipline specific but are instead integral themes that apply across the natural and mathematical sciences. Repeated exposure is necessary to develop science-proficient and quantitatively literate officers. Therefore, cadets must encounter these proficiencies across multiple disciplines, such as biology, chemistry, mathematics, and physics.

USAF ACADEMY GRADUATES WILL BE ABLE TO:

Proficiency 1: Demonstrate understanding of the basic principles, concepts, and language in the natural and mathematical sciences.

Foundational knowledge and skill in the scientific disciplines is crucial in developing a scientifically literate individual. Summarized generally, a scientifically literate individual understands the basic concepts and mathematical tools of the scientific disciplines. Built upon this foundation is the ability to approach and solve problems from a scientific mindset and the ability to assess scientific information pertinent to decision making.

Cadets can demonstrate this proficiency by the following

- Recall and apply appropriate scientific knowledge
- Identify and use explanatory models
- Make and justify appropriate predictions

Proficiency 2: Apply the methods and practices of the natural and mathematical sciences.

No matter what career path is chosen, the study of science will enrich critical thinking skills and expand appreciation of the natural world. Summarized generally, a scientifically literate individual understands how science works. More specifically, a scientifically literate individual knows how to ask scientific questions, how to collect and evaluate empirical data, how to identify patterns in those data, how to access and read relevant primary research, and how to determine the strengths and limitations of different methodologies.

Cadets can demonstrate this proficiency by the following

- Plan and carry out discovery-based investigations
- Identify assumptions and propose methods to explore a question scientifically
- Record observations and collect data
- Analyze and interpret data
- Generate tables and graphics to convey data
- Construct explanations of findings based on principles and evidence

Proficiency 3: Apply scientific habits of mind to access and evaluate scientific information that is pertinent to decision-making.

Leadership requires continuous decision-making. It is essential that Air Force officers recognize questions for which scientific information is relevant and that they have the skills to access and evaluate scientific information. Leaders should recognize that science is an ongoing process that results in reliable knowledge that is nonetheless subject to change.

Cadets can demonstrate this proficiency by the following

- Describe science as an ongoing intellectual pursuit of knowledge that is subject to change
- Identify the types of questions that science can address
- Acquire scientific information from published literature that is relevant to a subject or a question
- Distinguish between sound scientific work and flawed science or pseudoscience

¹http://undsci.berkeley.edu/article/think_science

²<http://www.oecd.org/pisa/test/PISA2015-Released-FT-Cognitive-Items.pdf>

ETHICS AND RESPECT FOR HUMAN DIGNITY

Outcome Team Lead: Dr. Paul Macdonald (DFPY)

When deciding how to act, Air Force leaders of character *comprehend* moral knowledge and ethical alternatives, *respect* the dignity of all affected persons, use ethical *judgment* in moral decision making as leaders to select the best alternative, and act consistently with that judgment so as to develop *habits* of moral excellence. Moral knowledge, respect for human dignity, sound ethical judgment, and virtuous habits of character all crucially contribute to the central leadership practices of living honorably, lifting others, and elevating performance.

USAF ACADEMY GRADUATES WILL BE ABLE TO:

Moral Knowledge

Proficiency 1: Explain the main theoretical approaches to normative ethics.

Proficiency 2: Explain how social science facts and theories relate to the cultivation of moral character and describe how one's own background, habits, values, and assumptions may affect one's moral views and behaviors.

Proficiency 3: Defend the existence of moral knowledge against challenges.

Proficiency 4: Uphold the existence of the ethical and legal foundations of the USAF mission.

Respect for Human Dignity

Proficiency 5: Demonstrate professional behaviors and attitudes with others, including fair and equitable treatment of others and consideration of another person's basic human rights.

Proficiency 6: Understand the perspectives of others.

Proficiency 7: Recognize and respond appropriately to violations of human dignity, especially degrading and humiliating treatment.

Proficiency 8: Leverage the value of differences in perspectives, approaches, preferences, race, gender, background, religion, experience, generation, thought, and other factors for mission accomplishment and foster an environment of inclusion. (Includes the Airman's Foundational Competancy of "Fosters Inclusion" as detailed in Table A5.5 of the Air Force Handbook 36-2647.)

Moral Decision Making

Proficiency 9: Act in accord with procedures that integrate ethical theory, psychological and sociological facts, and principles of the profession of arms as part of a transparent process for deliberation and decision-making that includes careful analysis of the consequences of one's actions.

Habits of Moral Excellence

Proficiency 10: Develop trust and commitment by promoting Air Force core values (integrity first, service before self, excellence in all we do) through goals, words, and actions. (Includes the Airman's Foundational Competencies of "Accountability," "Perseverance," "Initiative," and "Service Mindset" as detailed, respectively, in Tables A4.1, A 4.2, A4.8, and A5.3 of the Air Force Handbook 36-2647.)

Table A5.5. Fosters Inclusion.

FOSTERS INCLUSION	
Definition: Creates a culture where all members of an organization are free to make their fullest contributions to the success of the group, and where there are no unnecessary barriers to success	
Competency Levels	Example Observable Behaviors
Expert - Models, guides or teaches - Sustains application of competency on exceptionally complex situations	- Creates a diverse and inclusive environment in new work settings which brings together different cultures, ideas, and experiences - Identifies creative approaches to recruit and develop a representative workforce that benefits from diverse strengths
Advanced - Sustains application of competency over time in complex situations	- Builds a diverse staff of people with a variety of skills who function effectively to accomplish the organizational mission - Develops new initiatives to recognize the various dimensions of diversity and encourage inclusiveness in the workforce
Intermediate - Sustains application of competency over time in a variety of situations	- Recognizes and utilizes skills of staff with diverse backgrounds - Addresses and corrects the use of inappropriate language or actions which deride diversity - Uses appropriate intervention to ensure a member's experiences are not negatively impacted by his or her personal characteristics
Basic - Sustains application of competency over time	- Participates in meetings about diversity issues within work center - Adheres to equal employment opportunity policies and objectives in everyday duties

Table A4.1. Accountability.

Developing Self	ACCOUNTABILITY	
	Definition: Demonstrates reliability and honesty; takes responsibility for the actions and behaviors of self and team	
	Competency Levels	Example Observable Behaviors
	<i>Expert</i> - Models, guides or teaches - Sustains application of competency on exceptionally complex situations - Demonstrates influence beyond the organization	- Leads by example - Models professionalism and excellence in every endeavor - Take personal responsibility for unit performance
	<i>Advanced</i> - Sustains application of competency over time in complex situations - Demonstrates influence across units	- Does the right thing even when it is unpopular or difficult - Admits shortcomings and mistakes
	<i>Intermediate</i> - Sustains application of competency over time in a variety of situations - Demonstrates influence across work center	- Follows through on promises and commitments - Embodies the Air Force Core Values of Integrity, Service Before Self and Excellence in All We Do
	<i>Basic</i> - Sustains application of competency over time - Demonstrates influence across individuals	- Adheres to Air Force standards - Looks after fellow Airmen and the families

Table A4.2. Perseverance.

Developing Self	PERSEVERANCE	
	Definition: Displays grit in accomplishment of difficult long-term goals. Works strenuously toward challenges; maintains effort and interest over years despite failure, adversity, and plateaus in progress.	
	Competency Levels	Example Observable Behaviors
	<i>Expert</i> - Models, guides or teaches - Sustains application of competency on exceptionally complex situations	- Helps others regain motivation and commitment to long-term goals after major setbacks - Overcomes initial objections of others; persuades others to provide needed resources or other tangible support for a long-term goal - Sustains passion and commitment over a long period of time
	<i>Advanced</i> - Sustains application of competency over time in complex situations	- Models perseverance and effort in pursuit of challenging, long-term goals - Maintains focus on long-term projects
	<i>Intermediate</i> - Sustains application of competency over time in a variety of situations	- Displays commitment to achieving difficult work goals in challenging environments - Overcomes setbacks in order to achieve goals
	<i>Basic</i> - Sustains application of competency over time	- Persists after criticism - Keeps at it when trying to learn something challenging

Table A4.8. Initiative.

Developing Self	INITIATIVE	
	Definition: Does more than is required or expected to improve job results; takes action appropriately without prompting	
	Competency Levels	Example Observable Behaviors
	<i>Expert</i> - Models, guides or teaches - Sustains application of competency on exceptionally complex situations	- Inspires others to contribute more than the job requires. - Exceeds mission requirements to achieve higher-level mission goals - Puts in extraordinary effort by working outside the norm to get the job done
	<i>Advanced</i> - Sustains application of competency over time in complex situations	- Puts in extra effort to complete work when not required - Acts quickly and decisively when the norm is to hope a problem will resolve itself
	<i>Intermediate</i> - Sustains application of competency over time in a variety of situations	- Recognizes and acts on present opportunities or addresses present problems - Takes action to create opportunities or avoid problems
	<i>Basic</i> - Sustains application of competency over time	- Completes assignments without close supervision - Displays good effort in performance of assigned tasks

Table A5.3 Service Mindset

Developing Others	SERVICE MINDSET	
	Definition: Desires to help or serve others to meet their needs; makes and focuses efforts to discover and meet others' needs	
	Competency Levels	Example Observable Behaviors
	<i>Expert</i> - Models, guides or teaches - Sustains application of competency on exceptionally complex situations - Impact on strategic level	- Acts as a trusted advisor to help others identify new or different approaches to address their needs - Provides advice and counsel to serve and support higher-level strategies or goals, even when one disagrees with those strategies or goals - Acts to support higher-level organizational goals, even when such goals may negatively affect one's own career or personal goals
	<i>Advanced</i> - Sustains application of competency over time in complex situations - Impact on operational level	- Continues to provide a high level of support to others even when they are rude, mean, or fail to appreciate efforts to meet their needs - Attempts to identify win/win solutions that meet the needs of others
	<i>Intermediate</i> - Sustains application of competency over time in a variety of situations - Impact on tactical level	- Makes self fully available when others are going through a critical period - Expresses positive expectations about others.
	<i>Basic</i> - Sustains application of competency over time - Impact on peers	- Expresses genuine concern for the welfare of others - Lends a helping hand to team members when needed

THE HUMAN CONDITION, CULTURES, AND SOCIETIES

Outcome Team Lead: Professor Peter Swanson (DFLC)

Following their four-year course of study at USAF Academy, our graduates will be required to interact successfully with a wide range of individuals, to include those representing cultures and societies different from their own. To foster their success in these interactions, USAF Academy has created a three-phased approach to help cadets better understand the human condition, cultures, and societies. The first phase has to do with knowing oneself in order to live honorably, where cadets are required to examine their own identity as human beings, citizens in a republic, and officer-statesmen in the United States Air Force. The second phase has to do with knowing others to lift others, where cadets begin to examine the identity of others and to include those from cultures and societies different from their own. These first two phases are necessary to accomplish the third phase, which involves constructive engagement with others in order to elevate performance. Being able to prudently interact with individuals from different milieus resides at the heart of intercultural or cross-cultural competence and includes both domestic and international environments.

USAF ACADEMY GRADUATES WILL BE ABLE TO¹:

Know Oneself to Live Honorably

Proficiency 1: Describe key elements of their own identity as human beings, citizens of a republic, and officer-statesmen.

Proficiency 2: Explain historical, cultural, societal, and political developments that have shaped their own identity and worldview.

Know Others to Lift Others

Proficiency 3: Describe key elements of an identity different from one's own.

Proficiency 4: Explain historical, cultural, social, and political developments that have shaped another's identity and worldview.

Elevate Performance through Constructive Engagement

Proficiency 5: Explain the uniqueness, differences, and interconnections of various peoples, cultures, and societies.

Proficiency 6: Respond in culturally competent ways to various cultural and social scenarios, settings, and situations.

¹ These proficiencies incorporated elements of the American Association of Colleges and Universities Essential Learning Outcomes (<http://www.aacu.org/leap/essential-learning-outcomes>).

NATIONAL SECURITY OF THE AMERICAN REPUBLIC IN A COMPLEX GLOBAL ENVIRONMENT

Outcome Team Lead: Dr. Paul Bezerra (DFMI)

National Security refers to protecting and advancing a society's fundamental interests. Regardless of academic major, USAFA graduates must understand the fundamental interest of the U.S., the methods and tools available to the U.S. for furthering those interests, and both the domestic and international constraints the U.S. faces in doing so. Indeed, USAFA graduates appreciate and navigate the multifaceted and complex nature of national security and the inherent challenges of developing and implementing U.S. national security policy.

USAF ACADEMY GRADUATES WILL BE ABLE TO:

Constitutional Foundations of National Security in the American Republic

Proficiency 1: Compare and contrast the U.S. Constitution's impact on domestic and foreign policy.

Proficiency 2: Explain and assess the effects of civilian leadership controlling the military in the U.S.

Developing U.S. National Security Policy in a Complex Global Environment

Proficiency 3: Differentiate relevant institutions and actors within the U.S. national security apparatus.

Proficiency 4: Explain the relationship between the international environment's structure, and the values and interests of the U.S. and others.

Proficiency 5: Explain the evolution of U.S. military strategy, and economic and foreign policy in grand strategy.

Implementing U.S. National Security Strategy

Proficiency 6: Design and defend a plan to achieve national security objectives using appropriate forms and instruments of power.

Proficiency 7: Design and defend a plan to achieve military objectives through force consistent with relevant military theory.

WARRIOR ETHOS AS AIRMEN AND GUARDIANS

Outcome Team Lead: Dr. Justin Stoddard (CCLD) and Lt Col Nick Reynolds (CWXX)

Warrior ethos is the embodiment of the warrior spirit: tough-mindedness, tireless motivation, an unceasing vigilance, a commitment to be the world's premier air, space, and cyberspace force, and if necessary, a willingness to sacrifice one's life for the defense of the Nation. USAF and USSF warfighters exemplify warrior ethos by examining the profession of arms and the nature of war through many perspectives and cultural dynamics. Armed with this knowledge, warfighters demonstrate warrior ethos through self-discipline in their personal and professional lives as they exemplify the core values and AF standards. They further exemplify the moral character and courage it takes to do the right thing in the face of adversity, even at an increased risk to themselves or the mission. Finally, warfighters exemplify warrior ethos by developing their resiliency through repetition and practice, while also employing the durable mindset necessary to keep moving forward and apply lessons learned despite significant challenges, mental and physical hardships, and even failure. The warrior ethos proficiencies that follow comprise a process of the intellectual development inherent to every warfighter on their journey to becoming a Leader of Character.

USAF ACADEMY GRADUATES WILL BE ABLE TO:

Understand the Profession of Arms.

Proficiency 1: Critically examine and demonstrate comprehension of the military profession of arms and the nature of war through multiple perspectives (AFH36-2647 Table A2.1, 1.5 – Information Seeking; AF724-A I.1– Job Proficiency).

Exemplify Discipline

Proficiency 2: Exhibit reliable, responsible, orderly composure while under stress that conforms to professional AF standards (AFH36-2647 Table A2.1, 1.1 – Accountability, 1.9 – Self-Control; AF724-A III.2 – Accountability).

Demonstrate Moral Character

Proficiency 3: Demonstrate and apply the USAF core values in a variety of contexts, personifying honesty and integrity, living honorably, lifting others, elevating performance, and doing the right thing in service to others and the unit (AFH36-2647 Table A2.1, 2.3 – Service Mindset, 2.5 – Fosters Inclusion; AF724-A II.1 – Inclusion and Teamwork; USAFAMAN 36-3526, 2.2 – A Leader of Character).

Demonstrate Courage

Proficiency 4: Initiate and complete well-informed, appropriate actions to influence mission completion even at an increase to personal risk or risk of failure (AFH36-2647 Table A2.1, 1.4 – Decision Making, 1.8 – Initiative; AF724-A I.2 – Initiative).

Exhibit Resiliency

Proficiency 5: Work tirelessly toward long-term challenges, analyzing and applying creative strategies to adapt to changing conditions and increase physical, mental, and professional performance despite adversity, hardships, or failure (AFH36-2647 Table A2.1, 1.2 – Perseverance, 1.7 – Resilience, 3.3 – Creative Thinking; AF724-A I.2 – Adaptability, IV.2 – Innovation).

CURRICULUM MAP

	Proficiencies				
	1	2	3	4	5
	History 100	X			
	MSS 251	X	X	X	X
	PE 110		X	X	X
	PE 111		X	X	X
	PE 112		X	X	X
	PE 119		X	X	X
	PE 211		X	X	X
	PE 215		X	X	X
Aligned Courses/Experiences	PE 222		X	X	X
	PE 315		X	X	X
	BCT	X	X	X	X
	Commissioning Education	X		X	
	CW req'd training (HRE, ECDT, etc.)		X	X	
	CST	X	X	X	X
	CULEX		X	X	X
	NCLS	X			

X = denotes courses where proficiencies will be assessed

Note: The assessment strategy over the next few years will focus primarily on the courses and experiences shown above. Additionally, as other courses and experiences are recommended, they will be considered and initially assessed, and revisions to this list will be submitted as permitted.

LEADERSHIP, TEAMWORK, AND ORGANIZATIONAL MANAGEMENT

Outcome Team Lead: Lt Col Matthew Orlowsky (DFMA)

The vision of USAF Academy is to be the Air Force's premier institution for developing Air and Space Force officers who are leaders of character.. USAFA provides an immersive developmental experience preparing cadets to succeed amidst challenges of the 21st century. Over 47 months, cadets participate in education, training, and experiences found in the Leader of Character Framework and Core Values to bring to life the roles and responsibilities they will face on active duty. By aligning USAFA's leadership development and assessment activities to USAFA Manual 36-3526, the Air Force's four major performance areas, foundational competencies, and Airman Leadership Qualities, USAFA builds and reinforces a character foundation exposes cadets to officer performance metrics and encourages them to develop a culture of personal and organizational responsibility, innovation, and continuous improvement. This approach prepares cadets to succeed in the face of rapid change, advance the mission, and pursue the best version of themselves and the organizations in which they serve. Through this intentionality, cadets grow and strive to become leaders of character and serve as officers who live honorably, lift others, and elevate performance.

Proficiency 1: Develop the Foundations of Character & Leadership within the Major Performance Areas

USAFA graduates will be able to:

Quality 1: Demonstrate humility, respect, dignity, and integrity in their leadership, followership, team member and organizational roles.

Quality 2: Articulate the role of leaders as architects of the system and behaviors within it.

Quality 3: Understand that people are complex and greater diversity adds competency, capability and value.

Quality 4: Guide organizations as shifting coalitions of people with diverse interests and align group and individual interests with organizational goals.

Quality 5: Apply theories, frameworks, and tools, to understand and influence organizations as complex systems that produce what they are deliberately or inadvertently designed to produce.

Proficiency 2: Executing the Mission

Demonstrate effective planning and use of systems and processes to manage resources and align individuals toward organizational goals in complex environments.

USAFA graduates will consider the following as a minimum when working to execute the mission:

Quality 6: Demonstrate strategic mindset to identify coherent actions that support organizational strategy

Quality 7: Demonstrate the implementation of steps and integration of coherent actions that are coordinated with one another to execute and support the mission.

Quality 8: Demonstrate independent initiative in adapting to the changing conditions of a complex environment to accomplish the mission.

Proficiency 3: Leading People

Exhibit sound decision-making while appreciating and motivating others with respect and empathy.

USAFA will consider the following as a minimum when leading people:

Quality 9: Exhibit effective team leadership by exercising emotional intelligence rooted in self-awareness and empathy in appropriately managing relationships to create a culture of teamwork and inclusion.

Quality 10: Develop communication strategies to successfully lead people to accomplish the mission.

Proficiency 4: Managing Resources

Develop and implement valid performance measures to manage resources to provide accountability and fairly respond to affect mission accomplishment.

USAFA graduates will consider the following as a minimum when managing resources:

Quality 11: Develop expectations and proactive accountability systems for the organization and its members.

Quality 12: Justly Respond to the needs of the mission while holding themselves and others responsible for their actions and behaviors.

Quality 13: Demonstrate responsible stewardship and management of assigned resources including time, equipment, funds and facilities.

Proficiency 5: Improving the Unit

Understanding that organizations are complex systems, demonstrate unit improvement by using and creating tools to influence and develop others and facilitate responsible innovation.

USAFA graduates will consider the following as a minimum when working to improve their unit:

Quality 14: Engage in strategic, informed, and ethical decision-making that considers constraints, risks, and benefits of their decisions.

Quality 15: Develop people and tools to facilitate individual and unit improvement and innovation.

Quality 16: Apply foundational principles of teamwork to maximize mission accomplishment.

APPENDIX 2: COURSE DESCRIPTIONS

Descriptions of courses offered are listed here by subject in alphabetical order. Course numbers have a general meaning. The first digit of a course number normally indicates the class year for which the course is designed: 100 series for the fourth-class year, 200 series for the third-class year, 300 series for the second-class year, and 400 series for the first-class year.

Following the title of each course is a code, such as 3(2). The number before the parentheses is the semester-hour value, used to determine a cadet's semester course load and minimum graduation requirements. A "0" before the parentheses means the course has no semester-hour value. The number within the parentheses is a code indicating the contact hours and scheduling pattern for the course as follows:

CONTACT HOURS AND SCHEDULING PATTERN CODES

CONTACT HOURS SCHEDULING PATTERN

0	Course not scheduled by DFVR; cadet, instructors, and department make individual arrangements
1	One 53-minute period per lesson (every other day)
1x	One 53-minute period per lesson (every other day) for part of a semester
2	One 113-minute period per lesson (every other day)
2'	Two 53-minute periods per lesson (one every day)
2x	Two 53-minute periods per lesson (one every day) for part of a semester
2"	One 113-minute period each odd lesson, each even lesson, or once per week
2xx	One 113-minute period per lesson (every other day) for part of a semester
3	One 173-minute period per lesson (every other day)
3x	One 173-minute period per lesson (one every day) for part of a semester

A "*" designation on the right side of the parentheses means an honors version of the course is offered. Not all honors versions are offered both fall and spring semesters. Final examination or final report requirements, course prerequisites, semester hours and offering times are shown at the end of each course description. A number of academic courses are offered in both the fall and spring semesters.

NOTE: 3.0 semester hour double-period academic core courses may utilize the second hour of a lesson a maximum of 10 times per semester. Exemptions may be granted only by the Curriculum Committee. DFLC has a temporary exemption for core foreign language courses.

AERONAUTICS

(Aero Engr)

Offered by the Department of Aeronautics (DFAN)

Aero Engr 206. *Fundamental Tools for Engineering.* 1(1x). Introduces programming, modeling, and simulation in MATLAB, introduces CAD using Fusion 360, SolidWorks, or a similar 3-D modeling software package, and provides practical CAM skills for 3-D printing of physical prototypes and wind tunnel models. Additional practical tools for engineering research, e.g. Lab VIEW, may be introduced. Pass/Fail. Final project. Coreq: Aero Engr 210S or equivalent. Sem hrs: 1 fall or spring.

Aero Engr 210. *Fundamentals of Aeronautics for Engineering majors.* 3(1). Introduction to aircraft design, fluid mechanics, airfoil and wing aerodynamics, steady and accelerated aircraft performance, and stability and control. Interdisciplinary design synthesis, analysis, and decision-making (including economic, political, and other non-technical considerations) of an aircraft to meet a contemporary requirement. This course is a core substitute for Aero Engr 315 and is intended for cadets who have declared or are considering declaring the aeronautical engineering major. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Aero Engr 210S. *Fundamentals of Aeronautics for Scholars.* 3(1). Introduction to aircraft design, fluid mechanics, airfoil and wing aerodynamics, steady and accelerated aircraft performance, and stability and control. Interdisciplinary design synthesis, analysis, and decision-making (including economic, political, and other non-technical considerations) of an aircraft to meet a contemporary requirement. This course is a core substitute for Aero Engr 315 for cadets enrolled in the Martinson Honors Program. This course will be offered when faculty resources are available. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Aero Engr 241. *Aero-Thermodynamics.* 3(1). Fundamentals of the 1st and 2nd laws of thermodynamics applied to systems and control volumes. Control volume approaches to the equations of motion of a fluid. Applications of gas dynamics to incompressible and compressible flows through nozzles, diffusers, and turbomachinery. Isentropic flows to include Prandtl-Meyer expansions, non-isentropic flows to include normal and oblique shocks, and flows with simple friction and heat transfer. Foundations in engineering problem solving. Final exam. Prereq: Physics 110. Sem hrs: 3 spring.

Aero Engr 315. *Fundamentals of Aeronautics.* 3(1). Introduction to aircraft design, fluid mechanics, airfoil and wing aerodynamics, steady and accelerated aircraft performance, and stability and control. Interdisciplinary design synthesis, analysis, and decision-making (including economic, political, and other non-technical considerations) of an aircraft to meet a contemporary requirement. Final exam. Prereq: None. Coreq: Mech Engr 220. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Aero Engr 316. *Fundamentals of Aeronautics – French language section.* 3(1). Section taught in French; available for students qualified for Aero Engr 315 and having successfully completed or validated French 321. DFLC strongly encourages cadets to enroll in this course prior to participating in the French semester exchange program. Final exam. Prereq: Mech Engr 220. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Aero Engr 341. *Aeronautical Fluid Dynamics.* 3(1). Fluid properties, the basic equations of motion: the continuity equation, conservation of linear momentum, and conservation of energy (both the differential and the integral forms). Use of the integral momentum equation to experimentally determine the drag acting on a cylinder in a low-speed stream; computation of unsteady Poiseuille flow. Potential Flow Theory. Introduction to viscous flow. Final exam. Prereq: Aero Engr 210S or Aero Engr 315; Aero Engr 241. Sem hrs: 3 fall.

Aero Engr 342. *Computational Aerodynamics.* 3(2). This course covers the theory and application of modern computational tools used to predict fluid flows around basic and complex geometries. The course is intended to give the student the necessary knowledge to choose the relevant computational tool and perform independent computational analysis of moderately complex geometries. The course will cover grid generation, computational fluid dynamic (CFD) solvers, and post-processing using state-of-the-art tools, as well as computational potential methods such as panel codes or vortex lattice codes. The course is project-oriented and explores the important concepts of temporal and spatial resolution, stability and convergence, and flow-field analysis. Final project or final exam. Prereq: Aero Engr 341. Coreq: Engr 346 or equivalent. Sem hrs: 3 spring.

Aero Engr 351. *Aircraft Performance and Static Stability.* 3(1). Aircraft force, moment and response definition in various coordinate systems. Takeoff and landing, cruise, climbs, turns and other accelerated performance by both analytic and numerical methods. Static stability and control and related aircraft design considerations. Design project. Final exam. Prereq: Math 243 and either Aero Engr 210 or Aero Engr 315. Coreq: Physics 110. Sem hrs: 3 fall.

Aero Engr 352. *Aircraft Dynamic Stability and Control.* 3(1). Aircraft equations of motion. Examination of aircraft dynamic modes based on both limited and full degree of freedom models utilizing analytical and numerical methods. Aircraft design considerations. Determination and evaluation of aircraft flying qualities against military specifications. Application of control system

theory to the design of aircraft stability augmentation systems and autopilots. Control system design project. Final exam. Prereq: Aero Engr 351 and Math 245. Sem hrs: 3 spring.

Aero Engr 361. *Propulsion I.* 3(1). Introduction to Brayton and jet engine cycles. Application of aero-thermodynamics to aircraft jet engines and major engine components. Overview of the design, performance, and applications of turboprops/shafts, turbofans, turbojets, ramjets, scramjets, and rockets. Focus on preliminary cycle analysis of aircraft gas turbine engines to include mission analysis, parametric cycle analysis, and engine performance analysis. Lab. Design project. Final exam. Prereq: Aero Engr 241 or department approval. Sem hrs: 3 spring.

Aero Engr 436. *Aircraft Structures, Dynamics and Aeroelasticity.* 3(1). Design of aircraft structure and structural components to meet in flight dynamic, and aerodynamic loads. Design of components to meet fatigue life requirements including material selection. Forced and unforced vibration of aircraft components and aeroelastic phenomena of an aircraft in flight. Dynamic pressure, Mach and angle of attack effects on the bending and twisting of aircraft components. Aeroelastic equations and coefficients related to flight characteristics such as flutter and divergence. Final design project and/or final exam. Prereq: Aero Engr 210S or Aero Engr 315 and Mech Engr 330. Coreq: Mech Engr 350. Sem hrs: 3 fall or spring.

Aero Engr 442. *Advanced Aerodynamics.* 3(1). Analytical and numerical solution techniques applied to incompressible, compressible, transonic, and supersonic flight regimes over airfoils, wings, and bodies. Introduction to hypersonic aerodynamics. Techniques include those historically used in incompressible flow up to and including state-of-the-art supersonic solutions using high speed computers. Final exam. Prereq: Aero Engr 342. Sem hrs: 3 fall.

Aero Engr 446. *Introduction to Hypersonics.* 3(1). Analysis of heat transfer and high temperature effects on hypersonic vehicles. Application to reentry and transatmospheric vehicles. Final exam or final project. Prereq: Aero Engr 241 or Mech Engr 341. Sem hrs: 3 spring.

Aero Engr 447. *Advanced Applied Aerodynamics.* 3(1). Advanced topics in steady and unsteady aerodynamics in all speed ranges are considered for study by analytical, experimental and computational methods. Final exam or final project. Coreq: Aero Engr 442. Sem hrs: 3 spring.

Aero Engr 456. *Flight Test Techniques.* 3(2). Fundamental flight test methods for defining performance and flying qualities characteristics of fixed wing aircraft. Patterned after the Flight Test Engineer's Course at the USAF Test Pilot School. Students fly in designated aircraft to obtain flight test data. Final project or final exam. Prereq: Aero Engr 351 and department approval. Sem hrs: 3 fall or spring.

Aero Engr 456L. *Flight Test Techniques Laboratory.* 1(2). Application of fundamental flight test methods for defining the performance and flying qualities characteristics of high performance fixed wing aircraft. This laboratory experience serves as a final project for Aero Engr 456. Students receive credit for this course by participating in a field trip to Edwards AFB, flight test sortie in a high performance aircraft, creation of a written report, and presentation of a final

briefing. This course will be scheduled during the same class period as Aero Engr 456. Coreq: Aero Engr 456 and department approval. Sem hrs: 1 fall or spring.

Aero Engr 457. *Aircraft Feedback Control Systems.* 3(1). Design and analysis of aircraft stability augmentation and automatic flight control systems by classical root locus and frequency domain techniques. Introduction to digital system analysis. Analytical and numerical methods complemented with aircraft simulation. Final exam. Prereq: Aero Engr 352. Sem hrs: 3 fall.

Aero Engr 466. *Propulsion II.* 3(1). Analysis of advanced aircraft engines. Preliminary aerodynamic and structural design of major engine components including inlets, compressors, combustors, turbines, mixers, afterburners, and nozzles. Final exam. Prereq: Aero Engr 361. Sem hrs: 3 fall.

Aero Engr 471. *Aeronautics Laboratory.* 3(2). Introduction to experimental methods and techniques. Introduction to instrumentation and data acquisition systems. Statistical analysis of data. Selected experiments in the fields of aerodynamics, gas dynamics, propulsion, and flight mechanics. Labs. Final report. Prereq: Aero Engr 341 and ECE 315. Coreq: Math 356. Sem hrs: 3 fall or spring.

Aero Engr 472. *Advanced Computational Aerodynamics.* 3(1). Advanced theory and application of computational tools used to predict and analyze fluid flows of interest supporting USAF research, development, test, and evaluation programs. Working in teams, students will gain the necessary knowledge and background to make contributions using the DoD's High Performance Computing (HPC) Modernization Program resources. Projects will include investigation of unsteady flows, boundary layers, turbulence models, shocks, and multi-physics simulations. Final report. Prereq: Aero Engr 342. Sem hrs: 3 fall.

Aero Engr 480. *Introduction to Aircraft Engine Design.* 3(2). Fundamentals of aircraft and propulsion system design taught using a systems engineering approach. Aerodynamic design and drag prediction. Parameter effects on constraint analyses and preliminary weight estimation. Configuration optimization. Conceptual layout and preliminary analysis of aircraft structures. Factor and margin of safety. Material selection including strength, stiffness, weight, and cost considerations. Introduction to and emphasis on propulsion system design and selection criteria, in preparation for taking Aircraft Engine Design course. Safety, reliability, maintainability, schedule, and cost management concerns are addressed during the course. This course is strongly recommended for those who plan to take Aero Engr 483 – Aircraft Engine Design for their Aero Design Option. Cadets may not receive credit for both Aero Engr 480 and Aero Engr 481. Final report. Prereq: Aero Engr 341 and Aero Engr 351. Coreq: Mech Engr 330 and Aero Engr 361. Sem hrs: 3 fall.E

Aero Engr 481. *Introduction to Aircraft Design.* 3(2). Fundamentals of aircraft and propulsion system design taught using a systems engineering approach. Aerodynamic design and drag prediction. Parameter effects on constraint analyses and preliminary weight estimation. Configuration optimization. Conceptual layout and preliminary analysis of aircraft structures.

Factor and margin of safety. Material selection including strength, stiffness, weight, and cost considerations. Introduction to propulsion system design and selection criteria. Safety, reliability, maintainability, schedule, and cost management concerns are addressed during the course. Cadets may not receive credit for both Aero Engr 480 and Aero Engr 481. Final report. Prereq: Aero Engr 341 and Aero Engr 351. Coreq: Mech Engr 330 and Aero Engr 361. Sem hrs: 3 fall.

Aero Engr 482. *Aircraft Design.* 3(2). Design of an aircraft using a systems engineering approach to meet specifications provided. Detailed configuration optimization, aerodynamic analysis, structural layout, material selection, and structural component sizing, weight and center of gravity analysis, and stability and control analysis. Safety, reliability, maintainability, schedule, and cost management concerns are addressed. Final report. Prereq: Aero Engr 352, Aero Engr 481, and Aero Engr 342 (or department approval). Sem hrs: 3 spring.

Aero Engr 483. *Aircraft Engine Design.* 3(2). Preliminary design of an aircraft engine to meet specified performance requirements. Cycle selection, installation effects, and engine sizing. Determination of installed and uninstalled performance of selected and sized engine. Preliminary design of major engine components to include variable geometry inlets, fans, compressor, main burner, turbine, afterburner, and exhaust nozzles. Material selection for each component is accomplished based on criteria such as the stress and temperature environments, manufacturability, radar absorption capability, weight, and cost. Safety, reliability and maintainability concerns during the design process are addressed throughout the course. This course will include, if possible, a voluntary field trip to a government/industry design facility. Final report. Prereq: Aero Engr 466 and Aero Engr 480 (or department approval). Sem hrs: 3 spring.

Aero Engr 495. *Special Topics.* 3(1). Selected topics in aeronautical engineering. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Aero Engr 499. *Independent Study.* 3(0). Individual study and research supervised by a faculty member. Topic established with the department head. Final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Aero Engr 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Aero Engr 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Aero Engr 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

AIRMANSHIP **(Armnsnp)**

Offered by the 306 Flying Training Group (306 FTG)

Armnsnp 201, *Powered Flight Fundamentals.* Elective. 0(3). A 10-lesson (AY) / 3-week course (Summer) designed to develop Air-mindedness, expose and motivate toward rated career opportunities, and enable a more informed career decision. Live flight orientation only – no solo possibility. See the AEM Enrollment Table for preferred timing. Enrollment facilitated by the

HQ USAFA/A3O Airmanship Registrar, in coordination with the 306 FTG Registrar and CW Summer Scheduler, and based on interest garnered via the Pre-Registration (October/March) query, 4° elective query (October timeframe), Armnshp 251 end-of-course critique, or email contact with the A3O Registrar (av.am.scheduling@afacademy.af.edu). No academic credit. Aviation 100 completion prior to Armnshp 201 is highly desired.

Armnshp 251, *Basic Soaring*. Elective. 0(3). A 20-lesson (AY) / 3-week course (Summer) designed to

develop Airmindedness, expose and motivate toward rated career field opportunities, and enable a more informed career decision. Solo opportunities are limited and are afforded based on individual attitude, aptitude, level of effort and prior flying experience. See the AEM Enrollment Table for preferred timing. Enrollment facilitated by the HQ USAFA/A3O Airmanship Registrar, in coordination with the 306 FTG Registrar and CW Summer Scheduler, and based on interest garnered via the 4° Interest Query (October timeframe), summer elective query, AV100 completion critique, or email contact with the A3O Registrar (av.am.scheduling@afacademy.af.edu). No academic credit. Prereq: USAF Flight Medicine medical exam.

Armnshp 302, *Powered Flight Training*. Elective. 0(3). A 4-week course (Summer only) designed to develop future AV cadre and/or Graduate Assistants. Enrollment based on rated assignment interest, prior flying experience (primarily at USAFA) and individual attitude, aptitude, and level of effort. Primary object is pattern solo flight. See the AEM Enrollment Table for preferred timing. Enrollment facilitated by the HQ USAFA/A3O Airmanship Registrar, in coordination with the 306 FTG Registrar and CW Summer Scheduler, and based primarily on: 1) Cadet response to the Armnshp 302, 2° fall semester interest query; 2) AFOQT & PCSM scores; and 3) Aviation 100 and Armnshp 201 completion. Graduates of this course will be considered for cadet instructor duty. No academic credit. Prereq: USAF Flight Medicine medical exam.

AX302, *Pattern Solo (RDI: ROTC - Aim High Flight Academy)*. Elective. 0(0). 3-week course, Summer only. If completed, may fulfill USAFA's internal rated assignment eligibility requirement. Opportunity (aptitude permitting) to: 1) Execute 15 flight hours, with a potential to solo in the traffic pattern; and 2) Mentor 16-18 year old high school students with no Air Force affiliation on USAFA operations. Course is offered during each 3-week summer period to appropriately-vetted rising 1° cadets. Enrollment is orchestrated by the Career Field Manager—in coordination with the HQ USAFA/A3O Airmanship Registrar and CW Summer Scheduler—through an application process based primarily on: 1) GPA, MPA and PEA; 2) AFOQT/PCSM; 3) Minimal previous flying experience; and 4) A one-on-one interview. No academic credit. Prereq: Aviation 100 (waiverable); No probations; FAA Class 1 Medical Exam.

Armnshp 401. *Private Pilot Certificate (PPC) Training - USAF Academy*. 0(3x). Fulfills USAF Academy's rated assignment eligibility and AETC's IFT requirement (if approved). Intended for appropriately-vetted (8-12) 4° cadets whose overall performance, interest in participating in additional USAF Academy Airmanship programs, and desire to attain aviation excellence warrants

the additional challenge of a Private Pilot Certificate. Enrollment is orchestrated by the HQ USAF Academy/A3O Operations Career Field Manager and the 557th Flying Training Squadron and is based on interest indicated by each cadet via the 4^o fall semester Operational Career Interest Query, Aviation 100 end-of-course survey, and the course application process. Post-enrollment, cadets must be medically qualified via an FAA Class III medical certificate. Ground training includes completion of an FAA approved ground school course and FAA written exam completed prior to initiation of flight training. Flight training includes ~25 instructional and solo flights, including night and navigation sorties, with FAA Licensed and Certified Flight Instructors. No final exam, but cadets will take an FAA check ride with an FAA Designated Pilot Examiner. Prereq: Not on any probation. Sem hrs: 0 fall or spring. No academic credit.

AX401, *Private Pilot Certificate (PPC) - USAFA.* Elective. 0(0). 9-week course, Summer only. If completed, may fulfill USAFA's internal rated assignment eligibility and AETC's IFT completion requirement (if approved). 1 course offering, duration is 9 weeks (in lieu of break and all other Summer programs). Opportunity (aptitude permitting) to: 1) Complete a PPC; and 2) Mentor 16-18 year old JROTC cadets on USAFA operations. Taught at a civilian university. Enrollment is orchestrated by the Career Field Manager—in coordination with the HQ USAFA/A3O Airmanship Registrar and CW Summer Scheduler—through an application process based primarily on: 1) GPA, MPA, PEA; 2) AFOQT, PCSM; and 3) Rated Assignment Interest, and 4) a one-on-one interview. Cadets will take an FAA written and oral exam and complete a checkride with an FAA Designated Pilot Examiner. No academic credit. Prereq: Aviation 100 and Armnshp 251 or Armnshp 201 (waiverable); No probations; FAA Class 1 Medical Exam.

Armshp 461, *Soaring Instructor Pilot Upgrade.* Elective. 0(3) fall. 3(3) spring. A 3^o fall and spring semester course designed to create future cadet soaring IPs. Enrollment based on prior flying experience and individual attitude, aptitude and level of effort in Armnshp 251. During AY operations, this course is scheduled for multiple, consecutive periods in the afternoon only. Enrollment recommended by the 94 FTS selection process (based primarily on performance during Armnshp 251), in coordination with the HQ USAFA/A3O Airmanship and 306 FTG Registrar(s) and CW Summer Scheduler. Saturday flying is common, and cadet participation is mandatory. Limited-on-Season (LOS) status (i.e. excusal from intramurals) is afforded on scheduled days; on squadron off-intramural days, cadets may also report to the airfield. However, on non-scheduled days, intramural participation is required if the cadet's availability aligns with their squadron's intramural schedule. The Armnshp 461 Program Manager will input LOS rosters into the SIS NLT lesson 3 of the semester. Rosters must include cadet's full names, SSN, class year and squadron. No academic credit. Prereq: Armnshp 251; Application and selection process conducted by 94 FTS; USAF Flight Medicine medical exam.

Armshp 465, *USAFA Flying Team.* (AM465X indicates Precision Flying Team tryouts). Elective. 0(3). Cadets participate in a 3-year training program in a powered flight aircraft. Tryouts begin in the 4^o fall semester. Team selections are made in the 4^o spring semester. Participation continues thru the 1^o spring semester. During the fall and spring semesters, the

Flying Team is scheduled for a 4-hour training block on either M or T days. Flying training includes precision landings, cross-country navigation, aircraft preflight, instrument flying and message drop. Ground training includes aircraft identification and familiarization with the Aeronautical Information Manual and Federal Aviation and USAF Flying regulations. Qualified cadets may participate in regional and national flying competitions under the National Intercollegiate Flying Association (NIFA). Eligibility requirements include: 1) A Private Pilot Certificate (PPC) to compete in Flying Events. (Note: Up to 2 non-PPC holder cadets per class may be selected to compete in ground events only); 2) Not on any probation; 3) Minimum entry GPA 2.75 (sem or cum); 4) Minimum entry PEA 2.30 (cum); and 5) Minimum entry MPA 2.50 (cum). Enrollment recommended by the 557 FTS selection process, in coordination with the HQ USAFA/A3O Airmanship and 306 FTG Registrar(s), and CW Summer Scheduler. Saturday flying is common, and cadet participation is mandatory. No academic credit. Prereq: Application and selection process conducted by 557 FTS; USAF Flight Medicine medical exam.

Armnsbp 472, *Basic Soaring IP*. Elective. 0(3). A 2°/1° fall and spring semester, and Summer course afforded only to cadet Soaring IPs, during which time they provide live-flight and Immersive Training Device (VR) instruction in support of Armnsbp 251 objectives. Course requires semester long participation in the AY and multiple period participation during the Summer. During AY operations, this course is scheduled for multiple, consecutive periods in the morning only. See the AEM Enrollment Table for preferred timing. Enrollment selection recommended by the 94 FTS, in coordination with the HQ USAFA/A3O Airmanship and 306 FTG Registrar(s), and CW Summer Scheduler. Saturday flying is common, and cadet participation is mandatory. No academic credit. Prereq: Armnsbp 461; USAF Flight Medicine medical exam.

Armnsbp 473, *Soaring Instructor Upgrade IP*. Elective. 0(3). A 2°/1° fall and spring semester and summer course afforded only to cadet Soaring IPs, during which time they provide live-flight and Immersive Training Device (VR) instruction in support of Armnsbp 461 objectives. Course requires semester long participation in the AY and multiple period participation during the summer. During AY operations, this course is scheduled for multiple, consecutive periods in the afternoon only. See the AEM Enrollment Table for preferred timing. Enrollment selection recommended by the 94 FTS, in coordination with the HQ USAFA/A3O Airmanship and 306 FTG Registrar(s) and CW Summer Scheduler. Saturday flying is common, and cadet participation is mandatory. Limited-on-Season (LOS) status (i.e. excusal from intramurals) is afforded on scheduled days; on squadron off-intramural days, cadets may also report to the airfield. However, on non-scheduled days, intramural participation is required if the cadet's availability aligns with their squadron's intramural schedule. The Armnsbp 473 Program Manager will input LOS rosters into the SIS NLT lesson 3 of the semester. Rosters must include cadet's full names, SSN, class year and squadron. No academic credit. Prereq: Armnsbp 461, Armnsbp 472; USAF Flight Medicine medical exam.

Armnsbp 474, *Sailplane Racing / Cross-Country Competition Team*. Elective. 0(3) Advanced Soaring course designed to challenge aviation and leadership aptitudes. Candidates are selected from AM461 during spring semester of third-class year and typically upgrade during the

following summer period(s) and second-class academic year. Operations normally occur from 1200-1800 MST Monday-Thursday and 1200-sunset on Fridays. Saturday flying is common, and cadet participation is mandatory. Team candidates and members typically attend a training deployment after the final day of the academic year and prior to USAFA Graduation day. Qualified cadets may be selected to travel to regional and national cross-country soaring competitions during summer. Enrollment recommended by the 94 FTS, in coordination with the HQ USAFA/A3O Airmanship and 306 FTG Registrar(s) and CW Summer Scheduler. Rising 2°s are required to complete two summer periods of Armnshp 472 or Armnshp 473, will forego break, and complete Mil Tng 201, *Ops AF*, as part of scheduled Armnshp 474. Mil Tng 201 credit is granted by CW, at CW discretion. Limited-on- Season (LOS) status (i.e. excusal from intramurals) is afforded on scheduled days; on squadron off- intramural days, cadets may also report to the airfield. However, on non-scheduled days, intramural participation is required if the cadet's availability aligns with their squadron's intramural schedule. The Armnshp 474 Program Manager will input LOS rosters into the SIS NLT lesson 3 of the semester. Rosters must include cadet's full names, SSN, class year and squadron. No academic credit. Prereq: Armnshp 461; Armnshp 472; USAF Flight Medicine medical exam.

Armnshp 475, *Sailplane Aerobatic Demonstration/Competition Team*. Elective. 0(3). Advanced Soaring course designed to develop advance aviation skills. Candidates are selected from Armnshp 461 and typically upgrade during the following summer period(s) and second-class academic year. Operations normally occur either on M or T days, periods 2-4. Saturday flying is common, and cadet participation is mandatory. Team candidates and members typically attend a training deployment during Spring Break. Qualified cadets may be selected to travel to regional aerobatic competitions, and participate in home football game aerial demonstrations and airshows. Enrollment recommended by the 94 FTS, in coordination with the HQ USAFA/A3O Airmanship and 306 FTG Registrar(s) and CW Summer Scheduler. Rising 2°s are required to complete two summer periods of Armnshp 472 or Armnshp 473, will forego break, and complete Mil Tng 201, *Ops AF*, as part of scheduled Armnshp 475. Mil Tng 201 credit is granted by CW, at CW discretion. Limited-on- Season (LOS) status (i.e. excusal from intramurals) is afforded on scheduled days; on squadron off- intramural days, cadets may also report to the airfield. However, on non-scheduled days, intramural participation is required if the cadet's availability aligns with their squadron's intramural schedule. The Armnshp 475 Program Manager will input LOS rosters into the SIS NLT lesson 3 of the semester. Rosters must include cadet's full names, SSN, class year and squadron. No academic credit. Prereq: Armnshp 461; Armnshp 472; USAF Flight Medicine medical exam.

Armnshp 490, *Basic Parachuting*. Elective. 0(2xx). A 10-lesson (AY: C, D, E or F Block) / two-week course (Summer) designed to provide basic free fall parachuting and familiarization with emergency parachuting. The weight limit for participation is 215 lbs. Demonstration of a 10-second flex arm hang is required prior to course start. See the AEM Enrollment Table for preferred timing. Enrollment facilitated by the HQ USAFA/A3O Airmanship Registrar, in coordination with the 306 FTG Registrar and CW Summer Scheduler and based on cadet interest garnered via the 4° Elective Query (October timeframe) or via email contact with the A3O

Registrar (av.am.scheduling@afacademy.af.edu). Saturday parachuting is common during the AY, and cadet participation is mandatory. No academic credit. Prereq: USAF Flight Medicine medical exam.

Armnsbp 491, *Advanced Parachute/Jumpmaster/Instructor Training*. Elective. 0(3) fall. 3(3) spring. A 3^o fall and spring semester course designed to create cadet parachute instructors, and future demonstration and competition team members. Enrollment based on individual attitude, aptitude, and level of effort in Armnsbp 490. During AY operation, course requires three scheduled periods (M1-3, M3-5, T1-3, or T3-5). Eligibility requirements include: 1) Not on any probation; 2) AOC and academic advisor approval; and 3) Minimum entry MPA/PEA/GPA 2.60 (semester or cumulative). Enrollment recommended by the 98 FTS selection process, in coordination with the HQ USAFA/A3O Airmanship and 306 FTG Registrar(s). Bring a current copy of Form 2992 on first day of class. Saturday parachuting is common during the AY, and cadet participation is mandatory. Limited-on-Season (LOS) status (i.e. excusal from intramurals) is afforded on scheduled days; on squadron off-intramural days, cadets may also report to the airfield. However, on non-scheduled days, intramural participation is required if the cadet's availability aligns with their squadron's intramural schedule. The Armnsbp 491 Program Manager will input LOS rosters into the SIS NLT lesson 3 of the semester. Rosters must include cadet's full names, SSN, class year and squadron. No academic credit. Prereq: Armnsbp 490; Application and selection process conducted by 98 FTS; USAF Flight Medicine medical exam.

Armnsbp 496, *Parachute Team*. Elective. 0(3). A 2^o/1^o fall and spring semester, and summer course afforded only to qualified cadet parachute instructors (Armnsbp 491 graduates). Cadets participate in competitive parachuting events and demonstrations throughout the United States and abroad. Course requires three scheduled periods (M1-3, M3-5, T1-3, or T3-5). Eligibility requirements include: 1) Not on any probation; 2) AOC and academic advisor approval; and 3) Minimum entry MPA/PEA/GPA 2.60 (semester or cumulative). Enrollment recommended by the 98 FTS, in coordination with the HQ USAFA/A3O Airmanship and 306 FTG Registrar(s) and CW Summer Scheduler. Bring a current copy of Form 2992 on first day of class. Saturday parachuting is common during the AY, and cadet participation is mandatory. Limited-on-Season (LOS) status (i.e. excusal from intramurals) is afforded on scheduled days; on squadron off-intramural days, cadets may also report to the airfield. However, on non-scheduled days, intramural participation is required if the cadet's availability aligns with their squadron's intramural schedule. The Armnsbp 496 Program Manager must input LOS rosters into the SIS NLT lesson 3 of the semester. Rosters must include cadet's full names, SSN, class year and squadron. No academic credit. Prereq: Armnsbp 491; USAF Flight Medicine medical exam.

ASTRONAUTICS

(Astr Engr)

Offered by the Department of Astronautics (DFAS)

Astr Engr 201. *Technology Skills for Astronautics*. 1(1). A self-paced course designed to provide the programming, modeling, and simulation skills required in the various courses in the

Astr Engr major. Students will be introduced to the MatLab/Simulink tools for programming, modeling, and simulation and to state-of-the-art 3-D computer tools for satellite analysis and visualization. A series of proficiency tasks using the various tools must be completed over the course of the semester. Prereq: Comp Sci 110. Coreq: Astr Engr 310. Sem hrs: 1 fall or spring. Pass/fail.

Astr Engr 310. *Introduction to Astronautics.* 3(1). Introduction to the history, principles, and challenges of space. Elements of space missions are examined including orbits, spacecraft systems, launch vehicles, re-entry, operations, and mission management. Emphasis is placed on understanding the underlying physical principles and the system engineering process used to select orbits, plan maneuvers, and accomplish preliminary design of spacecraft payloads/subsystems to meet mission requirements. Concepts are reinforced through hands-on use of application-based analysis and visualization software and communication of these learned principles through written reports. Final exam. Prereq: Math 142 and Physics 110. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Astr Engr 310S. *Introduction to Astronautics for Scholars.* 3(1). Introduction to the history, principles, and challenges of space. Elements of space missions are examined including orbits, spacecraft systems, launch vehicles, re-entry, operations, and mission management. Emphasis is placed on understanding the underlying physical principles and the system engineering process used to select orbits, plan maneuvers, and accomplish preliminary design of spacecraft payloads/subsystems to meet mission requirements. Concepts are reinforced through hands-on use of application-based analysis and visualization software and communication of these learned principles through written reports. This course fulfills one of the course requirements for the Martinson Honors Program. Final exam. Prereq: Math 142 and Physics 110. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Astr Engr 321. *Intermediate Astrodynamics.* 3(1). An intermediate course in orbit mechanics. Topics include orbit determination and prediction, orbit maneuvers, perturbations, rendezvous and proximity operations. Emphasis is on the design and use of structured computer programs to solve real-world astrodynamics problems. Programming experience is recommended. Final exam. Prereq: Astr Engr 201 or Comp Sci 211; Astr Engr 310; completed or enrolled in Math 245. Sem hrs: 3 fall or spring.

Astr Engr 331. *Space Systems Engineering.* 3(2). Fundamentals of space vehicle design are presented with an emphasis on systems engineering. Introduction to system-level spacecraft design issues are covered including reliability, environments, radiation effects, testing, materials engineering, integration, launch vehicles, and operations. Introduction to and analyses of payloads, structures, propulsion, electrical power, communications and data handling, attitude determination and control, and thermal control subsystems are also covered. The course includes an integrated lab experience where small teams develop, analyze, and integrate subsystems into a

functioning engineering model satellite. Each team demonstrates and documents their engineering model satellite at the system level as a part of a comprehensive laboratory report. This course is scheduled for the first 34 lessons of the semester. Final report or final exam. Prereq: Astr Engr 310 and Physics 215 (or DFAS Department Head approval.) Sem hrs: 3 fall or spring.

Astr Engr 332. *Satellite Communications.* 3(1). This course will explore how satellites enable global communication networks. Students will study several modulation and encoding technologies as well as the techniques for providing multiple access. They will study antenna design and terrestrial footprint based on orbital geometries. The class will also discuss the international governance of communications frequencies and learn how the Space Force provides service in the narrowband, wideband, and protected regimes of the SATCOM spectrum. Students will hear joint perspectives of SATCOM usage and learn how adversary systems can deny our SATCOM capabilities. The class may also include operational exercises with SATCOM organizations at Schriever AFB and Peterson AFB. Final project or final exam. Prereq: Astr Engr 310 and ECE 315. Sem hrs: 3 fall or spring.

Astr Engr 335. *Human Spaceflight.* 3(1). The course focuses on the design implications and costs / benefits of launching humans into space. It is an orientation for those cadets who are interested in participating in the Nation's human spaceflight program. The course also covers much of the history of human spaceflight, both its great successes and deep tragedies, from the Cold War to the International Space Station. The final project is an architectural design of the most demanding human spaceflight objective, a mission to Mars. Final Project. Prereq: Astr Engr 310 or Department Head approval. Sem hrs: 3 spring.

Astr Engr 351. *Rocket Propulsion.* 3(1). Introduction to rocket propulsion and propulsion system design. The basic laws of thermodynamics, thermochemistry, and conservation are used to determine ideal motor performance. Emphasis is placed on describing the components and conceptual design criteria for liquid, solid, and hybrid rockets. Electric, nuclear, and other advanced propulsions systems are also studied. Final exam or final project. Prereq: Astr Engr 310 and Aero Engr 241. Sem hrs: 3 fall or spring.

Astr Engr 422. *Advanced Astrodynamics.* 3(1). A continuation of Astr Engr 321. The course focuses on applying numerical and analytical techniques to solve realistic Air and Space Force problems in astrodynamics and space operations. Perturbations and the associated effects on satellite orbits are examined. Least Squares and Kalman filter estimation techniques are applied to the orbital prediction problem using batch and sequential processing. Structured computer programming is used extensively in problem solutions. Final exam. Prereq: Astr Engr 321. Sem hrs: 3 spring.

Astr Engr 423. *Space Mission Design.* 3(1). An advanced mission design course for civilian and military space applications. The course focuses on applying numerical and analytical techniques to solve realistic problems for space missions involving maneuvering and trajectory design. Topics include advanced proximity operations, cislunar trajectories, hypersonic reentry, and other dynamic space operations. Structured computer programming is applied to analyze space missions. Final project. Prereq: Astr Engr 321. Sem hrs: 3 fall.

Astr Engr 431. *Space Warfighting Payload Design*. 3(1). An in-depth look at U.S. Space Force satellite payloads and how they are used to support warfighters. Course will consist of three blocks of instruction: producing GPS timing signals and determining a navigation solution; designing optical/IR focal planes and satellite constellations for remote sensing; and interpreting radio frequency signals to glean synthetic aperture radar, SIGINT and ELINT intelligence. Content will include the design and function of various payloads, how they are used in operational environments, and case studies of historical payload acquisition lessons learned. MATLAB and STK software packages will be used. Final project. TS/SCI security clearance required. Prereq: Astr Engr 310. Sem hrs: 3 spring.

Astr Engr 436. *Small Spacecraft Engineering I*. 4(2). An introduction to small spacecraft systems engineering. Multi-disciplinary system design of spacecraft hardware and software to include subsystems, propulsion systems, attitude determination and control systems, electrical power systems, structures, payloads, and ground stations. Define mission and system requirements, perform engineering trade studies, design and analyze spacecraft systems, and build and test flight hardware. Course also includes opportunities to operate on-orbit small satellites. Final project or report. Coreq: Astr Engr 310. Prereq: C1C standing and departmental approval. Sem hrs: 4 fall.

Astr Engr 437. *Small Spacecraft Engineering II*. 4(2). A second course in small spacecraft systems engineering. Multi-disciplinary system design of spacecraft hardware and software to include subsystems, propulsion systems, attitude determination and control systems, electrical power systems, structures, payloads, and ground stations. Finalize design, fabricate, test, and fly actual spacecraft as a rideshare on a space launch vehicle. Course also includes opportunities to operate on-orbit small satellites. Final project or report. Coreq: Astr Engr 310. Prereq: C1C standing (C2C accepted with department approval). Sem hrs: 4 spring.

Astr Engr 438. *Small Spacecraft Engineering III*. 4(2). A continuation of small spacecraft systems engineering. Multi-disciplinary system design of spacecraft hardware and software to include subsystems, propulsion systems, attitude determination and control systems, electrical power systems, structures, payloads, and ground stations. Finalize design, fabricate, test, and fly actual spacecraft as a rideshare on a space launch vehicle. Course also includes opportunities to operate on-orbit small satellites. Final project or report. Coreq: Astr Engr 310. Prereq: C1C standing and department approval. Sem hrs 4 spring.

Astr Engr 445. *Spacecraft Attitude Dynamics and Control*. 3(1). Fundamental introduction to the problem of controlling satellite attitude. Topics include direction cosine and Euler angle attitude parameters, torque-free rigid body motion, spin stabilization, gravity-gradient stabilization, momentum and reaction wheel control, and reaction jet control. Projects include the development of a satellite attitude dynamics simulation and the design of a reaction wheel and reaction jet attitude control system. Final project or final exam. Prereq: Mech Engr 320 or Physics 355; completed or enrolled in Engr 342. Includes analysis and synthesis with MATLAB™ simulation. Sem hrs: 3 fall or spring.

Astr Engr 495. *Special Topics*. 3(1). Selected topics in astronautics. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Astr Engr 499. *Independent Study*. 3(0). Individual study and research supervised by a faculty member. Topic established with the department head. Final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Astr Engr 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Astr Engr 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Astr Engr 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

Astr Engr 543. *Methods of Optimization for Engineers*. 3(1). Course in optimization methods taught at graduate level. Topics include parameter optimization, optimization for dynamic systems, optimal control and numerical solutions. Final exam. Prereq: Math 346, Math 356 and Engr 342 or either ECE 333 or Mech Engr 325 with Course Director approval. Computer projects require programming proficiency. Sem hrs: 3 spring.

AVIATION

(Aviation)

Offered by USAF Academy/A3

Aviation 100. *Aviation 100, Introduction to Powered Flight Operations*. 0(1x). Aviation 100 is a Virtual Reality (VR)-only course offered in Fairchild Hall. Course is comprised of 10, single period lessons, and is offered on M & T-Days, during both academic semesters (and if necessary during summer operations), exclusively to 4[°]s. Enrollment is orchestrated by the HQ USAFA/A3O Registrar, in coordination with DFVR, AD, and CWT (when scheduled during summer operations). All fourth-class cadets will be scheduled for this course. Disenrollment decisions are rare, but collaborative (Coach, AOC, Academic Advisor, A3 Career Field Manager, A3O Registrar), and made in the best interest of the cadet (on a case by case basis). While not a graduation requirement, all cadets will be enrolled in this course unless previously cleared by the A3O Registrar as the final enrollment authority. Aviation 100 (like Armnshp 201 or Armnshp 251) fulfills USAFA's internal rated assignment eligibility requirement (which is waivable by USAFA/A3). No academic credit; non-graded.

Aviation 202. *Cadet VR Instructor Pilot Assistant Duty – AV-100*. 0(1x). AV-202 is intended for cadets who have successfully completed AV-100, AM-201 and/or AM-302 and who have demonstrated instructional proficiency and overall excellent aviation performance. Appropriately vetted cadets will perform instructor assistant responsibilities in AV-100. Course is comprised of 10 single period lessons, and is offered on M & T-Days during both academic semesters as well as each summer period. Enrollment is based on program requirements and will vary each semester, orchestrated by the HQ USAF Academy/A3O Operations Career Field Manager and is based on interest indicated by each cadet during Aviation 100, Armnshp 201 and/or Armnshp 302 end-of-course surveys. No final exam. Prereq: Aviation 100 and Armnshp 201 or Armnshp 302. Sem hrs: 0 fall, spring, or summer. No academic credit.

Aviation 300. *Powered Flight Training Ground School.* 0(0). Aviation 300 is a Virtual Reality-only course offered in the cadet area and a pre-requisite for/immediately precedes Armnshp 302. Course is scheduled during transition week(s) prior to summer/academic semester for those cadets enrolled in Armnshp302. Course is offered to 2^os and 1^os whose overall performance and desire to attain aviation excellence warrant the additional challenge of initial skills training prior to graduation. Enrollment is orchestrated by the HQ USAF Academy/A3O Operations Career Field Manager. Prereq: Aviation-100 and Armnshp 251 or Armnshp 201. Early enrollment and superior performance in Aviation-100, Armnshp251 and/or Armnshp 201 are highly desired and normally contribute to selection. Sem hrs: 0 fall, spring, or summer. No academic credit.

Aviation 400, *Introduction to T-6 Operations.* Elective. 0(2xx) Seats are extremely limited, and homework completion is mandatory/assessed daily...for seriously interested cadets only. Virtual Reality-only course offered in the cadet area designed to better prepare cadets for Undergraduate Pilot Training (UPT). Course has no bearing on rated assignment selection. Curriculum emphasis on instrument procedures in all weather conditions. Comprised of 19 consecutive double period lessons, and offered on M & T-Days during both academic semesters. Priority registration for the fall semester is 1^os; 2^os receive priority during the spring semester. Enrollment facilitated by the HQ USAFA/A3O Airmanship Registrar, in coordination with DF Registrar, and based on cadet interest garnered via an interest query (October timeframe), inputs provided by cadets upon Armnshp 201/Armnshp 302 completion, or via email contact with the A3O Registrar (av.am.scheduling@afacademy.af.edu). No academic credit. Prereq: Aviation 100, Armnshp201, or Course Director approval.

Aviation 401, *Cadet VR Instructor Cadre - AV100.* Elective. 0(1x). AY only. Intended for cadets who have successfully completed a combination of the following: Aviation 100, Armnshp 201, Armnshp 302 (or AX302, AX401), and Aviation 400. Candidates are vetted by permanent party cadre based on demonstrated instructional potential and overall excellent performance in prior courses and will perform instructor assistant responsibilities in Aviation 100. Enrollment is based on program requirements, will vary by semester, and is orchestrated by the HQ USAFA/A3O Operations Career Field Manager – in coordination with the HQ USAFA/A3O Airmanship Registrar and DF Registrar. Enrollment consideration is based on interest indicated by each cadet during end-of-course surveys. No academic credit. Prereq: See course description.

BASIC SCIENCES

(Bas Sci)

Offered by the Basic Sciences Division

Bas Sci 401. *Basis Sciences Divisional Core Substitute.* 3(0). This course can only be awarded for coursework accomplished during a semester of study abroad (CSSAP), international exchange (CSEAP), or service academy exchange (SAEP). With applicable Department Head or Division Chair approval, this course can fulfill the core requirement for Biology 215 or Math 300/356/377. Sem hrs: 3 fall or spring.

BEHAVIORAL SCIENCES

(Beh Sci)

Offered by the Department of Behavioral Sciences and Leadership (DFBL)

Beh Sci 110. *Using Psychology in the Modern World.* 3(1). Upon commissioning, graduates of USAF Academy will tackle some of the Air and Space Force's most difficult problems, many - perhaps even most - of which have at least something to do with other people. In this course, cadets will learn both foundational concepts and thinking strategies from psychology so that they can more effectively engage with problems specifically related to people's behavior and mental processes. Throughout, the course will emphasize commitment to the scientific method, the importance of tackling complex problems from multiple perspectives, and the value of diversity, inclusion, and respect for human dignity. Final project or final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Ethics and Respect for Human Dignity outcome.

Beh Sci 110S. *Scholars Using Psychology in the Modern World.* 3(1). This course is the Martinson Honors Program version of the Beh Sci 110 course. The course will focus on the philosophical and historical roots of the discipline, and will seek and examine connections between psychology and related disciplines (i.e., sociology, anthropology, law, political science). The course goals include, but are not limited to (1) acquainting cadets with the diverse disciplines within psychology as well as related behavioral science disciplines, their methods, and approaches used to study human behavior, and (2) encouraging cadets to think critically about the nature of human nature within a rigorous scientific framework that will equip them to apply their knowledge both in their college careers and throughout their lives. Materials required in this course will be a common textbook(s) with selected readings, laboratory simulations, and video case studies. There will also be supplementary materials that are commonly used in the non-scholars version of Beh Sci 110. The course will be conducted primarily as a seminar. This means cadets can expect to be active participants in class. Cadets will be evaluated via GRs, presentations, participation, and a final project/paper as selected by the instructor. Final project or final paper. Prereq: Scholar status. Sem hrs: 3 spring.

This course is a contributor to the development and assessment of the Ethics and Respect for Human Dignity outcome.

Beh Sci 231. *Basic Research Methods and Statistical Tools.* 3(1). This course is the first in a two-course sequence that includes Beh Sci 332, and both of these courses need to be taken in consecutive semesters. Within this sequence, students are introduced to and then apply an integrated approach to empirical research, statistics, and ethics through study of the scientific method, hypothesis testing, and research design. Students will study and compute probability and descriptive statistics for normal and non-normal distributions on differing levels of measurement. Students will use statistical software to perform descriptive and inferential statistical analyses including, but not limited to, measures of central tendency and variability, normality, ANOVA, t-tests, Chi-square, correlation, and the principles of regression; with an emphasis on knowing when to use each method. Students will apply

methodological and statistical knowledge in a behavioral science research study they design. Final exam and/or final project or paper. Prereq: None. Sem hrs: 3 spring.

Beh Sci 330. *Abnormal Psychology.* 3(1). This course examines the development, nature, and treatment of psychological disorders within a biopsychosocial context. Special consideration is given toward leadership and military applications. Final exam or final project. Prereq: Beh Sci 110. Sem hrs: 3 fall.

Beh Sci 332. *Advanced Research Methods and Statistical Tools.* 3(1). Continuation of Beh Sci 231 (please see Beh Sci 231 course description.) Final exam and/or final project or paper. Prereq: Math 142/152, Beh Sci 231, or departmental approval. Sem hrs: 3 fall.

Beh Sci 335. *Learning and Cognition.* 3(2). How does experience affect behavior? This age old question has been examined both in theory and in practice by behavioral psychologists since the early 1900's. With the cognitive revolution in the late 1950s, a keen interest turned to experimentally studying mental activity. In this course, cadets will examine theories from both domains to better understand human behavior and mental activity. Cadets will test concepts from learning and cognition in the laboratory using rats and report their experimental findings. Lab. Final exam or final project. Prereq: Beh Sci 110. Sem hrs: 3 fall or spring

Beh Sci 352. *Social Psychology.* 3(1). This course provides an introduction to social psychology and Behavioral Sciences. Social psychologists seek to understand the nature and causes of individual behavior in social situations. In other words, social psychology explains how the average person reacts to various social pressures. Topics covered include social perception, attitudes, prejudice and discrimination, interpersonal attraction, social influence, prosocial behavior, aggression, groups and personality. From a practical standpoint, this course explains how and why people react to the world and other people as they do. Leadership implications are discussed. Final exam or final project. Prereq: Beh Sci 110. Sem hrs: 3 spring.

Beh Sci 355. *Introduction to Neuroscience.* 3(1). Using the interdisciplinary lens of neuroscience, cadets will learn how the brain and nervous system generate behavior and mental activity. Learning experiences will focus on how the wiring and structure of the brain are responsible for the way we behave. We will examine how real life issues such as traumatic brain injury, learning, memory, decision-making, sleep, emotions, psychological disorders, drug effects, and stress are best explained by understanding how the brain processes and computes different kinds of information. Cadets will develop a three-dimensional understanding of neuroanatomy through extensive sheep brain dissections. Final exam or final project. Prereq: Beh Sci 110. Sem hrs: 3 fall.

Beh Sci 358. *Sociology of War and Violence:* This course provides concepts, perspectives, and evidence for thinking about and making sense of violence and war from sociological and criminological perspectives. The course examines the forms violence and warfare take in human societies, such as incidences of assault, homicide, riots, and genocide. The course also emphasizes the contextual environment surrounding combat, the people involved in combat and

the support of armed conflict, and the relationships between them. Finally, the course considers how individuals and societies respond to violence and warfare, with attention to policing systems and militaries, and how they are related to the cultures in which they are located. Exact topics covered may vary in any one semester. Final exam or final project/ paper. Prereq: None. Sem hrs: 3 spring.

Beh Sci 360. *Sociology*. 3(1). Introduces sociology's foundational perspectives and methodologies and applies them to the systematic study of human behavior in social contexts. Basic topics include the "sociological imagination," biology and social behavior, the origins and components of culture, socialization, the structure of social interaction, and the creation and maintenance of groups, organizations, and societies. Additional themes include social stratification, race/ethnicity, gender and sexuality, globalization and development, marriage and family, religion, and social change. Final project. Prereq: None. Sem hrs: 3 fall or spring.

These courses contribute to the development and assessment of the Human Condition, Cultures, and Societies outcome.

Beh Sci 360S. *Sociology (Scholars)*. 3(1). Critically examines social life, social change, and the social causes and consequences of human behavior. Topics include an introduction to major sociological paradigms, how society is structured, the interaction between social structure and the individual, culture, deviance, social institutions, social stratification/inequality, and social change. Overall, students will gain an understanding of the connection between themselves, as individuals, and society; including their role in making, maintaining, and changing society. This course is a core substitute for Beh Sci 360 (Advanced Sociocultural Option) and is intended for cadets accepted into the Scholars program or who have declared the Behavioral Sciences and Leadership major. Final project. Prereq: Scholar status or 3.5 cumulative GPA and DFBL Department Head approval. Sem hrs: 3 spring.

This course contributes to the development and assessment of the Human Condition, Cultures, and Societies outcome.

Beh Sci 361. *Social Problems*. 3(1). This course will introduce students to the sociological study of contemporary social problems both within the United States and globally. Topics studied may include social conflict, social inequality, drug abuse, crime, juvenile delinquency, divorce and other family problems, community health, social class, race relations, media literacy, urbanization and demographic change, war, violence, and other selected social issues. Topics analyzed will change based on context and need. The course uses different theoretical perspectives and research methods to identify and understand social problems, including accompanying controversies. We also consider possible interventions and structural changes that could alleviate each problem. Final paper or project. Prereq: None, although Beh Sci 360 is recommended. Sem hrs: 3 spring.

Beh Sci 362. *Class, Race, and Ethnicity in Society*. 3(1). Class, race, and ethnicity shape society, individual life chances, and daily social interaction in powerful ways. For example, the American Dream highlights opportunity for individuals to achieve success based on their own ability and initiative while beliefs in a colorblind society forward ideas that race and ethnicity are no longer meaningful in shaping experience. In this course, we examine how and why class and

race/ethnicity matter and the consequences of these for people's lives both in the United States and in other countries. We review sociological theories of class and race/ethnicity, look at the social contexts in which they emerged, and explore the political issues at stake in their various formulations. Particular attention is paid to the significance of class and race/ethnicity in a variety of institutional contexts including education, communities, housing, the criminal justice system, the military, and the family; the link between class and race/ethnicity; and how gender and sexuality inform our ideas about class and race/ethnicity. Final paper or final project. Prereq: None, although Beh Sci 360 is recommended. Sem hrs: 3 fall.

Beh Sci 363. *Crime and Deviance.* 3(1). This course will introduce students to the sociological study of crime and deviance. Possible topics include physical, sexual, and family violence; ideological extremism, political terrorism, and organized crime; drug and alcohol use; physical and mental disorders; pornography, prostitution, and other forms of sexual deviance; and stigmatized behaviors, beliefs, and appearances. Students will also consider how contemporary sociological and criminological theory can inform military and civilian policies related to the punishment, treatment, and prevention of crime and deviance. Final paper or project. Prereq: None, although Beh Sci 360 is recommended. Final paper or project. Sem hrs: 3 fall of odd-numbered years.

Beh Sci 364. *Gender, Sexuality, and Society.* 3(1). Our ideas about gender and sexuality - about men, women, masculinity, and homosexuality, for example - organize our social life in important ways that we often do not notice. These ideas are either invisible to us (such that we take them for granted as "normal") or explained away (such that they seem like the "natural" way life works). This course adopts a different approach by viewing gender and sexuality through the lens of the social - as shaped by social processes, including social interaction, institutions, ideologies, and culture - and how these beliefs create and enforce a system of difference and inequality. We review contemporary sociological theories of gender and sexuality, look at the social contexts in which they emerged, and explore the political issues at stake in their various formulations. Particular attention will be paid to exposing how gender works in institutions like education, the family, the workplace, and the military; the link between gender and sexuality; and how race/ethnicity and class inform our ideas about gender. Final paper or final project. Prereq: None, although Beh Sci 360 is recommended. Sem hrs: 3 spring.

Beh Sci 365. *Sociological Theory.* 3(1). Sociological theory is a set of interrelated ideas that allow for the systemization of knowledge of the social world, the explanation of that world, and predictions about the future of the world. In this course, theory is brought down-to-earth to show how a sociological imagination is valuable to self and society. Particular attention will be given to the questions arising for the conceptual distinctions between macro social structure and individual agency, on the one hand, and identity and the culture, on the other. Key questions addressed in this course include: "How is social order possible?" "How autonomous and authentic are human agents?" "Are families disintegrating?" "Why are some people discriminated against?" "What accounts for the crime rate?" "Are religion and economics compatible?" "Why is the sexual division of labor so persistent?" "Are wars inevitable?", and "How does social change take place?" Theories are thus tentative explanations to the important questions that preoccupy us as members

of families, professions, institutions, communities, nations and, increasingly, as global citizens. Final paper or project. Prereq: Beh Sci 360. Sem hrs: 3 fall.

Beh Sci 366. *Environmental Sociology*. 3(1). This course explores the socio-cultural dimensions of human-nature interaction. Topics covered include: the social construction of nature, social psychology of environmental attitudes and behaviors, trends in environmental policy and public opinion, environmentalism as a social movement, human-induced environmental decline, and environmental justice. Students will explore how changes in ecosystems influence the achievability and sustainability of societal values such as security from natural disasters, health, good social relations, and freedom to pursue personal and cultural interests. Final paper or final project. Prereq: None, although Beh Sci 360 is recommended. Sem hrs: 3 spring of even-numbered years.

Beh Sci 373. *Human Factors Engineering*. 3(1). This course examines the process, principles, and guidelines of human factors engineering as they impact the design of systems used by people and provides an introduction to human factors engineering and Systems Design. Emphasizes the interaction between human capabilities and limitations, to the task, and the environment, as they relate to system performance. Final exam or final project. Prereq: Beh Sci 110. Sem hrs: 3 spring.

Beh Sci 375. *Aviation Psychology and Human Factors*. 3(1). This course examines human performance and human-machine design issues in military and civilian aviation systems. Students learn about human factors engineering in aviation systems and their failures as well as reviewing the nature and scope of human factors impacts on performance by air and ground crews and their supervisors. Students review the body of knowledge demonstrating how human flight-related performance is based on psychological and physiological capabilities and limitations that, in turn, influence the ability of humans to interact within the systems design constraints. Students also learn how the application of effective systems design, specialized automation, and ongoing training can facilitate optimal human-system performance associated with flight. Final exam or final project. Prereq: None. Sem hrs: 3 fall.

Beh Sci 380. *Theories of Personality*. 3(1). Examines major psychological theories of personality, including analytic, humanistic, cognitive, and learning approaches. Other non-traditional approaches are also considered which explain personality development from the socio-cultural perspective. Theoretical concepts are examined to understand individual personality development, relevant current and historical issues, and applications to military leadership. Final exam or final project. Prereq: Beh Sci 110. Sem hrs: 3 fall.

Beh Sci 390. *Sensation and Perception*. 3(1). This course will provide an introduction to the way the outside world is perceived through our senses and how our brain makes sense of all the sensory inputs. How our body experiences the world and what we perceive of the world are two interrelated, but different entities. This is an important topic for Air Force officers, because our perceptions do not always accurately represent the outside world. For example, pilots with inaccurate perceptions of their aircraft attitude (e.g., spatial disorientation) could lead to loss of

control of their aircraft. Through lectures, labs, demonstrations and discussions, this course will introduce the basic anatomy of the sensory systems, as well as, how these structures are used to “make sense” out of what we are experiencing so that we can do such things as understand speech, perceive color, see motion and depth, and recognize faces. Final exam or final project. Prereq: Beh Sci 110. Sem hrs: 3 spring.

Beh Sci 440. *Lifespan Development.* 3(1). This course examines how people develop physically, psychologically, socially, and cognitively from birth to death. It explores changes that are universal and changes that are unique to specific individuals. Developmental theories explaining these changes are presented. The course also focuses on the social context of development: "What is the impact of income, education, ethnicity, race, sex, culture, and historical time period on developmental outcomes?" Final exam or final project. Prereq: Beh Sci 110. Sem hrs: 3 spring.

Beh Sci 471. *Human-Computer Interaction.* 3(1). Human-Computer Interaction is an applied, interdisciplinary field which includes psychology (perception, memory, decision-making), design, computer science, linguistics, and a variety of other fields. In this course, you will learn the principles of HCI along with how to design and evaluate interfaces and systems from a human-centered framework. Topics include the performance of tasks by humans and machines, the structure of communication between human and machines (including machine response to changes in user state), algorithms and programming of interfaces, engineering concerns that arise in the design and construction of interfaces, the process of specification, design, and implementation of interfaces, and design tradeoffs. By the end of this course, cadets will be able to design useful, usable interfaces and evaluate interfaces using a variety of HCI methodologies. Students will also learn the social, organizational, and team consequences of technological innovations including issues in diversity, robotics, and mobility. Final project/paper. Prereq: Beh Sci 373 (waivers can be approved on a case-by-case basis). Sem hrs: 3 fall.

Beh Sci 473. *Human Factors Engineering in Systems Design.* 3(1). This advanced course emphasizes the role and responsibilities of the human factors engineer in the design and evaluation of systems. The course uses a combination of group, individual, and in-class design projects to explore the system design process. Particular attention is given to human characteristics and their effects on system performance. Final exam or final project. Prereq: Beh Sci 471. Sem hrs: 3 spring.

Beh Sci 495. *Special Topics.* 3(1). Selected topics in the Behavioral Sciences. Final exam or final paper. Prereq: Department approval. Sem hrs: 3 fall or spring.

Beh Sci 498. *Senior Capstone in the Behavioral Sciences.* 3(1). This course culminates the Behavioral Sciences curriculum, integrating previous coursework and departmental goals into a seminar-based course. The specific content area adapts based on desired outcomes. The course uses literature reviews as a basis to understand psychology and sociology as foundational sciences. It develops learners dedicated to the application, advancement, and clear communication of our disciplinary knowledge. Finally, empirically- driven content and analysis will be used to develop

inclusive leaders who respect the human dignity of all people. Final project. Prereq: CIC standing and Beh Sci 332. Sem hrs: 3 fall.

This course is a contributor to the development and assessment of the Critical Thinking USAF Academy outcome through departmental reinforcement within our major.

Beh Sci 499. Independent Study. 3(0). Research or practicum in a specific area of behavioral science. Conducted on a tutorial basis. Final paper. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Beh Sci 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Beh Sci 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Beh Sci 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring

BIOLOGY

(Biology)

Offered by the Department of Biology (DFBI)

Biology 215. Introductory Biology with Laboratory. 4(2). An overview of biological systems, their structure and function, and the concepts and vocabulary essential to understanding biology today. Course content includes recent biological advances in genetic engineering, human health and performance, evolution, integrated global ecology, and environmental science. Discussions address application and limitations of the scientific method, ethical issues of modern biology, and the influence of biological science on society. Laboratories reinforce concepts and promote scientific reasoning. Final exam. Prereq: Chem 100. Sem hrs: 4 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Biology 320. Biomechanics. 3(1). A study of the physical, anatomical, mechanical, and physiological basis for motion focused on the human. Joint and muscle physiology will be explored as a basis for functional activities. Physics and mechanical engineering concepts will be applied to describe, investigate, and compare the ways we initiate and control movement. Students also learn the effects musculoskeletal injury may have on normal motion. Final exam and/or final project. Prereq: Biology 215 and Mech Engr 220. Sem hrs: 3 spring even numbered years.

Biology 330. Zoology. 4(2). An integrated study of the principles of invertebrate and vertebrate zoology presented with a phylogenetic approach. Examines the behavior, ecology, morphology, physiology, reproductive biology, classification, and evolutionary relationships of animals. Functional aspects of respiration, circulation, osmoregulation, excretion, metabolism, and thermoregulation are highlighted through comparisons within and among animal groups. Through laboratory exercises, students will learn and recognize structural, physiological, and evolutionary features of selected animals. Final exam. Prereq: Biology 215. Sem hrs: 4 fall or spring.

Biology 331. Botany. 4(2). An integrated study of the biology of plants is presented from molecular to community levels of organization. Course content is organized into five units of study: the plant system, plant anatomy and morphology, plant physiological ecology, plant reproductive biology, and plant evolution and classification. This course focuses primarily on seed plants because of their relevance to human nutrition, drugs, fibers, and flowers. A botanical perspective enriches an understanding of the natural world. Laboratory and fieldwork is required. Final exam. Prereq: Biology 215. Sem hrs: 4 fall or spring.

Biology 332. Microbial Diversity. 3(1). Microscopic organisms are intimately involved in our daily lives, where they produce many familiar foods and medicines, impact health, and play important roles in natural and engineered systems. This course will survey microbial groups that include algae, bacteria, fungi, protozoa, viruses, viroids, prions, and selected invertebrates. Each group will be considered in terms of structure, classification, biochemistry, ecology, and economic and medical significance. Relevance to the Air Force mission, such as deployment health issues and biowarfare defense, is reinforced throughout the course. Includes integrated labs and demonstrations. Final exam or final project. Prereq: Biology 215. Sem hrs: 3 fall or spring.

Biology 345. Aerospace Physiology. 3(1). This course provides in-depth knowledge as to how human performance relates to the warrior and aircrew member. Specifically, it includes a survey of the physiological stresses associated with the aerospace environment. Topics include: effects of pressure changes with altitude, hyperbaric environments, respiratory and circulatory physiology, hypoxia and hyperventilation, pressurization and aircraft decompression, effects of "G" forces, self-imposed stresses, thermal stresses, human factors, crash dynamics and escape systems, sensory physiology, spatial disorientation, and space physiology. Suitable for cadets majoring in any academic discipline, including the Bachelor of Science program. Optional field trip. Final exam. Prereq: Biology 215. Sem hrs: 3 fall.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Biology 360. Cell and Molecular Biology. 3(1). This course provides a comprehensive examination of the cell, the fundamental unit of life. Emphasis on eukaryotic cells, cellular organization and processes, and how cell structure and activity ultimately determine structures and functions at the organismal level. Lesson topics include, but are not limited to, major cell structures, energy transforming cellular processes, application of cell biology to human disease, the cell cycle, and biotechnology. Fundamental cellular concepts will be illustrated and reinforced through discussions of factual information applied to case studies and critical thinking exercises. The course reinforces current principles of cell biology and facilitates learning of the scientific method. Final exam. Prereq: Biology 215; Chem 230 or Chem 233 or concurrent enrollment. Sem hrs: 3 fall or spring.

Biology 363. Genetics. 4(2). This introductory course in classical and contemporary genetics explores a variety of topics, processes, and issues, including simple (Mendelian) and complex inheritance patterns, genetic mapping, sex determination, population/evolutionary genetics, DNA/RNA biochemistry/function, genome structure, DNA replication, gene expression,

mutations, genetic/chromosomal disorders, forensics, and genetic engineering. Throughout the course, the ethical and social issues that emerge from modern genetics are discussed, and the relevance of the lesson material in personal, clinical, and military contexts is emphasized. Laboratory and practical exercises complement the course content and provide hands-on experience with classical and modern techniques used in genetic research and biotechnology. A group laboratory project reinforces course concepts, provides experience with live organisms, and develops skills in problem solving, critical thinking, scientific writing, and effective teamwork. Final exam. Prereq: Biology 215; Chem 230 or Chem 233 or concurrent enrollment. Sem hrs: 4 fall or spring.

Biology 364. *Molecular Biology Methods*. 3(2). A practical study of the methods and techniques used in the modern molecular biology and genetic engineering laboratory. Instructor-assisted laboratory exercises with complementary lectures will focus on bacterial genetics, preparation and analysis of nucleic acids, recombinant DNA construction, bacterial transformation, analysis of cloned gene products, chromatographic separation of biomolecules, and polymerase chain reaction applications. Selected methods used in cancer, immunology, and animal development research will be included. Final exam or final project. Prereq: Biology 215. Sem hrs: 3 fall.

Biology 365. *Synthetic Biology and Biotechnology Seminar I*. 1.5(1). This classroom and laboratory based advanced research skills seminar will focus on the theory and applications of advanced genetic engineering skills. Electrophoresis, cloning, transformation, gene expression, and other advanced techniques will be discussed and performed, along with the discussion and implementation of the experimental design process. Laboratory skills will be assessed, to also include safety, record keeping, and organization, in addition to teamwork and leadership skills. Final project. Prereq: Instructor approval. Sem hrs: 1.5 spring.

Biology 366. *Synthetic Biology and Biotechnology Seminar II*. 1.5(2). This classroom and laboratory based advanced research skills seminar will focus on the theory and applications of advanced genetic engineering skills. Electrophoresis, cloning, transformation, gene expression, and other advanced techniques will be discussed and performed, along with the discussion and implementation of the experimental design process. Laboratory skills will be assessed, to also include safety, record keeping, and organization, in addition to teamwork and leadership skills. Final project. Prereq: Instructor approval. Sem hrs: 1.5 fall.

Biology 370. *Human Nutrition*. 3(1). Provide a comprehensive, thoroughly updated account of nutrition principles and their application. This course furnishes students with accurate nutrition information and teaches them how to use a critical-thinking approach in making important daily decisions about their own diet. Course material will focus on the fundamentals of nutrition, such as defining the roles of carbohydrates, fats, proteins, vitamins, and minerals in metabolism; examining eating practices through individual dietary analysis, exploring the importance of nutrition in the prevention of disease; and discussing the interplay of diet options with various body systems for athletic performance, daily fitness, and overall health. Final exam or final project. Prereq: Biology 215. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Biology 380. *Principles of Ecology.* 3(1). Fundamental interrelationships between organisms and their environments, emphasizing energy flow through ecosystems, biogeochemical cycling, population dynamics, and community interactions. Emphasis is placed on how human activities affect the quality of life and the natural world. Case studies include the impact of environmental concerns on regional and global Air Force operations. Final exam. Prereq: Biology 215. Sem hrs: 3 fall or spring.

Biology 410. *Anatomy and Physiology: Sensory and Motor Integration.* 3(2). An introduction to human sensory and locomotory systems via experimentation and dissection of the human cadaver, with dissection emphasized. The course focuses on feedback mechanisms and the integration of organ systems for voluntary control. Final exam or final project. Prereq: Biology 215. Sem hrs: 3 fall.

Biology 431. *Microbiology Lab.* 3(2). A study of classical microbiology to include: environmental, industrial, and medical applications. This laboratory intensive course covers the systematics and classification of bacteria and viruses including the structure, function, and metabolic pathways of groups of bacteria. Specifically, the course will include the culture methods and identification of microbes important in the microbial ecology of humans, environmental microbiology, industrial microbiology, and biowarfare. Final exam or final project. Prereq or Coreq: Biology 332. Sem hrs: 3 spring.

Biology 435. *Animal Behavior* 3(1). An integrative approach to animal behavior: the evolution, ecology, genetics, and endocrinology of why and how animals do what they do. Emphasis is given to the physiology and behavior of animal systems relatable to humans. Topics explored include courtship and mate choice, aggression and territoriality, as well as the 'fight, flight, freeze' response. Course concepts are couched in an evolutionary context and are relatable to human sexuality, conflict, competitiveness, and cooperation. Final Project. Prereq/Coreq (Biology 330 accepted as a coreq for graduating first degrees only): Biology 330. Sem hrs: 3 spring only of odd years.

Biology 440. *Anatomy and Physiology: Visceral Systems Integration.* 3(2). An introduction to systems physiology via experimentation and dissection of the human cadaver, with experimentation emphasized. The course focuses on neural and endocrine feedback mechanisms for involuntary control and maintenance of homeostasis. Final exam or final project. Prereq: Biology 215. Sem hrs: 3 spring.

Biology 455. *Human Sex, Reproduction, and Sexuality.* 3(1). This course is designed to increase students' knowledge of the biological, behavioral and psychological aspects of human sex, sexuality and reproduction within the social context of family, culture, and society. Students will explore the role of sexuality in human development and conduct critical analysis of media and research. Communication and decision-making skills relating to sex, reproduction, sexuality, and relationships will underline all topics of the course. Course requirements, including class activities, have been designed to emphasize the importance of both content and process in human sexuality

education. This course will provide an opportunity for students to explore and clarify their personal sexual attitudes and beliefs. Final exam or final project. Prereq: Biology 215. Sem hrs: 3 spring only.

Biology 459. *Principles of Evolution.* 3(1). This course will examine the principles, patterns, mechanisms, and processes of biological evolution. The course format will comprise instructor presentations, student-led discussions, guest speakers, practical exercises, video programs, and selected readings. This course will draw on examples from botany, zoology, human anatomy, cell and molecular biology, ecology, and genetics to provide a fuller understanding of evolution in terms of evidence, processes, and outcomes. Through the study of evolutionary biology, students will gain an appreciation of evolution as a unifying theme in biology, and will acquire a more complete understanding of the origins, diversity, interrelationships, geographical distributions, and adaptations of living organisms. Final exam. Prereq: Biology 363. Sem hrs: 3 fall or spring.

Biology 465. *Advanced Biotechnology Seminar I.* 1.5(1). This leadership and research management course will teach principles of lab research leadership, peer mentoring, management, training, safety, and the overall process of running a biotech lab and research team. Advanced project management, proposal development, grant applications, budgets, experimental design, data collection, and analysis will be discussed and practiced through leadership of the USAF Academy iGEM team. Students will lead the team in preparing competition deliverables, website development, peer review, and publications. Final project. Prereq: Instructor approval. Sem hrs: 1.5 spring.

Biology 466. *Advanced Biotechnology Seminar II.* 1.5(1). This leadership and research management course will teach principles of lab research leadership, peer mentoring, management, training, safety, and the overall process of running a biotech lab and research team. Advanced project management, proposal development, grant applications, budgets, experimental design, data collection, and analysis will be discussed and practiced through leadership of the USAF Academy iGEM team. Students will lead the team in preparing competition deliverables, website development, peer review, and publications. Final project. Prereq: Instructor approval. Sem hrs: 1.5 fall.

Biology 480. *Biology Capstone Seminar.* 3(1). The Biology Capstone Seminar emphasizes student participation in exploring a variety of current biological issues. Students are challenged to develop a deep, reflective understanding of a wide range of biological concepts as they evaluate evidence, analyze issues, clarify assumptions, and consider different perspectives. They communicate clear logical, scientific thinking through reading, listening, speaking, and writing. Final paper. Prereq: C1C standing. Sem hrs: 3 fall or spring.

Biology 481. *Applied Ecology.* 3(2). Lecture and laboratories that address ecology and field biology. Lecture includes biotic and abiotic inputs and controls of various ecosystems. Laboratory exercises introduce survey techniques used in field studies. Classroom and laboratory work emphasizes environmental issues that are of special interest to Air Force personnel. Includes field

studies conducted on USAF Academy grounds. Field trip. Final exam and/or final project. Prereq: Biology 380 or concurrent enrollment with department approval. Sem hrs: 3 fall.

Biology 495. *Special Topics*. 3(1). Selected topics in the biological sciences. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Biology 499. Independent Study. 3(0). Individual research or tutorial study in the biological sciences under the direction of a faculty member. Emphasis is on using pertinent biological literature and conducting field and laboratory research. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Biology 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Biology 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Biology 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

CHARACTER AND LEADERSHIP

(CL)

Offered by the Commandant of Cadets (CW)

Character and Leadership (CL)100. 0(0). This program, executed within the 8-lesson course block for CE100, develops cadet skills and attitudes related to the Leader of Character Framework outlined in the USAF Academy Manual 36-3526, *Developing Leaders of Character at USAFA*. Pass/Fail. Prereq: None. Sem hrs: 0 fall or spring. Assessment: Closed-book test. Grading criteria: Each cadet must complete each closed-book test and score at least 75% to meet USAFA Graduation requirements.

This course, integrated with Leadership 100 and CE100, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome. CE and CL courses are taught within a 10 lesson block scheduled during the academic day.

Character and Leadership (CL)200. 0(0). This program, executed within the 8-lesson course block for CE200, develops cadet skills and attitudes related to the Leader of Character Framework outlined in the USAF Academy Manual 36-3526, *Developing Leaders of Character at USAFA*. Pass/Fail. Prereq: CL100. Sem hrs: 0 fall or spring. Assessment: Closed-book test. Grading criteria: Each cadet must complete each closed-book test and score at least 75% to meet USAFA Graduation requirements.

This course, integrated with Leadership 200 and CE200, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome. CE and CL courses are taught within a 10 lesson block scheduled during the academic day.

Character and Leadership (CL)300. 0(0). This program, executed within the 8-lesson course block for CE300, develops cadet skills and attitudes related to the Leader of Character Framework

outlined in the USAF Academy Manual 36-3526, *Developing Leaders of Character at USAFA*, through focusing on owning, engaging, and practicing habits of thought and action in a team leadership context. The importance of trust, loyalty, and commitment in maintaining a healthy culture and climate is also addressed to enhance their ability to effectively fulfill their role as team leaders and stewards of culture and climate in the Cadet Wing. Pass/Fail. Prereq: CL200. Sem hrs: 0 fall or spring. Assessment: Closed-book test. Grading criteria: Each cadet must complete each closed-book test and score at least 75% to meet USAFA Graduation requirements.

This course, integrated with Leadership 300 and CE300, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management Outcome. CE and CL courses are taught within a 10 lesson block scheduled during the academic day.

Character and Leadership (CL)400. 0(0). This program, executed within the 8-lesson course block for CE400, develops cadet skills and attitudes related to the Leader of Character Framework outlined in the USAF Academy Manual 36-3526, *Developing Leaders of Character at USAFA*. Pass/Fail. Prereq: CL300. Sem hrs: 0 fall or spring. Assessment: Closed-book test. Grading criteria: Each cadet must complete each closed-book test and score at least 75% to meet USAFA Graduation requirements.

This course, integrated with Leadership 400 and CE 400, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management Outcome and the Ethics and Respect for Human Dignity Outcome. CE and CL courses are taught within a 10 lesson block scheduled during the academic day.

Cadet Service Learning. Cadet Service Learning is a “Service Before Self” focused experience, designed to develop a sense of commitment, dedication, sacrifice, followership, and leadership in our cadets and the USAF Academy culture. The program targets community service activities, and helps cadets develop their leadership and organizational abilities while enhancing their sense of responsibility to others and giving of their free time to meet community needs. Cadet Service Learning continually seeks out service opportunities both in the local community and on a national scale as well; examples include: Habitat for Humanity and significant relief and service efforts like Hurricane Katrina. Cadet Service Learning is a catalyst for cadet development and growth in key leadership areas designed to create officers of character for the nation.

Lessons of Living Honorably in the Profession of Arms (Honor Education). Cadets acquire an awareness of the foundational concepts of living honorably in the profession of arms during Basic Cadet Training, and thereafter continually expand their awareness and internalization of virtues that support living honorably throughout their four years at USAF Academy. The education plan begins with the Introduction to Living Honorably in the Profession of Arms (ILHPA) instructional series during Basic Cadet Training (BCT). Living honorably in the profession of arms is a series of lessons and small group sessions aimed at developing the highest standards of personal integrity and strength of character in each cadet, in preparation for commissioning and to serve as a moral basis throughout his or her officer career. During BCT and the academic year the Cadet Wing and Cadet Wing Character & Honor Representatives train, manage, administer, and teach the lessons.

Ultimately the goal is the internalization of habits of living honorably in order to produce a leader of character.

National Character and Leadership Symposium (NCLS). Attended by 4,000 cadets; 1,000+ USAF Academy faculty and staff; and 1,000+ guests, students, and faculty from military academies and universities across the nation and around the world. This nationally-recognized forum ties together distinguished scholars, military leaders, and corporate executives with a popular student consortium to explore character and leadership issues. Past keynote lectures have been given by the Chairman, Joint Chiefs of Staff, the Secretary of the Air Force, Olympic gold medalists, military personnel from all services, and sports role models – including Coach John Wooden of UCLA and Mr. Tommy Lasorda of the Los Angeles Dodgers. NCLS provides our cadets and permanent party the opportunity to enhance their understanding of character-based leadership.

CHEMISTRY

(Chem)

Offered by the Department of Chemistry (DFCH)

Chem 100. General Chemistry I Lecture and Lab. 4(2). This course presents fundamental chemistry with an emphasis on concepts underlying Air Force and other practical applications. Provides a foundation in inquiry based learning to facilitate the development of critical thinking skills, data driven decision making, and technical writing skills. Topics to include atomic and molecular structure, electronic structure, oxidation-reduction reactions, stoichiometry, chemical bonding and structure, chemical analysis, intermolecular forces, thermochemistry, gas laws, and special topics. Laboratories emphasize both quantitative and qualitative analysis, with possible computer/IT interface. Final exam. Prereq: None. Sem hrs: 4 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and Principles of Science outcome.

Chem 200. General Chemistry II Lecture and Lab. 4(2). This course is a continuation and extension of the material taught in Chem 100. Topics will include solutions, kinetics, equilibrium, acid/base chemistry, thermodynamics, electrochemistry, and special topics such as nuclear chemistry, organic chemistry, modern materials, metals, and biochemistry. The course will use methods (e.g. case studies) that tie together chemical knowledge with economic, social, and political information to make informed decisions. Laboratories will be a foundational aspect of this course, emphasizing both qualitative and quantitative analysis. Cadets will be required to use modern chemical analysis (such as infrared spectroscopy) as part of the laboratory experience. The laboratories are designed to develop a fundamental understanding of the role of experimentation in scientific reasoning. Cadets who are placed into Chem 200 and received validation or transfer credit for Chem 100 will have grade protection as described elsewhere in this handbook. Final Exam. Prereq: Chem 100. Sem hrs: 4 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and Principles of Science outcome.

Chem 222. *Analytical Chemistry*. 4(2). Lecture and laboratory experience in both qualitative and quantitative analysis using classical wet techniques and modern instrumentation. Topics may include proper use of laboratory equipment, preparing solutions, calculating experimental error, calibration methods, chemical equilibrium, titrations, spectroscopy, chromatography, mass spectrometry, and electrochemistry. This course emphasizes using the analytical process in solving real-world problems, making accurate and precise measurements, analyzing and interpreting data, and using and understanding modern instruments. This course highlights real-world applications of analytical chemistry across the medical and pharmaceutical sectors, bioanalysis and forensics disciplines, the operational Air Force, and more. Final exam. Prereq: Chem 200 or DFCH approval. Sem hrs: 4 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and Principles of Science outcome.

Chem 230. *Introductory Organic Chemistry*. 3(1). Introduction to the fundamentals of organic chemistry. Topics include: nomenclature of organic compounds; stereochemistry; reaction mechanisms; structure and function of organic functional groups; introduction to carbohydrates, lipids, amino acids and proteins, and nucleic acids; basic aspects of polymer chemistry. This is a service course primarily designed for Biology and Basic Science majors. Chemistry majors and those cadets desiring to apply for medical school will not take this course in lieu of Chem 233 and Chem 234. Final exam. Coreq: Chem 200 or equivalent. DFCH approval required for enrollment. Sem hrs: 3 fall.

Chem 233. *Organic Chemistry I*. 3(1). The scientific study of the structure, properties, composition, reactions, and preparation of organic compounds. Topics include classification and naming of organic compounds, stereochemistry and conformational analysis, reaction and synthesis of alcohols, alkyl halides, alkenes, and alkynes; conjugated systems; spectroscopy and structure determination. Final exam. Prereq: Chem 200 or taken concurrently with approval from DFCH Department Head. Sem hrs: 3 fall.

Chem 234. *Organic Chemistry II*. 3(1). Continuation of Chem 233. Topics include mechanisms and reactions of aromatic compounds, organometallics, alcohols, ethers, and carbonyl-containing functional groups to include enolate chemistry. Multi-step syntheses integrating the knowledge of multiple functional groups is emphasized. Other topics such as carbohydrates, polynuclear aromatics, heterocyclic compounds, amino acids, and proteins may be introduced. Final exam. Prereq: Chem 233; a grade of "C" or better in Chem 233 or Department Head approval. Concurrent enrollment in Chem 243 is recommended but is optional for non-chemistry majors. Sem hrs: 3 spring.

Chem 243. *Organic Chemistry Laboratory*. 4(2). Experiments in the preparation, purification and identification of representative organic compounds. The lab is designed to illustrate the principles discussed in Chem 233/Chem 234 and develop techniques needed for the isolation, purification, and characterization of organic materials. Sample preparation techniques include recrystallization, distillation, melting point determination, including sample preparation of IR,

NMR, GC, and GC/MS, as well as instrument operation and data interpretation. Coreq: Chem 234. Sem hrs: 4 spring.

Chem 325. *Space Chemistry.* 3(1). This course examines the integral role chemistry plays in our efforts to effectively utilize space. Topics may include the chemical derivation of the elements found in the universe, materials science, propulsion chemistry, how the Air Force exploits the space environment to accomplish the mission, and other subjects of current interest. Final exam, final report, or final project. Prereq: Chem 200. Sem hrs: 3 spring.

Chem 335. *Physical Chemistry I.* 3(1). This course will focus on the application of physical chemistry to protein interactions and the connections between the different sub-disciplines of physical chemistry: quantum mechanics, spectroscopy, dynamics, kinetics, thermodynamics, and statistical thermodynamics. This course will explore a foundational basis in each of the six sub-disciplines of physical chemistry. Final exam, final report, or final project. Prereq: Chem 200, Math 142/152. Sem hrs: 3 fall.

Chem 336. *Physical Chemistry II.* 3(1). This course will focus on the applications of physical chemistry to materials science and the connections between the different sub-disciplines of physical chemistry: quantum mechanics, spectroscopy, dynamics, kinetics, thermodynamics, and statistical thermodynamics. This course will explore an in-depth basis in each of the six sub-disciplines of physical chemistry and build from the foundations established in Chem 335. Final exam, final report or final project. Prereq: Chem 335 or DFCH approval. Sem hrs: 3 spring.

Chem 344. *Instrumental Analysis.* 4(2). The course content and execution will focus on gaining an understanding of instrumental design, operational theory, practical use, and interpretation of data as applied to several instrumental methods of analysis that are used in chemistry major courses. Spectroscopic instrumental methods covered may include nuclear magnetic resonance (NMR) spectroscopy, Fourier transform infrared (FTIR) and Raman spectrometry, gas chromatography/mass spectroscopy (GC/MS), MALDI-TOF mass spectroscopy, atomic and molecular electronic absorption (AA and UV-Vis) as well as emission (ICP-OES/MS, fluorescence) spectroscopy and X-ray microanalysis (SEM and EDAX). Non-spectroscopic methods covered may include various chromatographic methods of separation such as gas-liquid, liquid-liquid and gel permeation chromatographic methods as well as thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), and combustion methods. Prereq: Chem 222 and Chem 243. Sem hrs: 4 fall.

Chem 350. *Chemistry of Weapons.* 3(1). The primary focus of this course is on the chemistry associated with weapons, from construction to delivery to by-products and detection as a result of delivery or destruction. Topics covered include conventional explosives, propellants, chemical weapons, biochemical effects, munitions design, and current topics. Emphasis is on understanding the chemical principles and thermodynamic processes involved in a variety of current and future weapon systems. Final exam and/or final project. Prereq: Chem 200 or DFCH approval. Sem hrs: 3 fall.

This course is a contributor to the development and assessment of the Scientific Reasoning and Principles of Science outcome.

Chem 353. *Theory of Instrumental Methods of Chemical Analysis.* 3(1). Basic theory and real-world examples of modern analytical methods of chemical analysis. Topics include ultraviolet, visible, infrared absorption, Raman and emission spectroscopies; mass spectrometry, nuclear magnetic resonance and electron paramagnetic resonance spectroscopy; chromatography; thermal methods, and other methods as appropriate. Applied numeric methods will also be discussed, with an emphasis on error analysis and determination of signal-to-noise ratio. Focus is placed on theory of methods currently applied in advanced courses offered in the USAF Academy Department of Chemistry. Final exam. Prereq: Chem 200. Sem hrs: 3 spring or fall.

Chem 381. *Chemistry of the Environment.* 3(1). Discussion of the chemistry and alteration of the natural environment due to human impacts. Areas of study include atmospheric, soil, water, and industrial chemistry, environmental contaminant properties, hazardous materials, waste disposal, toxicology and environmental analytical techniques. Special topics of current or regional interest may be included. Emphasis is on understanding the chemical principles, phenomena, and basic chemistry associated with protecting and improving our environment. Final exam or final report. Prereq: Chem 200. Sem hrs: 3 spring.

Chem 399. *Independent Study Techniques.* 1.5(1). Methods and strategies for proposing, planning, and executing independent research. A very useful and strongly recommended lead-in to Chem 499. Knowledge and skills gained will facilitate the initiation of research projects and improve efficiency of the research process. Exercises in searching the chemical literature, reading journal articles, and preparation of proposals. With DFCH approval, this course may be combined with Chem 499B for three semester hours of independent study credit. Final report/research proposal. Prereq: Chem 200 and DFCH approval. Sem hrs: 1.5 fall or spring.

Chem 431. *Theoretical Inorganic Chemistry.* 3(1). Theoretical approach to atomic structure, covalent bonding, and molecular structures. Additional topics include a selection from the following options: acid-base chemistry, ionic compounds, a general survey of the periodic table, coordination chemistry, organometallics, catalysis, bio-inorganic chemistry, and inorganic synthesis. Final exam. Prereq: semester of quantum chemistry. Sem hrs: 3 fall.

Chem 432. *Special Topics in Inorganic Chemistry.* 3(1). Applications of Chem 431 will be explored using a combination of seminar- and discussion- styled classes. Faculty will be invited to speak on areas of their specialty. Topics of study will be selected by the cadets in the class. Reading material will be taken from a wide range of sources with an emphasis on evaluating the quality of the information from an inorganic perspective. Connections to other chemistry disciplines will be explored and evaluating the material in the context of the larger world will be encouraged. This will draw upon the wide range of core courses the cadets have taken in other fields of study. Final exam or final project. Prereq: Chem 431. Sem hrs: 3 spring.

Chem 433. *Advanced Organic Chemistry.* 3(1). Advanced studies of chemical bonding and molecular structure; molecular orbital theory, aromaticity, structure-reactivity relationships, kinetics, mechanisms, and linear free energy relationships. Topics include concerted reactions, conservation of orbital symmetry, frontier molecular orbitals, photochemistry, selected synthetic methods, nucleophilic carbon species, carbonyl compounds, principles of stereochemistry, and asymmetric synthesis. Final exam or final project. Prereq: Chem 234; Chem 335, and DFCH approval. Sem hrs: 3 fall or spring.

Chem 434. *Introduction to Biochemistry.* 3(1). Chemistry of the life processes. Topics covered include the chemistry of biomolecules (carbohydrates, lipids, proteins, and nucleic acids); energetics and metabolic control; enzyme kinetics and enzyme mechanisms, intermediary metabolism, biosynthesis and function of macromolecules and an introduction to biotechnology and recombinant DNA techniques. This course is designed to aid cadets with the biochemistry portion of the MCAT exam. Final exam. Prereq: Chem 234. Sem hrs: 3 fall.

Chem 435. *Advanced Physical Chemistry.* 3(2). Development of molecular quantum mechanics and its application to molecular spectroscopy and chemical reaction dynamics. Topics include rotational, vibrational, and electronic spectroscopy; chemical reaction dynamics with emphasis on theoretical calculations for reactions, and advanced theoretical chemical methods. Laboratories provide hands-on experience in advanced physical chemistry concepts and characterization of the physical world. Final exam or final project. Prereq: Chem 336 and DFCH approval. Sem hrs: 3 fall or spring.

Chem 440. *Polymer Chemistry.* 3(2). An introduction to polymer chemistry. Lecture topics include discussions on the interrelations between molecular and gross physical properties; polymer structure; methods of polymerization; polymer development; and Air Force applications for polymers. Laboratories provide hands-on experience in synthesis of polymeric materials. Final exam or final project. Prereq: Chem 234, Chem 243, and Chem 335 or DFCH approval. Sem hrs: 3 spring of even-numbered years.

Chem 444. *Integrated Chemistry Laboratory.* 3(2). The intent of this course is to provide students with a comprehensive chemistry laboratory experience that reinforces principles and techniques gained in 200- and 300-level courses. The topics are presented as research-style problems that may span the primary sub-disciplines of chemistry. As such, students are exposed to chemistry as an integrated subject that requires them to put into practice cutting-edge technology and state-of-the art chemical practices to answer modern scientific questions. The course, therefore, will be modified in content as the course director sees fit in order to emphasize evolving investigations in chemistry. Prereq: Chem 234 and Chem 243. Coreq: Chem 335 and Chem 344. Sem hrs: 3 fall.

Chem 445. *Advanced Laboratory Techniques.* 3(2). This course is designed to enhance cadets' experience in advanced laboratory techniques in inorganic, organic, analytical, and physical chemistry. Experiments include preparation, purification, identification, and analysis of

representative organometallic and inorganic compounds. Final project or final exam. Prereq: Chem 234, Chem 243, Chem 335, and Chem 444. Coreq: Chem 431 or DFCH approval. Sem hrs: 3 spring.

Chem 465. *Chemistry of Advanced Materials*. 4(2). Chemical studies in modern and high-tech materials emphasizing physical chemistry fundamentals, the interface between molecules and materials, and the development of these materials. Topics include chemical computational models, materials for energy storage, electronics, structures, optics, and glasses. Laboratories provide hands-on experience in synthesis and characterization of materials. Final exam or final project. Prereq: Chem 243, Chem 335, and Chem 444. Coreq: Chem 336. Sem hrs: 4 spring of odd-numbered years.

Chem 481. *Biochemistry I*. 3(1). Chemistry of living organisms emphasizing the roles played by biomacromolecules and macromolecular assemblies. Topics covered include an introduction to primary literature in biomedical research, cells and organelles, amino acids, nucleic acids, protein structures and enzymes, sugars and polysaccharides, lipids and membranes, and an introduction to metabolism. Final exam. Prereq: Chem 234 or DFCH approval. Sem hrs: 3 fall.

Chem 482. *Biochemistry II*. 3(1). Chemistry of living organisms emphasizing the central metabolic processes and the transmission of genetic information. Topics covered include glycolysis and other pathways of carbohydrate metabolism, the citric acid cycle, lipid and amino acid metabolism, signal transduction, DNA replication, transcription of DNA and RNA, and translation of mRNA into protein. Final exam. Prereq: Chem 481. Sem hrs: 3 spring.

Chem 491. *Biochemistry Laboratory*. 4(2). Experiments to manipulate DNA, RNA, and proteins. Techniques covered include agarose and acrylamide gel electrophoresis, recombinant DNA techniques, microbial culture and transformation, cell culture, and production and purification of recombinant proteins. This lab is designed to illustrate the conceptual principles presented in Chem 481. Laboratory Practical Exam at semester's end. Final project. Coreq: Chem 481. Sem hrs: 4 fall.

Chem 495. *Special Topics*. 3(1). Selected topics in chemistry. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring

Chem 499. *Independent Study*. 3(0). The capstone course for all Chemistry majors. A hands-on laboratory experience applying the culminated knowledge and skills gained in the major towards a novel research project. Individual research using state-of-the-art equipment under the direction of a faculty member. Includes use of chemical literature. Final report. Prereq: DFCH approval. Sem hrs: 3 fall, spring, or summer.

- Chem 499A. Independent Study. 2(0). Sem hrs: 2 fall, spring, or summer.
- Chem 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Chem 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

CIVIL ENGINEERING

(Civ Engr)

Offered by the Department of Civil and Environmental Engineering (DFCE)

Civ Engr 215. *Computer Applications for Civil Engineers.* 3(1). Application of commercially available computer-based tools for solving common types of Civil Engineering problems. Use of spreadsheet and relational database software with an emphasis on information input, data handling, and professional output. Introduction to geospatial mapping capabilities and using GIS technologies. Component, architectural, and engineering modeling using state-of-the-art computer-aided design (CAD) software, including presentation and working drawings. Final project. Prereq: Cadets who are not Civil Engineering majors must receive approval from DFCE AIC before enrolling. Sem hrs: 3 fall or spring.

Civ Engr 330. *Elementary Structural Analysis.* 3(1). Static analysis of determinate structures. Stresses and deformations in beams, trusses, and frames. Final exam. Prereq: Mech Engr 220 and completed or enrolled in Math 245. Sem hrs: 3 fall or spring.

Civ Engr 351. *Civil Engineering Practices - Field Engineering.* 3(0). This two-phase course includes Operation Civil Engineering Air Force (OpsCEAF) and a three week field experience at the USAF Academy Field Engineering and Readiness Laboratory (FERL). Second-class cadets spend first period at a government facility working on a project in the civil engineering field. Participants will be scheduled for a second or third summer period leadership program. The three week field experience introduces surveying, construction materials, design of concrete mixes, and hands-on construction using metal, timber, asphalt and concrete, and working knowledge of environmental systems. Cadets will construct various projects that they will design in later civil and environmental engineering courses. OpsCEAF is in lieu of Operation Air Force (Mil Tng 301). OpsCEAF credit is Pass/fail. Civ Engr 351 is graded. Prereq: Mech Engr 220; department approval required for non-Civ Engr majors. Sem hrs: 3 summer (5 week course beginning after final exams).

Civ Engr 352. *Lightweight Concrete Design, Analysis, and Construction.* 3(2). The design, analysis, and construction of the concrete canoe is an integration of several course experiences and develops cadets' understanding of fundamental concepts in concrete, structural design, hydraulics, and computer applications. Cadets learn skills in project management, design, concrete technology, material testing, and physical construction. Cadets use computer tools such as computer aided design to complete three-dimensional modeling, project management software to develop and track progress of the project, spreadsheets to design concrete mix, and structural analysis packages to determine forces within the structure. Extensive time is spent in the laboratory testing the engineering properties of concrete mixes and composite materials. Final report and final project. Prereq: Civ Engr 351 or department approval. Sem hrs: 3 fall.

Civ Engr 355. *Blast Effects and Protective Structures.* 3(1). The purpose of this course is to educate cadets on protective design strategies to mitigate blast damage and progressive collapse of structures. An understanding of the principals covered in this course is critical for the safe

design of USAF structures that may be subjected to blast events. Topics include: computation of blast loads on structures, computation of blast-loaded structural components' dynamic responses, design of structural components to achieve prescribed levels of performance for specific blast scenarios, and analyses of structures to determine potential for progressive collapse. Final project. Coreq: Civ Engr 372. Sem hrs: 3 fall.

Civ Engr 356. *Introduction to Sustainability.* 3(1). This course covers sustainability and green engineering principles including industrial ecology, life cycle assessment, climate change, renewable energy, and green buildings and infrastructure. The course will outline commonly employed green engineering principles, metrics, and evaluation techniques. Topics will be developed using case studies framed in the context of the UN Sustainable Development Goals and the Triple Bottom Line. At the conclusion of the course, students will be able to integrate and advocate for sustainability principles in plans and decisions affecting the built and natural environment. Final project. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Civ Engr 361. *Fundamental Hydraulics.* 3(1). Introduction of the principles of incompressible fluid mechanics. Topics include: fluid properties, pressure measurement and manometry, hydrostatics, forces on submerged surfaces, buoyancy and stability, continuity, the energy equation, pipe flow, impulse-momentum principle, and open channel flow. Hydraulics laboratories with reports. Final exam. Prereq: Mech Engr 220 and Civ Engr 351 or department approval. Sem hrs: 3 fall or spring.

Civ Engr 362. *Introduction to Environmental Engineering.* 3(1). Introduction to the theory and principles fundamental to the discipline of environmental engineering. Topics may include risk, environmental chemistry, mass balance and its application to reactor theory and kinetics, air and water pollution, water and wastewater treatment, indoor air quality, green engineering, renewable energy, and climate change. Final exam. Prereq: Mech Engr 220. Coreq: Civ Engr 361. Sem hrs: 3 fall or spring.

Civ Engr 363. *Humanitarian Engineering.* 3(1). Focus on the application of scientific and engineering principles and practices for the betterment of individuals and communities in disadvantaged circumstances. Introduction to co-design, co-creation, co-implementation paradigm for the implementation of innovative science- and engineering-based solutions with communities, rather than for communities. Identification of needs, resources, and appropriate technologies. Assessment of potential environmental, social, political, economic, cultural, and human health impacts. Case studies from international development projects. Linkages to Air Force Civil Engineer experiences. Final project. Prereq: Comp Sci 110, Civ Engr 351, or Department Head approval. Sem hrs: 3 spring.

Civ Engr 372. *Behavior and Analysis of Structures.* 3(1). Behavior and analysis of statically determinate and indeterminate beams, frames, and trusses. Calculate loads on a structural member by applying load path and tributary area concepts. Determining design loads for dead, live, snow,

and wind loads. Calculate displacements using virtual work. Analysis of indeterminate structures by consistent deformation and slope deflection. Introduction to direct stiffness method. Computer analysis projects. Final exam. Prereq: 'C-' or better in Civ Engr 330 or department approval. Sem hrs: 3 fall or spring.

Civ Engr 373. *Behavior and Design of Steel Members.* 3(1). Behavior of structural steel beams, columns, and connections, and frames; using the Load and Resistance Factor Design method. Design for tension, flexure, shear, compression, and combined loads. Design of bolted and welded steel connections. Design project. Final exam. Prereq: completed or enrolled in Civ Engr 372. Sem hrs: 3 spring.

Civ Engr 376. *Forest Service Bridge Design.* 1.5(1). Design of a U.S. Forest Service (USFS) pedestrian bridge at a National Forest site determined jointly by USAF Academy and the USFS. Topics include construction site surveying, site plan development, field soil investigation and analysis, environmental compliance and sustainability, waterway design flow determination, Federal land management, recreation and bridge planning, and structural analysis and design. Students work in design teams similar to those in civil engineering consulting firms. Includes overnight visit to bridge construction site to accomplish preliminary site analyses. Cadets who enroll in this course must also enroll in Civ Engr 377 and Civ Engr 378. Course enrollment is typically limited to 10 students, who must be second-class cadets. Final project. Prereq: Civ Engr 330, Civ Engr 351, or Department approval. Sem hrs: 1.5 fall.

Civ Engr 377. *Forest Service Bridge Construction Planning.* 1.5(1). Preparation of construction documents for Forest Service pedestrian bridge designed in Civ Engr 376. Submittal of bridge design and construction documents to the U.S. Forest Service for technical review and approval. Bridge construction preparation, including final plans and specifications preparation, project planning and scheduling, project cost estimating, equipment and tools selection, and construction project safety. Preparation of bridge project bill of materials for submittal to U.S. Forest Service for use in construction materials ordering. Students work in teams similar to those in commercial construction companies. Course enrollment is typically limited to 10 students. Final project. Prereq: Civ Engr 376. Sem hrs: 1.5 spring.

Civ Engr 378. *Forest Service Bridge Construction.* 0(1). Three-week summer course to construct Forest Service bridge designed and planned in Civ Engr 376 and 377. USFS provides construction materials and oversight, and cadets physically construct bridge foundation and abutments, primary bridge stringers, deck, handrails and bridge approaches. Course includes daily planning and scheduling meetings, construction safety briefings, USFS standard construction practices and procedures, public relations guidance and team building activities. Students will also visit previous USAF Academy cadet bridge project sites to assess deterioration and complete bridge maintenance procedures. Course enrollment is typically limited to 10 students. Prereq: Civ Engr 377. Sem hrs: 0 third summer period. Pass/fail.

Civ Engr 385. *Project Management and Contract Administration.* 3(1). This course introduces the principles and practices of managing infrastructure programs. Through a semester-long

project, cadets take an owner's project requirements through stages of scope definition, budgeting and planning, conceptual design, scheduling, and construction contract administration. Cadets apply engineering standards and consider realistic issues including engineering economics, constructability, environmental requirements, sustainability, and safety. The course addresses and applies management topics and concepts of planning, organizing, leading, and controlling in the context of an engineering project. Final project. Final project. Prereq: None. Sem hrs: 3 spring.

Civ Engr 390. *Introduction to Geotechnical Engineering.* 3(2). Engineering properties of soils, soil classification, compaction, hydraulic conductivity, consolidation, shear strength and introduction to slope stability and foundation design. Soils laboratories with reports. Final exam. Prereq: Civ Engr 351 or department approval. Sem hrs: 3 fall or spring.

Civ Engr 405. *Civil Engineering Seminar.* 0(1). A course designed to give Civil Engineering majors the opportunity to synthesize and apply the concepts they have learned throughout their undergraduate education. Topics discussed include engineering ethics and those that cadets may encounter in the Air Force after graduation. The course meets once per week. Open only to 1^o Civil Engineering majors. Sem hrs: 0 spring. Pass/fail, no final.

Civ Engr 451. *Civil Engineering Capstone 1.* 3(2). This is the first course in the civil engineering capstone sequence. This course challenges students to solve a complex engineering problem in teams. The problems will be open-ended in nature and involve the application of math, science, and engineering principles acquired in previous coursework. The students will be assigned to a team, and either conduct research, design, or design and build for their project. Work will require application of engineering methods to define the problem, analyze alternatives, and select the best alternative to solve the problem. Work on this problem will continue in the next course: Civ Engr 452. Coreq: One of the civil engineering design options or department approval. Sem hrs: 3 fall.

Civ Engr 452. *Civil Engineering Capstone 2.* 3(2). This is the second course in the civil engineering capstone sequence. This course continues the process initiated in Civ Engr 451. Students will implement, test, model, or communicate their solution to solve a complex engineering problem in teams. They will determine the applicable standards and requirements associated with their problem and will consider, as appropriate and applicable, how the project meets specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Teams will communicate their recommended solutions either orally, in a written report or draft journal manuscript, or both. Teams will receive feedback, reflect on their work and iterate towards a more robust final solution. Prereq: Civ Engr 451 or department approval. Sem hrs: 3 spring.

Civ Engr 456. *Sustainability Capstone.* 3(1). Life-Cycle Assessment (LCA) has become a leading methodology for assessing environmental impacts and resources used throughout the life of a product, process, or service. LCA is becoming increasingly more prominent in both industry and government with the intent to find more sustainable supply chains. This course introduces a research-focused introduction to life-cycle assessments divided into two main components. The

first component details the methodology of LCA including mathematical structure, modeling of production systems, and methods for environmental impact assessments with focuses around social, economic, and environmental implications. The second component challenges cadets to develop an LCA for an emergent issue utilizing the student cohort's culminating sustainability knowledge developed from the cadets' minor and major courses. Final project. Prereq: Civ Engr 356. Sem hrs: 3 spring.

Civ Engr 461. *Hydraulic Design.* 3(1). Hydrology and drainage system design. Topics may include: hydrologic cycle, surface water flow, hydrographs, stormwater runoff estimation, overland flow, drainage channel flows, design of storm-drain systems, pipe and sewer networks, and culverts. Special emphasis on airfield drainage and flood control problems. Sustainability considerations and potential impacts of climate change on hydraulic designs. Best stormwater management practices. Design projects. Prereq: Civ Engr 361 (C- or better). Sem hrs: 3 fall.

Civ Engr 462. *Site Assessment & Remediation.* 3(1). A comprehensive introduction to groundwater hydrology, contaminant transport, and the design of technical approaches to remediate subsurface environmental contamination. Topics may include site conceptual models, groundwater flow, well hydraulics, reactive transport in the subsurface, design of common isolation and in situ treatment technologies, and the use of feasibility studies to select appropriate remedial approaches. Applications related to current Air Force environmental liabilities are also discussed. Design Projects. Prereq: C- or better in Civ Engr 361. Coreq: Civ Engr 362, Civ Engr 390. Sem hrs: 3 fall or spring.

Civ Engr 463. *Wastewater Treatment Plant Design.* 3(2). Design of facilities for physical, chemical, and biological treatment of wastewater; and treatment and disposal of sludge. Coverage of advanced wastewater treatment and land treatment systems. Laboratory exercises analyzing raw sewage with data being used for the design processes. Final design project consists of a complete wastewater treatment plant design. Prereq: Civ Engr 362. Sem hrs: 3 spring.

Civ Engr 464. *Architectural Design.* 3(2). Design of a commercial building. Uses computer-aided-design and drafting (CADD) software in developing design to include: site plan, functional layout, structure, energy and HVAC, aesthetic design, landscaping, and electrical. Produces set of design working drawings by end of course. Final project. Prereq: Civ Engr 215; Civ Engr 351; or department approval. Sem hrs: 3 fall or spring.

Prereq: Civ Engr 473. *Structural Design.* 3(2). Design of a multi-story steel and reinforced concrete building, including structural frame, floor and roof system, and foundation. Computer-aided analysis and design. Final report. Prereq: Civ Engr 373 and Civ Engr 474. Sem hrs: 3 spring.

Civ Engr 474. *Behavior and Design of Concrete Members.* 3(1). Properties of reinforced concrete. Behavior and ultimate strength design of reinforced concrete beams, slabs, columns, and footings. Design for flexure, shear, compression, bond, and anchorage. Design project. Final exam. Prereq: Completed or enrolled in Civ Engr 372. Sem hrs: 3 fall.

Civ Engr 485. *Construction Engineering and Management.* 3(1). This course expands upon the content in Civ Engr 385, focusing on construction engineering and management during a project's execution phase. The course covers topics such as surveying, slope stabilization, designing temporary structures, planning, scheduling, cost estimation, risk management, and quality control, as well as legal and ethical considerations in construction projects. Cadets will learn how to apply engineering and management principles to construction projects, and how to evaluate and manage project risks. Throughout the course, cadets will engage in case studies and project-based learning to gain practical experience applying course concepts. Upon completion of the course, cadets will have a solid understanding of the key principles and practices of construction engineering and management. A semester project, in the form of a detailed study of a major construction project, complements the classroom experience. Final project. Prereq: CivEngr 351 and CivEngr 385 or department approval. Sem hrs: 3 fall.

Civ Engr 486. *Applied Construction Practices.* 3(1x). Students in this course will learn about construction processes and project delivery methods. Their work will be in preparation to form one or more teams to compete in the annual Associated Schools of Construction regional student competition each February. The cadet teams will play the role of construction or design-build firms competing to win a project award. Student products will include a qualifications package, site plans, conceptual architectural and/or engineering designs, cost estimates, project schedules and construction plans. The students will also present their plans to a panel of industry representatives. They will compete against other teams from universities across the western U.S. The deliverables include the final versions of all cadet work and their lessons learned for next year's teams. The course is offered in the first 20 lessons (1-20) of the spring semester. This is a continuation of Civ Engr 486X. Final project and presentation. Prereq: Civ Engr 486X. Sem hrs: 3 spring.

Civ Engr 486X. *Applied Construction Practices.* 0(1). Students in this course will learn about construction processes and project delivery methods. Their work will be in preparation to form one or more teams to compete in the annual Associated Schools of Construction regional student competition each February. The cadet teams will play the role of construction or design-build firms competing to win a project award. Student products will include a qualifications package, site plans, conceptual architectural and/or engineering designs, cost estimates, project schedules and construction plans. The students will also present their plans to a panel of industry representatives. They will compete against other teams from universities across the western U.S. The deliverables include the final versions of all cadet work and their lessons learned for next year's teams. The course is offered in the last 20 lessons (21-40) of the fall semester. Final project and presentation. Prereq/Coreq: One of the civil engineering design options or department approval. Sem hrs: 0 fall.

Civ Engr 488. *Pavement Design and Rehabilitation.* 3(1). Fundamental theory and design principles of flexible and rigid pavements covering traffic characteristics (loads and repetitions), airfield and highway pavement design, pavement evaluation and maintenance, and pavement

rehabilitation techniques. The course content may include traffic operations (safety, volume, flow, and level of service) and roadway geometrics (intersections and horizontal and vertical alignment). Final exam or project. Prereq: Civ Engr 390. Sem hrs: 3 spring.

Civ Engr 491. *Foundation Engineering.* 3(1). Students design a facility foundation. Topics include site investigation, bearing capacity and settlement, analysis and design of deep and shallow foundations. Introduction to lateral earth pressures. Final design project. Prereq: Civ Engr 390. Sem hrs: 3 fall.

Civ Engr 492. *Earth Structures.* 3(1). Estimate/predict lateral earth pressures, analyze slope stability, design embankments, design retaining walls, and summarize current research on retaining wall design. Final design project. Prereq: Civ Engr 390. Sem hrs: 3 spring.

Civ Engr 495. *Special Topics.* 3(1). Selected topics in civil engineering. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Civ Engr 499. *Independent Study.* 3(0). Individual study and research in an advanced civil engineering topic approved by the department head. Final report. Sem hrs: 3 fall or spring.

- Civ Engr 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Civ Engr 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Civ Engr 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

COMMISSIONING EDUCATION

(CE)

Offered by the Commandant of Cadets

CE 100. CE100. 0(1x). During this 8-less course, fourth-class cadets receive training on basic and essential knowledge, skills, and abilities needed to ensure success for all new Air and Space Force officers upon entry into commissioned service in accordance with DAFI 36-2614, *Pre-Commissioning Education and Training Program*, 06 October 2022, and CJCSI 1800.0ID, *Officer Professional Military Education Policy*. In addition, all CL100 material will be covered during the course. Final exam. Pass/Fail. Apply toward MPA. Prereq: Fourth-class standing. Sem hrs: 0 fall or spring. Assessment: Closed-book test. Grading criteria: Each cadet must complete each closed-book test and score at least 75% to meet USAFA Graduation requirements.

This course, integrated with Leadership 100 and CL100, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome. CE and CL courses are taught within a 10 lesson block scheduled during the academic day.

CE 200. CE200. 0(1x). This 8-lesson course provides education and training to provide the basic and essential knowledge, skills, and abilities needed to ensure success for all new Air and Space Force officers upon entry to commissioned service in accordance with DAFI 36-2614. In addition, all CL200 material will be covered during this course. Pass/Fail. Apply toward MPA. Prereq:

CE100. Sem hrs: 0 fall or spring. Assessment: Closed-book test. Grading criteria: Each cadet must complete each closed-book test and score at least 75% to meet USAFA Graduation requirements.

This course, integrated with Leadership 200 and CL200, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome. CE and CL courses are taught within a 10 lesson block scheduled during the academic day.

CE 300. CE 300. 0(1x). This 8-lesson course provides education and training to provide the basic and essential knowledge, skills, and abilities needed to ensure success for all new Air and Space Force officers upon entry to commissioned service in accordance with DAFI 36-2614. In addition, all CL300 material will be covered during this course. Pass/Fail. Apply toward MPA. Prereq: CE100. Sem hrs: 0 fall or spring. Assessment: Closed-book test. Grading criteria: Each cadet must complete each closed-book test and score at least 75% to meet USAFA Graduation requirements.

This course, integrated with Ldrshp 300 and CL 300, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome. CE and CL courses are taught within a 10 lesson block scheduled during the academic day.

CE 400. CE400. 0(1x). This 8-lesson course provides education and training to provide the basic and essential knowledge, skills, and abilities needed to ensure success for all new Air and Space Force officers upon entry to commissioned service in accordance with DAFI 36-2614. In addition, all CL400 material will be covered during this course. Pass/Fail. Apply toward MPA. Prereq: CE100. Sem hrs: 0 fall or spring. Assessment: Closed-book test. Grading criteria: Each cadet must complete each closed-book test and score at least 75% to meet USAFA Graduation requirements.

This course, integrated with Ldrshp 400 and CL 400, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome. CE and CL courses are taught within a 10 lesson block scheduled during the academic day.

COMPUTER SCIENCE

(Comp Sci)

Offered by the Department of Computer and Cyber Sciences (DFCS)

Comp Sci 110. Introduction to Computing and Cyber Operations. 3(1)*. An introduction to the principles, capabilities, applications, limitations, and vulnerabilities of computer-based systems. Topics include information representation, algorithmic problem solving, programming, artificial intelligence, computer networking, information security, and cyber operations. Final project. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Comp Sci 110S. *Introduction to Computer Science and Cyber Operations for Scholars.* 3(1). An overview of the great ideas in computing. We will investigate the “big questions” in computing and humanity’s best attempts to answer them, by reading the original writings of significant contributors to the field. Problems explored include: “What is computing?” “What can and cannot be computed?” “How can a computer be constructed?” “How can we best express our ideas to computers?” “How long does it take to compute something?” Particular emphasis is placed on reading original materials, learning by doing, and on the military and social consequences of computing. The latter will be illustrated through exercises emphasizing the results of applying computer science principles in the cyber domain. Programming experience is not required. Final exam. Prereq: Scholar status. Sem hrs: 3 spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Comp Sci 206. *Fundamentals of Programming for Engineers.* 1(1X). Introduces and applies programming, modeling, and simulation skills required in the various courses in engineering majors. Students will be introduced to MatLab for programming, modeling, and simulation. Students must successfully complete a series of proficiency tasks for credit. When registering for this course, please specify preference for taking the course during the first-half (e.g., Comp Sci 206) or second-half of semester (e.g., Comp Sci 206X). Pass/fail. Prereq: Comp Sci 110. Sem hrs: 1 spring.

Comp Sci 210. *Programming Fundamentals.* 4(2). Establishes an understanding of the fundamental concepts of software development along with applied computer programming and problem-solving skills. Topics include programming constructs, appropriate use of fundamental data types and libraries, error handling techniques, problem-solving strategies, algorithms, data structures, and recursion. Considerable attention is devoted to developing effective software engineering practices, emphasizing design, documentation, encapsulation, procedural abstraction, testing, debugging, and software reuse. Final project. Prereq: Comp Sci 110. Sem hrs: 4 fall.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Comp Sci 211. *Introduction to Programming for Scientists and Engineers.* 4(2). Introduces and applies the fundamental techniques of scientific programming as a foundation for solving scientific and engineering problems using computers. Topics include programming constructs, problem-solving strategies, testing and debugging, effective use of pre-defined functions, and vector and matrix operations, with a focus on engineering and scientific applications. Cadets will learn a programming language and development environment that is suited for science and engineering disciplines. Final project. Prereq: Comp Sci 110. Sem hrs: 4 fall or spring.

Comp Sci 212. *Introduction to Programming for Analysts.* 4(2). Introduces the fundamental techniques of software development as a foundation for solving analytical problems using computers. Topics include programming constructs, problem-solving strategies, algorithms, and data structures, with a focus on analysis applications. Considerable attention is devoted to developing effective software engineering practices, emphasizing design, decomposition,

encapsulation, modularity, testing, debugging, and software reuse. Cadets will learn a programming language and development environment that is widely used within the analytic discipline. Final project. Prereq: Comp Sci 110. Sem hrs: 4 spring.

Comp Sci 220. *Data Structures and Systems Programming.* 3(1). Continues the introduction of software development, with a particular focus on the ideas of data abstraction, data structures, and memory management. Topics include recursion, algorithmic complexity, memory management, reference semantics, and fundamental computing algorithms. Final exam. Prereq: C or better in Comp Sci 210. Sem hrs: 3 spring.

Comp Sci 330. *Software Design and Development.* 3(1). Focuses on advanced software analysis, design, implementation, and testing concepts and techniques within the object-oriented, functional, and possibly other paradigms. Primary topics include object-oriented analysis and design, inheritance and polymorphism, user interface design, object-oriented programming, testing techniques, functional language theory, and functional programming. Final exam. Prereq: Comp Sci 220. Sem hrs: 3 fall.

Comp Sci 350. *Software Engineering.* 3(1). Develops a theoretical and applied understanding of the concepts and techniques of software engineering emphasizing agile methodologies, software architectures, project planning and management, risk management, requirements engineering, prototyping, goal modeling, design techniques and quality measures, security considerations and protections, quality assurance techniques, testing methodologies, configuration management and control, sustainment, and tool support. Final exam. Prereq: Comp Sci 220. Sem hrs: 3 fall.

Comp Sci 351. *Computer Organization and Architecture.* 3(1). Introduces basic computer logic systems, major types of computing system organizations, and machine and assembly language programming. Topics include digital logic, processor architecture, data representation, memory architecture, performance analysis, computer arithmetic, pipelining, and multi-processing. Final exam. Prereq: Comp Sci 210 or department approval. Sem hrs: 3 spring.

Comp Sci 362. *Computer Simulation.* 3(1). Introduction to modeling and simulation. Topics include principles of computer simulation methodologies; simulation data analysis and input design; simulation development; analysis of results; and verification of system design, implementation, and assumptions. The course includes the development of small conceptual simulations, statistical analysis of data sets, and a group project involving the simulation and analysis of real-world systems. Final project. Prereq: Comp Sci 210, Comp Sci 211, or Comp Sci 212; Math 356 or Math 377. Sem hrs: 3 spring.

Comp Sci 364. *Databases and Applications.* 3(1). Introduction to the basic concepts of database systems. Topics include data models, database design theory, database performance, transaction processing, web-database interaction, techniques for handling large volumes of data, and contemporary database issues. Hands-on projects emphasize basic database and information storage and retrieval techniques. Final Project. Prereq: Comp Sci 210 or Comp Sci 211 or Comp Sci 212. Sem hrs: 3 spring.

Comp Sci 380. *Design and Analysis of Algorithms.* 3(1). Advanced design and analysis of algorithms used in modern computing systems. Topics include analysis of algorithms, basic structures, advanced abstract data types, recursion, computability and complexity. Problem solving and analytical skills are improved by examining the application of problem solving strategies to several problem domains with an emphasis on the impact of design decisions on algorithm performance. Concepts are reinforced by several programming exercises. Final exam. Prereq: Comp Sci 220; Math 340 or Math 374. Sem hrs: 3 spring.

Comp Sci 385. *Software Dev for Mobile Devices.* 3(1). Introduces the design and development of applications (apps) for mobile devices. Mobile device topics include runtime environments; human interface guidelines; display optimization; device orientation, location, and movement; user gesture handling; interactions metaphors; user interface paradigms; user content expectations; user-centric terminology; data reach-back; and multitasking. Hands-on projects emphasize the unique aspects of software development to meet device-specific user expectations and the unique aspects of mobile device sensors, input and output modes, and limitations. Final project. Prereq: Comp Sci 220. Sem hrs: 3 fall.

Comp Sci 405. *Computer Science Colloquium I.* 0(1). A course for Computer Science majors that provides for presentation of cadet and faculty research; guest lecturers; field trips; seminars on career and graduate school opportunities; goal setting exercises; and applications for Computer Science. The class meets once each week. Open only to 1^o Computer Science majors. Pass/fail. Prereq: C1C standing. Sem hrs: 0 fall.

Comp Sci 406. *Computer Science Colloquium II.* 0(1). A course for Computer Science majors that provides for presentation of cadet and faculty research; guest lecturers; field trips; seminars on career and graduate school opportunities; goal setting exercises; and applications of Computer Science. The class meets once each week. Open only to 1^o Computer Science majors. Pass/fail. Prereq: C1C standing. Sem hrs: 0 spring.

Comp Sci 426. *Languages and Machines.* 3(1). Students will learn the theoretical foundations of computer science and apply these concepts to appropriate stages in compiler implementation. Topics include finite automata, formal language theory, grammars, scanners, parsing techniques, code generation, symbol tables, and run-time storage allocation. Students will design and implement a syntax-directed compiler for a high-order programming language. Final exam. Prereq: Comp Sci 330. Sem hrs: 3 fall.

Comp Sci 453. *Software Engineering Capstone Project I.* 3(2). First course in the two- semester capstone design sequence for Computer Science majors. Applies contemporary concepts and techniques for the team-based analysis, design, implementation, testing, and maintenance of larger scale software engineering projects. Includes development of project management, configuration control, technical communications, and teamwork skills. Final project. Prereq: C1C standing and department approval. Sem hrs: 3 fall.

Comp Sci 454. *Software Engineering Capstone Project II.* 3(2). Second course in the two-semester project sequence for Computer Science majors. Continues the applied study of the software development lifecycle with the goal of delivering a robust and sustainable product. Final project. Prereq: Comp Sci 453. Sem hrs: 3 spring.

Comp Sci 467. *Computer Networks.* 3(1). Examination of modern data communications systems and related security issues. Topics include the TCP/IP reference model, data transmission theory, network design issues, internetworking, routing, network protocols, implementation of networks, and communications security. Final exam. Prereq: Comp Sci 210. Sem hrs: 3 fall.

Comp Sci 471. *Artificial Intelligence.* 3(1). Introduction to major subjects and research areas in artificial intelligence (AI). Topics include: problem solving techniques, knowledge representation, machine learning, heuristic programming, AI languages, expert systems, natural language understanding, computer vision, pattern recognition, robotics, and societal impacts. The course will also explore current and projected uses of AI in the Air Force. Final exam or final project. Prereq: Comp Sci 210 or Comp Sci 212. Sem hrs: 3 fall.

Comp Sci 472. *Autonomous Systems Integration.* 3(1). Cadets will learn the fundamentals of autonomous systems, machine learning and related technologies together with their application. Cadets will accomplish a series of focused projects utilizing modern hardware and software culminating in the creation of an autonomous system that is capable of tackling real-world scenarios. Final Project. Prereq: Comp Sci 471. Sem hrs: 3 spring.

Comp Sci 474. *Computer Graphics.* 3(1). Basic concepts of interactive computer graphics including both vector and raster graphics. Topics include mathematics of 2-dimensional and 3-dimensional geometric transformations, interactive techniques, graphics hardware architectures, graphic algorithms, and realism in computer-generated images. Course includes several computer projects. Final exam or final project. Prereq: Comp Sci 220. Sem hrs: 3 spring.

Comp Sci 483. *Operating Systems.* 3(1). Examines the design and implementation of programs that manage hardware resources and provide abstract interfaces for hardware control. Topics include resource allocation, synchronization primitives, virtual memory, information protection, performance measurement, I/O sub-subsystems, and distributed computing. Final exam. Prereq: Comp Sci 220. Sem hrs: 3 spring.

Comp Sci 495. *Special Topics.* 3(1). Selected topics in computer science. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Comp Sci 496. *Computer Science Seminar.* 3(1). Advanced topics in computer science. Students participate in and lead discussions on significant issues in current computer science research as well as key historical developments. Final report. Prereq: C1C standing and department approval. Sem hrs: 3 spring.

Comp Sci 499. *Independent Study.* 3(0). Individual study and research supervised by a faculty member. Topic established with the department head. Final report. Sem hrs: 3 fall or spring.

- Comp Sci 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Comp Sci 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Comp Sci 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

CREATIVE ARTS

(Creative Art)

Offered by the Department of English and Fine Arts (DFEN)

Creat Art 300. *Creative Writing: Prose (Fiction/Nonfiction).* 3(1). Examines techniques of creative writing. In a workshop atmosphere, students experiment with writing, focusing on prose. The student's own work becomes the subject of discussion and attention. Final project. Prereq: English 211. Sem hrs: 3 fall or spring.

Creat Art 305. *Creative Writing: Poetry, Drama, Adaptation.* 3(1). Examines techniques of creative writing. In a workshop atmosphere, students experiment with writing, focusing on forms such as poetry, drama, and/or the adaptation and reimagining of existing works. The student's own work becomes the subject of discussion and attention. Final project. Prereq: English 211. Sem hrs: 3 fall or spring.

Creat Art 310. *Film Studies.* 3(1). A structured introduction to cinema and/or cinema history. Topics vary but the course will take a thematic or chronological approach to the study of film as an art form, with attention to developing an understanding of film grammar, terminology, narration, forms of genre, and modes of production. Each film is viewed outside of class before it is discussed. Possible topics include, but are not limited to, film and war; horror stories; science fiction; film noir. Repeatable once. Final paper or project. Prereq: English 211. Sem hrs: 3 fall or spring.

Creat Art 315. *Drawing and Visual Design.* 3(1). This course features hands-on lessons to gain practical experience creating still lifes, landscapes, and figures from observation. Students will learn to critically engage with visual artistic expression through written analysis of significant works of art. No drawing or painting experience required. Final project. Prereq: None. Sem hrs: 3 fall or spring.

Creat Art 320. *Painting.* 3(1). This course features hands-on lessons that focus on visual artistic expression through applying traditional and modern acrylic painting techniques. A variety of painting styles, subjects, and approaches are covered. Critical analyses of the creative processes, concepts, and contexts, are included throughout the course, requiring students to reflect and study visual expression over time, geography, and culture. Final project. Prereq: None. Sem hrs: 3 fall or spring.

Creat Art 325. *Art of Photography.* 3(1). This course focuses on photography as an art form. Students will study the history of photography and aesthetics, producing written analyses of significant works of photography. In addition, this course features hands-on lessons to gain, practical experience with photography. Students will use digital cameras to explore a variety of art concepts, styles, and techniques. No art or photography experience is required. Final project and/or exam. Prereq: None. Sem hrs: 3 fall or spring.

Creat Art 330. *Art Seminar.* 3(1). This course features discussions of selected works of art across time, geography, and cultures. Topics may include major artists and periods, as well as neglected and re-emergent figures and artistic movements. Students will learn to critically engage with visual artistic expression through written analysis of significant works of art. No practical art experience required. Final paper or project. Prereq: None. Sem hrs. 3 fall or spring.

Creat Art 335. *Music Seminar.* 3(1). An introductory course featuring discussions of works of music across time, geography, and cultures. Topics may include major composers and periods as well as neglected and re-emergent figures and music. Students will learn to critically engage with musical artistic expression through written analysis of significant musical movements and works of composition. No practical musical experience required. Final paper or project. Prereq: None. Sem hrs. 3 fall or spring.

Creat Art 495. *Special Topics.* 3(1). Selected special topics in Creative Arts. Repeatable once. Final exam or final report. Sem hrs: 3 fall or spring.

Creat Art 499. *Independent Study.* 3(0). Independent study in art, music, or another creative field. Subject and meetings arranged with the instructor. Prereq: department approval. Sem hrs: 3 fall or spring.

- Creat Art 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Creat Art 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Creat Art 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

CYBER

Offered by the Department of Computer and Cyber Sciences (DFCS)

Cyber 256. *Basic Cyber Operations.* 0(2). Cyber operations training supports USAF Academy Outcomes and helps motivate cadets towards a career in the United States Air Force. Cadets will explore the joint cyber mission area during this course with hands-on training designed to teach the fundamentals of operating, attacking, and defending computers and networks. Successful completion of this course fulfills one military training requirement and partially fulfills the requirements for award of the Cadet Basic Cyber badge. Pass/fail. Prereq: Comp Sci 110. Sem hrs: 0 summer.

Cyber 355X. Senior Cyber Instructor Training. 1(1). This course prepares cadets to become Basic Cyber Operations (Cyber 256) Instructors. Focus will be on course development for the upcoming Cyber 256 course including exploring the mission planning process and ethical, legal, and operational challenges of executing missions in and through cyberspace. Cadets will learn and practice instructional skills and how to safely operate a cyber warfare training range. The course concludes with a qualification check ride evaluation. Successful completion will qualify cadets to wear the Senior Cyber Operations badge. This course is offered in the third- or second-class year during the last 20 lessons of the spring semester and is a prerequisite for Cyber 456. Pass/fail. Prereq: Cyber 256 or Department Head approval. Sem hrs: 1 spring.

Cyber 356. Senior Cyber Instructor. 0(0). Selected cadets serve as cadre and instructors for Cyber 256. Completion during the summer fulfills a military training leadership option. Pass/fail. Prereq: Cyber 355 or Department Head approval. Sem hrs: 0 summer.

Cyber 455X. Master Cyber Instructor Training. 1(1). This course prepares cadets to become Basic Cyber Operations (Cyber 256) senior cadre instructors. Focus will be on leading and designing the upcoming Cyber 256 course including exploring the mission planning process and ethical, legal, and operational challenges of executing missions in and through cyberspace. Cadets will learn and practice more advanced operational and leadership skills compared to Cyber 355. The course concludes with a qualification check ride evaluation. Successful completion will qualify cadets to wear the Master Cyber Operations badge. This course is offered in the second-class year during the last 20 lessons of the spring semester. Pass/fail. Prereq: Cyber 356 or Department Head approval. Sem hrs: 1 spring.

Cyber 456. Master Cyber Instructor. 0(0). Selected cadets serve as cadre and leadership for Cyber 256. Completion during the summer fulfills a military training leadership option. Pass/fail. Prereq: Cyber 455 or Department Head approval. Sem hrs: 0 summer.

CYBER SCIENCE

(Cyber Sci)

Offered by the Department of Computer and Cyber Sciences (DFCS)

Cyber Sci 333. Cyber Warfare. 4(2). This cyber security course addresses the fundamentals of understanding cyber vulnerabilities via immersive hands-on techniques. Emphasis is on both theory and practical applications behind computer exploitation and cyber warfare methods. Topics include fundamental security principles, low-level programming, application and programming security to include exploitation techniques, malware reverse engineering, and ethics. Final exam or final project. Prereq: Comp Sci 220 and either ECE 281 or Comp Sci 351. Sem hrs: 4 fall.

Cyber Sci 334. Cyber Defense. 3(1). This second course of a three-semester foundational sequence for Cyber Science majors focuses on the fundamentals of network defense and digital forensics. Topics include security models, vulnerability analysis, defense mechanisms, network design and management, incident response, file system structures, non-volatile memory analysis,

volatile memory analysis, network traffic analysis, file integrity, chain of custody, and ethics. Final exam or final project. Prereq: Comp Sci 467. Sem hrs: 3 spring.

Cyber Sci 405. *Cyber Science Colloquium I.* 0(1). A course for Cyber Science majors that provides for presentation of cadet and faculty research; guest lecturers; field trips; seminars on career and graduate school opportunities; goal setting exercises; and applications for Cyber Science. The class meets once each week. Open only to 1° Cyber Science majors. Pass/fail. Prereq: C1C standing. Sem hrs: 0 fall.

Cyber Sci 406. *Cyber Science Colloquium II.* 0(1). A course for Cyber Science majors that provides for presentation of cadet and faculty research; guest lecturers; field trips; seminars on career and graduate school opportunities; goal setting exercises; and applications of Cyber Science. The class meets once each week. Open only to 1° Cyber Science majors. Pass/fail. Prereq: C1C standing. Sem hrs: 0 spring.

Cyber Sci 431. *Cryptography.* 3(1). Introduces the principles of cryptography and number theory. Topics include: primes, random numbers, modular arithmetic and discrete logarithms, symmetric encryption, public key encryption, key management, hash functions, digital signatures, authentication protocols and protocols for secure electronic commerce. Additional advanced and contemporary topics in cryptography, such as cryptocurrency and quantum computing, will also be introduced. Final exam. Prereq: Comp Sci 210, Comp Sci 211, or Comp Sci 212; Math 340, Math 472, or Math 474; or department approval. Sem hrs: 3 spring.

Cyber Sci 435. *Cyber Operations.* 3(1). This immersive cyber operations course allows cadets to plan and execute realistic cyber operations. Topics include mission planning, risk assessment, the cyber-attack methodology, and the relevant legal, ethical, and strategic concerns. Practical tools and techniques are used within a cyber training range to allow realistic simulation of the cyber operations lifecycle. Particular focus is on the penetration testing of cyber-physical systems such as supervisory control and data acquisitions systems (SCADA). Final project. Prereq: Cyber Sci 333 and Cyber Sci 334. Sem hrs: 3 fall.

Cyber Sci 438. *Cyber Science Capstone I.* 3(2). First course in the two semester capstone design sequence for Cyber Science majors. Applies contemporary concepts and techniques for the team-based analysis, design, implementation, testing, and maintenance of larger scale cyber science projects. Includes development of project management, configuration control, technical communications, and teamwork skills. Final project. Prereq: C1C standing and department approval. Sem hrs: 3 fall.

Cyber Sci 439. *Cyber Science Capstone II.* 3(2). Second course in the two semester project sequence for Cyber Science majors. Continues the applied study of the cyber science topics. Final project. Prereq: Cyber Sci 438. Sem hrs: 3 spring.

Cyber Sci 495. *Special Topics.* 3(1). Selected topics in cyber science. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Cyber Sci 499. *Independent Study.* 3(0). Individual study and research supervised by a faculty member. Topic established with the department head. Final report. Sem hrs: 3 fall or spring.

- Cyber Sci 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Cyber Sci 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Cyber Sci 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

DATA SCIENCE

(Data)

Offered by the Department of Computer and Cyber Sciences (DFCS), Department of Management (DFMA), and Department of Mathematical Sciences (DFMS)

Data 364. *Data Acquisition and Management.* 3(1). Focuses on the collection, processing, structures, memory management, and exploration of data in preparation for subsequent analysis. Introduces tools and techniques for the access and storage of data in structured, semi-structured, and unstructured formats. Data cleansing and curation through Extract, Transform, Load activities are emphasized in both theory and practice with real-world data with goals of preparing data for the spectrum of operational and analytical usages. Prereq: Comp Sci 210, 211, or 212. Sem hrs: 3 fall.

Data 421. *Data Science Capstone I.* 3(2). The first course in a two-semester data science capstone experience. Students will complete the planning, design, and implementation of a significant multi-disciplinary project centered on the acquisition, curation, and analysis of data. Final project. Prereq: C1C Standing in the Data Science major or course director approval. Sem hrs: 3 fall.

Data 422. *Data Science Capstone II.* 3(2). The second course in a two-semester data science capstone experience. Students will continue work on a significant multi-disciplinary project centered on the acquisition, curation, and analysis of data. Final project. Prereq: Data 421 or course director approval. Sem hrs: 3 spring.

Data 495. *Special Topics.* 3(1). Selected topics in data science. Final exam or final project. Prereq: Department approval. Sem hrs: 3 fall or spring.

Data 499. Independent Study. 3(0). Individual study and research supervised by a faculty member. Topic established with the Data Science Program Director. Final report. Sem hrs: 3 fall or spring.

- Data 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Data 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Data 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

ECONOMICS

(Econ)

Offered by the Department of Economics and Geosciences (DFEG)

Econ 201. *Introduction to Economics.* 3.5(2). Introduces the economic way of thinking so that graduates can understand the world around them in economic terms and apply economic concepts to the challenges they will face as Air Force officers. The course focuses on using economic analysis to improve cadets' critical thinking, decision-making, and quantitative literacy skills to make them more effective leaders. Graduates can apply these skills to analyze economic policy, defense economics, engineering economics, and personal finance issues. Graduates will also develop literacy in the national and international economic environment in order to understand contemporary issues and public policy. Students will be able to apply the economic concepts to national security issues. This course is scheduled for the first 30 lessons of the semester. Final exam. Prereq: None. Sem hrs: 3.5 fall or spring.

This course is a contributor to the development and assessment of the following outcomes: 1) Critical Thinking, and 2) National Security of the American Republic in a Complex Global Environment.

Econ 201S. *Introduction to Economics (Scholars).* 3.5(2). This course is the Martinson Honors Program version of the Econ 201 course. Introduces the economic way of thinking so that graduates can understand the world around them in economic terms and apply economic concepts to the challenges they will face as informed citizens and Air Force officers. The course focuses on analyzing contemporary economic issues to enhance cadets' critical thinking, decision-making, and quantitative literacy skills. Graduates can apply these skills to analyze economic policy issues. Final exam or final project. Prereq: Scholar status. Sem hrs: 3.5 fall.

This course is a contributor to the development and assessment of the following outcomes: 1) Critical Thinking, and 2) National Security of the American Republic in a Complex Global Environment.

Econ 332. *Intermediate Microeconomics I: Competitive Markets.* 3(1). The first course in a calculus-based treatment of microeconomic theory. This course focuses on deriving general results in a competitive market, including in-depth analysis of market supply and demand, utility theory, consumer optimization, demand functions, income/substitution effects, production functions, long-run and short-run cost functions, and profit maximization. Final exam. Prereq: Econ 201 and Math 142/152. Sem hrs: 3 spring.

Econ 333. *Intermediate Microeconomics II: Market Failures and Advanced Topics.* 3(1). The second course in a calculus-based treatment of microeconomic theory. This course focuses on relaxing the assumptions of competitive markets and has an in-depth analysis of market failures (monopoly, public goods, externalities, asymmetric information). Game theory is developed and used to study markets with strategic interaction. Advanced topics may include auctions, intertemporal choice, choice under uncertainty, finite resources, and others. Final exam. Prereq: Econ 332. Sem hrs: 3 fall.

Econ 340. *Economics of Inequality*. This course examines inequality of income, wealth, and health with a large focus on the United States. We'll consider factors such as technological advances, globalization, returns to education, government policy, family structure, and the degree of competition within the US. Lastly, we'll examine government policies that impact inequality, including progressive taxation, the minimum wage, unions, public education, immigration policy, and government involvement in healthcare. Final exam or final project. Prereq: Econ 201 and Math 300/356/377 (or equivalent) or course director approval. Sem hrs: 3 fall.

Econ 351. *Comparative Economic Systems*. 3(1). This course is an examination of the world's major economic systems including capitalism, market socialism, and planned socialism. These systems will be examined through a critical analysis of the theoretical literature and case studies. Areas of study include the United States, the European Union, China, the Middle East, and parts of the developing world. Both economic and non-economic aspects of these countries' systems will be examined to come to an understanding of how these countries work and why countries experience different results despite similarities in their systems. Final exam or final project. Prereq: Econ 201; Econ 355 or Econ 374. Sem hrs: 3 fall.

Econ 355. *Principles of Macroeconomics*. 3(1). Foundations of key macroeconomic principles. Analysis of the macroeconomics of a nation at an aggregate level. Analytical models are developed and used to analyze the impacts of alternative government economic policies, introducing Keynesian, classical and other macroeconomics schools of thought. Topics include inflation, unemployment, national income, the banking system, fiscal and monetary policy, debt, deficits, and international finance and trade (including exchange rates and barriers to trade). Focuses on domestic and global economic environments of organizations and discusses current and historical issues in the macroeconomy relating to real-world events. Final exam or final project. Prereq or Coreq: Econ 201. Sem hrs: 3 fall.

Econ 356. *Intermediate Macroeconomics*. 3(1). Analysis of national income, employment, price level determination, growth, monetary, and fiscal policies. Contemporary macroeconomic issues are explored using both closed and open economy scenarios. Modern business cycle theory and stabilization policy are examined from the vantage point of varying macroeconomic schools of thought by comparing and contrasting Keynesian, classical and other competing theories. Final exam or final project. Prereq: Econ 355. Sem hrs: 3 spring.

Econ 361. *Statistics and Research Methods for Economists*. 3(1).

This course provides an integrated introduction to modern empirical research, statistics, and research ethics in economics. Students will study foundational concepts in probability and statistics and use statistical software to perform descriptive, inferential, and causal analyses, with a particular emphasis on economic data. Analysis techniques will include (but are not limited to) linear regression, measures of central tendency and variability, normality, and hypothesis testing. Final project, final exam, or research paper. Prereq: Math 142/152. Coreq: Econ 201 and Math 300. Sem hrs: 3 fall

Econ 365. *Econometrics I*. 3(1). Application of regression analysis and other statistical tools to economic data, concentrating on methodology, econometric model building, interpretation,

statistical inference, and applications to economic and policy issues. Final exam or final project. Prereq: Econ 361, Math 356, or Math 377. Sem hrs: 3 spring.

Econ 367. *Industrial Organization*. 3(1). The study of Industrial Organizations (IO) in economics explores the impacts and incentives associated with a variety of market and management structures, such as monopoly, oligopoly, public vs private provision, horizontal and vertical integration, price discrimination, strategic behavior, research and development decisions, and industry entrance and exit. This course expands on basic principles covered in traditional microeconomics course sequences and introduces real-world complexity into the theoretical framework. Participants in this course will apply these principles specifically to industries that support Air and Space Force capabilities and operations such as aerospace, space, robotics, cyber, energy, biotechnology, and strategic materials. Final exam or final project. Prereq: Econ 332 and 333 (or equivalent) or consent of instructor. Sem hrs: 3 spring.

Econ 369. *Causal Pathways: A Social Science Approach to Interdisciplinary Problems*. 3(1). Individual and societal decisions hinge on the expected consequences of those decisions. How does serving in the military affect later career outcomes? How does local air pollution impact health of residents? Despite the importance of understanding the causal effects of individual actions and policies, measuring those impacts empirically is challenging. This course will introduce cadets to systematic methods designed to estimate causal impacts, focusing on settings where experimentation is not practical. Cadets will evaluate intuition behind those methods. Final exam or final paper. Prereq: Math 300 or equivalent; cadets may not receive credit for both Econ 369 and Econ 365. Sem hrs: 3 spring.

Econ 374. *Survey of International Economics*. 3(1). This course spends the first part exploring the foundations of key macroeconomic principles and developing the tools that can be used to analyze the macroeconomic goals and performances of economies around the world. The second part is spent on the examination of current issues in the commercial relations among nations, including international trade, international finance, economic development, and the multinational enterprise. This course is designed for FAS majors and any interested cadets who are not majoring in economics. Final exam or final project. Prereq: Econ 201. Sem hrs: 3 spring.

Econ 377. *Financial Markets*. 3(1). Provides an introduction to analysis of financial markets looking at the characteristics, valuations, and functions of various financial instruments (mutual funds, stocks, bonds, real assets, options); emphasis is placed on developing investment policy and portfolio objectives; course rigorously addresses the mathematics of diversification to include statistical measures of variation and quadratic programming for portfolio optimization. Final exam or final project. Prereq: Econ 333 or Ops Rsch 331 and either Math 356 or Math 377 (or department approval). Sem hrs: 3 fall.

Econ 411. *Introduction to Game Theory*. 3(1). This course will introduce the concepts required to analyze strategic situations, or situations in which a player's payoff depend on his choices and those of the other players. Topics will include zero-sum and nonzero-sum games, normal and extensive form games, the implications of informational asymmetries on these strategic situations,

auctions, and bargaining models. Developing the ability to think strategically is valuable to everyone, but this course will be especially important for those studying any of the social sciences. Final exam or final project. Prereq: Econ 333 or Ops Rsch 331. Sem hrs: 3 fall.

Econ 422. *Labor Economics*. 3(1). This course examines how people make decisions regarding their participation in the labor market. Included in this course is the examination of government policies (such as social security, minimum wage, etc.) and their impacts of the supply and demand of labor. Wage determination for women and minorities will be discussed in light of the supply and demand forces in the influence of the human capital decisions made by individuals. Final exam or final project. Prereq: Econ 333 (or Ops Rsch 331) and Econ 365. Sem hrs: 3 spring.

Econ 423. *Managerial Economics*. 3(1). Traditional economic theory for cadets not majoring in economics emphasizing the principles of product and factor pricing, allocation and employment of resources, and the implications of various market structures. In addition to these microeconomic topics, the use of other economic tools which may aid the decision maker will be discussed including topics in macroeconomics and international economics. Final exam or final project. Prereq: Econ 201 and Mgt 303 or AIC approval. Semester hrs: 3 fall.

Econ 440. *Development of Economic Thought*. 3(1). This course explores the development of economic thought and economic methodology from the mercantilists to current schools of economic thought. The focus will be on economics as an evolving body of thought emphasizing the movement from classical economics to neoclassical economics as a foundation for modern economic theory. The student will gain an appreciation of how today's economic theories have been influenced by the important economic thinkers from the past, such as Adam Smith, Karl Marx, and John Maynard Keynes. Final exam or final project. Prereq/Coreq: Econ 201. Sem hrs: 3 spring.

Econ 447. *Quantitative Economic Methods*. 3(1). Analysis of economic problems through statistical and mathematical methods and the use of quantitative models. Final exam. Prereq: Econ 333 or Ops Rsch 331 (or department approval). Sem hrs: 3 fall.

Econ 450. *International Economics*. 3(1). This course develops and employs economics models to help analyze and explain the patterns of international trade, immigration and capital flows; assess the impact of international trade on workers, capital owners, and land owners; explore the motives and consequences of protectionism; and examine the strengths and weaknesses of a variety of exchange rate mechanisms and trading partnerships like the European Union and the North American Free Trade Agreement. The course relies heavily on economic modeling techniques developed in the micro- and macroeconomics curriculum. Final exam or final project. Prereq: Econ 333 and Econ 356 (or departmental approval). Sem hrs: 3 fall.

Econ 454. *Economics of Development and Conflict*. 3(1). This course examines the underlying theory, historical experiences, and lessons learned associated with economic development efforts, with special emphasis on countries at high risk of civil conflict or government failure. Students will assess the conventional wisdom on development programs using an analytical framework that

emphasizes the role of incentives, the importance of valid assumptions, and impact of the social environment in determining the prospects for successful development. Due to its strong emphasis on African development, this course is ideal for Foreign Area Studies majors in the Africa track. Prereq: Econ 201; Econ 355 or Econ 374. Final exam or final project. Sem hrs: 3 spring.

Econ 465. *Econometrics II*. 3(1). Continues development of additional econometric techniques, identification and treatment of violations of modeling assumptions, and complex applications of econometric analysis to economic and policy issues. Final exam or final project. Prereq: Econ 365. Sem hrs: 3 fall.

Econ 466. *Advanced Econometrics*. 3(1). Explores advanced topics in econometrics and further application of techniques. Topics covered may include time-series methods, maximum likelihood estimation, generalized method of moments, Bayesian econometrics, or bootstrapping. The course may also focus on application of econometric analysis to specific topics selected by cadets or the instructor. Final exam or final project. Prereq: Econ 465. Sem hrs: 3 spring.

Econ 473. *Public Economics*. 3(1). This course explores the role of the government (public sector) in a market economy. Students will use economic principles to analyze when government interventions are justified, which government policies are most effective in achieving their stated goals, and the effects of such policies on behavior. Students will then use these economic principles to evaluate contemporary public policies in the United States such as public education, government-sponsored health care, Social Security, other social insurance programs, and taxation. Final exam or final project. Prereq: Econ 333 or Ops Rsch 331 or department approval. Sem hrs: 3 fall.

Econ 475. *Money, Banking and Financial Institutions*. 3(1). Advanced treatment of money and its role in the economy. Critical analysis of financial structure and institutions, the Federal Reserve System, and the increasing importance of the global financial arena. Special emphasis is placed on financial events and policy issues. Final exam or final project. Prereq: Econ 356 (or department approval). Sem hrs: 3 spring.

Econ 476. *The Economics of Sports*. 3(1). This applied economics course explores aspects of the economics of sports and sports leagues. We will consider the business and economics of professional team sports and sports broadcasting and analyze competitive balance policies, player relations issues including the drivers of players' salaries, the public finance nature of sports teams and stadium financing, antitrust issues, and the nature of amateurism in collegiate sports. Final exam or final project. Prereq: Econ 201, Econ 333 (or Ops Rsch 331), and Econ 365. Sem hrs: 3 spring.

Econ 480. *Defense Economics*. 3(1). Defense economics is the field of national economic management concerned with the economic process and effects of military expenditures in peacetime and in conflict. This course develops understanding and familiarity with defense economics by introducing cadets to both the government and industry perspective, with an emphasis on using applied economic research to explore and assess relevant real-world case

studies from the national security and national defense domains. This is a course designed primarily for first-class cadets. Final project. Prereq: Econ 333 or Econ 423; C1C standing in the Economics major, or department approval. Sem hrs: 3 spring.

Econ 481. *Applied Economic Research Capstone I.* 3(1). Students will conduct an applied economic research project that uses economic principles and data analysis to address a real-world problem. Students will identify the scope of the problem, review relevant literature, identify analytic procedures, initiate data collection, and perform other aspects of the research as directed by a faculty mentor. Course director may require students to identify a project before enrolling in the course. This is a capstone course designed primarily for first-class cadets. Final project. Prereq: C1C standing in the Economics major or course director approval. Sem hrs: 3 fall.

Econ 482. *Applied Economic Research Capstone II.* 3(1). Students will conduct an applied economic research project that uses economic principles and data analysis to address a real-world problem. Students will continue projects started in Econ 481, completing data collection, conducting analysis, communicating findings to relevant stakeholders, and performing other aspects of the research as directed by a faculty mentor. This is a capstone course designed primarily for first-class cadets and substitutes for Econ 480. Final project. Prereq: Econ 481; C1C standing in the Economics major or course director approval. Sem hrs: 3 spring.

Econ 495. *Special Topics.* 3(1). Selected topics in economics of either an advanced treatment or general interest orientation. Final exam or final project. Sem hrs: 3 fall or spring.

Econ 499. *Independent Study.* 3(0). Tutorial investigation of a specific area of economics. Final report. Sem hrs: 3 fall or spring.

- Econ 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Econ 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Econ 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

ELECTRICAL AND COMPUTER ENGINEERING **(ECE)**

Offered by the Department of Electrical and Computer Engineering (DFEC)

ECE 210. *Introduction to Electrical and Computer Engineering.* 1(1). An introduction to Electrical and Computer Engineering principles through signal analysis and electronic system design of embedded hardware/software systems. This course is intended for cadets who have declared or are considering declaring the Electrical Engineering and Computer Engineering majors. Primary emphasis is placed on exploring concepts through the use of simulation, lab exercises, and projects. Lab. Final project. Pass/Fail. Prereq: None. Sem hrs: 1 fall.e

ECE 215. *Principles of Electronic Cyber Warfare.* 3(1). An introduction to electrical and computer engineering principles applied to Air Force electronic and cyber systems. Topics include resistive circuit analysis, power generation and storage, fundamentals of signal processing, digital

and analog communications, radio-frequency (RF) systems, radar, jamming, and electronic warfare. This course is a core substitute for ECE 315 and is intended for cadets who have declared or are considering declaring the Electrical and Computer Engineering major. Final exam. Coreq: Comp Sci 110 and Math 142. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

ECE 215S. *Principles of Electronic Cyber Warfare for Academy Scholars.* 3(1). An introduction to electrical and computer engineering principles applied to Air Force electronic and cyber systems, and systems of international strategic importance. Topics include resistive circuit analysis, power generation and storage, fundamentals of signal processing, digital and analog communications, radio-frequency (RF) systems, radar, jamming, and electronic warfare. This scholars course will place a greater emphasis on the economic, political and strategic dependencies on electrical power production and distribution. Upon gaining a fundamental understanding of electrical engineering concepts for power production and distribution, students will investigate recent events where the fragility of our nation's power grid highlights potential vulnerabilities and impacts to our ability to project power. This course is a core substitute for ECE 315 and is intended for cadets accepted into the scholars program or have declared or are considering declaring the Electrical and Computer Engineering major. Final exam. Prereq/Coreq: Comp Sci 110 and Math 142. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

ECE 245. *Differential Equations with Circuit Applications I.* 3(1). An introduction to the analysis of linear ordinary differential equations, circuit analysis and system design. Topics include circuit models and simulations of electrical devices and systems, nodal and mesh analysis, Thevenin and Norton equivalent circuits, dependent sources, operational amplifier circuits, transient, sinusoidal, steady-state and frequency response of first-order circuits. Differential equations solutions include separation of variables, integrating factors, and method of undetermined coefficients. Final exam. Prereq: Math 142. Sem hrs: 3 fall or spring.

ECE 281. *Digital Design and Computer Architecture.* 3(1). An introduction to the fundamental principles of logic design. Includes Boolean algebra, combinational and sequential logic circuits with basic design and analysis techniques, hardware description languages, FPGAs, and an introduction to computer architecture. Laboratory projects include the design and analysis of digital systems, computer architecture, and computer microarchitecture. Lab. Final Exam or Final Project. Sem hrs: 3 spring.

ECE 311. *Electric Power.* 3(1). The course covers applications of electrical power including the fundamentals of generation, transmission, distribution, and uses of electrical energy. Topics include sinusoidal steady-state circuit analysis, single-phase and three-phase AC power, per unit analysis, generators, transformers, transmission lines, renewable energy, and power system analysis. Students are introduced to by-hand and simulation solutions to load flow, symmetrical fault analysis, and economic dispatch problems. Lab. Final exam. Prereq: ECE 245. Sem hrs: 3 spring

ECE 315. *Principles of Air Force Electronic and Cyber Systems.* 3(1). An introduction to electrical and computer engineering principles applied to Air Force electronic and cyber systems through analysis and evaluation of signals and systems. Topics include signal representation, the realization of analog, digital, and radio-frequency (RF) systems using electronic devices, and their application in areas such as electrical power generation and distribution, digital networks, communication, radar, and electronic warfare. Final exam. Prereq: Comp Sci 110 and Math 142. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

ECE 321. *Electronics I.* 3(2). An introduction to semiconductor electronics. Covers qualitative and quantitative analysis of semiconductor devices to include diodes, bipolar junction transistors and the field effect transistor. Includes modeling, analysis, and design of related circuits, including combinational and sequential digital logic. Lab. Final exam. Prereq: ECE 245. Sem hrs: 3 fall.

ECE 332. *Differential Equations with Circuit Applications II.* 3(1). A continuation of differential equation applications, circuit analysis and systems design. Differential equation topics extend solutions covered in ECE 245 to second order equations and introduce transform solution techniques. Circuit analysis and design topics include natural, step and sinusoidal steady-state responses of second order circuits, Laplace transform techniques with circuit analysis applications, frequency response of first- and second-order circuits and analog filter design. Final exam. Prereq: ECE 245. Sem hrs: 3 fall or spring.

ECE 333. *Signal Processing and Linear Systems.* 3(1). An introduction to analog and digital signal processing by linear, time-invariant systems. Topics include continuous and discrete-time signal characterization, using Laplace and z transforms, as well as continuous and discrete-time convolution and Fourier-analysis. Final exam. Prereq: ECE 332. Sem hrs: 3 spring.

ECE 343. *Electromagnetics.* 3(1). The study of Maxwell's Equations, plane waves, transmission, and radiating systems. Topics include wave propagation, transmission lines, waveguides, and antennas. Lab. Final exam. Prereq: Physics 215 and ECE 346. Sem hrs: 3 spring.

ECE 346. *Engineering Mathematics with ECE Applications.* 3(1). Provides advanced mathematical concepts and skills required to succeed in Electrical Engineering. Topics include: Ordinary and Partial Differential Equations, Linear Algebra, Vector Calculus (Green's Theorem, Stokes' Theorem, and Divergence Theorem) and Fourier Analysis. The course will also look at numerical approaches to each of these topics. Final exam. Prereq: Math 243 and ECE 245. Sem hrs: 3 fall.

ECE 348. *Telecommunication Principles.* 3(1). Introduces the principles of telecommunication systems with application in cyber operations and satellite communications. Topics include physical mediums, signal modulation and propagation, and telecommunication network devices and protocols. Attention is devoted to developing effective telecommunication engineering

practices, emphasizing the ability to overcome common challenges, including noise, propagation delay, and channel security. This course is not intended for ECE majors. Final exam. Prereq: ECE 315. Sem hrs: 3 fall.

ECE 360. *Instrumentation Systems*. 3(1). Principles and design of modern data acquisition and instrumentation systems for non-electrical engineering majors. Includes measurement techniques, transducers, analog and digital data processing systems, and displays. Lab. Final exam. Prereq: ECE 315. Sem hrs: 3 spring.

ECE 373. *Digital VLSI Circuits*. 3(2). A continuation of the study of electronics for Computer Engineering majors. Applies diode and field effect transistor concepts to the design and implementation of Very Large Scale Integrated (VLSI) circuits. Applies VHDL descriptions in concert with logic synthesis tools to generate mask level implementations of physical VLSI circuit design. Lab. Final project. Prereq: ECE 281 and ECE 321. Sem hrs: 3 spring.

ECE 382. *Embedded Computer Systems I*. 3(1). Provides a broad understanding of microcontroller systems and embedded programming practices. The microcontroller and programming principles presented provide a foundation that can be used in other courses to simplify and improve projects. Includes design, application, interfacing, assembly language, C programming language, and microcontroller hardware / subsystems. Laboratory projects emphasize computer architecture implementation, assembly language programming, and microcontroller analysis. Lab. Final project or Final exam. Prereq: Comp Sci 110 and ECE 281. Sem hrs: 3 fall.

ECE 383. *Embedded Computer Systems II*. 3(2). A course in the design of digital systems using microprocessors, special-purpose processors, and field-programmable arrays (FPGAs). Students investigate processor architecture tradeoffs, implementation of high-speed digital circuits, configuration of processors on FPGAs, input/output, peripherals, hardware-software interfacing techniques, memory systems, and bus features, including serial communications. Lab. Final project. Prereq: ECE 382. Sem hrs: 3 spring.

ECE 386. *AI Hardware Applications*. 3(1). Students will use Artificial Intelligence pipelines and frameworks to train and deploy machine learning models onto various computational platforms. Deployments will consider engineering tradeoffs between model size, hardware constraints, and system design grounded in an understanding of computer architecture. Students will use Python to implement training on cloud-based hardware accelerators. Inference will be conducted on microprocessor and GPU boards. Emphasis will also be placed on the balance of AI provided prediction with human provided judgment. Lab. Final project or final exam. Prereq: Comp Sci 110 and ECE 281 or instructor approval. Sem hrs: 3 fall.

ECE 387. *Introduction to Robotic Systems*. 3(1). A course in practical skills in object-oriented programming in a Linux operating system for multiple robotic applications. Students will utilize software frameworks called Robot Operating System (ROS) to write, compile, debug, and run C++/Python programs. Includes design, evaluation, analysis, and demonstration of robotic tasks

such as closed-loop control, state estimation, and map building. Lab. Final project or final exam. Prereq: Comp Sci 206, Comp Sci 210, Comp Sci 211, Comp Sci 212, or department approval. Sem hrs: 3 spring.

ECE 423. *Power Electronics*. 3(1). An introduction to the analysis, design, simulation, control, prototyping, and evaluation of power electronics circuits. Topics include the mathematics necessary to analyze power-electronics circuits, heat sink and gate driver analysis, dc-to-dc voltage-level converters, rectifiers (ac-to-dc converters) and inverters (dc-to-ac converters). The course investigates the efficiency and harmonic performance of converters. Lab. Final project or final exam. Prereq: ECE 321. Sem hrs: 3 Spring.

ECE 434. *Digital Signal Processing*. 3(1). Advanced digital signal processing. Topics include classical solutions to linear difference equations, the z-transform, digital filter design, quantization effects of Analog-to-Digital and Digital-to-Analog converters, frequency analysis of decimation and interpolation, discrete Fourier transform, and the fast Fourier transform. Final project. Prereq: ECE 333. Sem hrs: 3 fall.

ECE 444. *Introduction to Antenna Theory and Design*. 3(1). Introduction to antenna theory and design via a project oriented class. Topics include reflection coefficient, impedance matching, antenna gain, polarization, and radiation patterns. Maxwell's equations applied to dipoles and monopoles with theory extended to other antennas such as phased-array antenna for beam steering. Microwave laboratory measurements (s-parameters) and antenna pattern measurements performed in lab/anechoic chamber. Field trip to antenna installation site. Lab. Final project. Prereq: ECE 343 or department approval. Sem hrs: 3 fall or spring, as available.

ECE 446. *Applied Communication Systems*. 3(1). An introduction to modern electronic communications systems with application in satellite communications. The performance of various analog and digital modulation and detection methods are analyzed. Coverage includes theory of operations of various modulation systems, effects of random noise, bandwidth, propagation channels, and other design constraints. ECE 446 is not appropriate for ECE majors. Lab. Final exam. Prereq: Math 346, Math 356 or Math 377, and Engr 342. Sem hrs: 3 fall.

ECE 447. *Communications Systems*. 3(1). An introduction to modern electrical communications. The performance of various modulation and detection methods for both analog and digital systems are analyzed. Coverage includes theory of operation, effects of random noise, bandwidth and other communication design constraints. Additionally, students will learn basic principles of operation and practical applications of Software Defined Radios (SDRs), using modern software packages such as GNU Radio and Python. Lab. Final Exam. Prereq: ECE 333 and ECE 346. Sem hrs: 3 fall.

ECE 448. *Applications of Software Defined Radios*. 3(1). A course in practical telecommunications using software-defined radios (SDRs). Building on the introduction to SDRs provided in ECE 447, students will apply SDRs to implement modern communications techniques, such as: amplitude/frequency/phase modulation, filtering, encoding/decoding, sampling, analog-to-digital conversion, multipath, channel noise, and antenna selection. Students will use

contemporary software tools, such as Python and GNU Radio Companion to implement complete transmitting and receiving systems using SDRs. Final project. Prereq/Coreq: ECE 447. Sem hrs: 3 spring.

ECE 463. *Capstone Design Project I.* 3(2). First course in the two-semester capstone design sequence for Electrical Engineering majors. Presents contemporary methods essential to design, planning, and execution of complex electrical and computer engineering projects. Includes instruction in contemporary Air Force project management methods and tools, organization of requirements, software and hardware specification and design, hardware fabrication, quality assurance, and testing. Planning and prototyping the semester-long design project is completed in this course. Final project. Prereq: C1C standing and department approval. Sem hrs: 3 fall.

ECE 464. *Capstone Design Project II.* 3(2). Second course in the two-semester project design sequence for Electrical and Computer Engineering majors. Continues study of the system software and hardware lifecycle. Emphasis is placed on system design, appropriate implementation in hardware and software, analysis, testing and evaluation, quality assurance, and documentation. The course uses a design project to emphasize Air Force applications. Final project. Prereq: ECE 463 or department approval. Sem hrs: 3 spring.

ECE 472. *Instrumentation System Fundamentals.* 3(1). Introduction to instrumentation components. Analysis and design of advanced operational amplifier circuits, including Schmitt-trigger, waveform generators, instrumentation amplifiers, and active filters. Discussion and practical design of transducer circuits to instrument various processes. Lab. Final exam. Prereq: None. Sem hrs: 3 fall.

ECE 473. *Introduction to CMOS VLSI Circuit Design.* 3(1). Introduction to design of Very Large Scale Integrated (VLSI) circuits in silicon Complementary Metal Oxide Semiconductor (CMOS) technology. Course includes discussion of the CMOS fabrication technology, combinational and sequential logic structures, analog circuit structures, computer-aided layout and simulation techniques, load/timing analysis and integrated systems design techniques/considerations. Lab. Final project. Prereq: Department approval. Sem hrs: 3 fall.

ECE 484. *Advanced Digital System Design.* 3(2). This course is a culmination of the digital design sequence using Application Specific Integrated Circuits and field-programmable gate arrays (FPGAs). Students investigate processor architecture tradeoffs, implementation of high speed digital circuits, configuration of digital systems on FPGAs, memory systems, and bus features. This is accomplished through a series of design exercises. Final project. Prereq: ECE 373 or ECE 383, or department approval. Sem hrs: 3 fall.

ECE 485. *Advanced Computer Architecture.* 3(1). This final course in the Computer Systems Area of Study quantitatively examines trade-offs in the design of high-performance computer systems. Topics include price/performance, instruction sets, hardwired control versus microprogramming, memory hierarchy, cache memory, virtual memory, pipelining, reduced instruction set computers (RISC), input/output, and parallel processing. Final project will examine

state-of-the-art processors and computers. Lab. Final project. Prereq: Math 300, Math 356, or Math 377; and ECE 382. Sem hrs: 3 spring.

ECE 487. *Advanced Robotics*. 3(1). An introduction to machine learning covering theoretical foundations, algorithms, methodologies, and applications. The course will cover topics in supervised methods for regression and classification, decision trees, neural networks, support vector machines, pattern recognition, and Bayesian parametric learning. Additionally, this course will discuss recent applications of machine learning, such as robotic control, data mining, and autonomous navigation. Labs and final project. Prereq: ECE 346 and Math 356/377 or department approval. Sem hrs: 3 fall

ECE 495. *Special Topics*. 3(1). Selected topics in electrical engineering. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

ECE 499. *Independent Study*. 3(0). Individual study and research in an engineering design topic approved by the department head. Final paper and oral report. Prereq: Department approval. Sem hrs: 3 fall or spring.

- ECE 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- ECE 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- ECE 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

ENGINEERING

(Engr)

Offered by various departments within the Engineering Division

Engr 341. *Linear Systems Analysis and Design*. 3(1). Analysis and design of linear systems. Includes modeling of electrical and mechanical systems; characterization of physical systems using linear, constant-coefficient differential equations and state-space models; Convolution using Laplace transform techniques; identification of system response using frequency response and Bode plots; specification of design criteria in the s-domain; and modification of system parameters to satisfy design requirements. MATLAB™ and Simulink™ are introduced as simulation tools and as a computer interface for analysis and design. Lab. Final exam. Prereq: Math 245. (Administered by the Department of Astronautics). Sem hrs: 3 fall.

Engr 342. *Linear Control System Analysis and Design*. 3(2). Formulation and analysis of the linear control problem by transform methods. Synthesis of linear control systems emphasizing the root locus and Bode methods. Includes laboratory analysis and synthesis with real hardware and/or MATLAB™ and Simulink™ simulation. Final project. Prereq: Engr 341 or Mech Engr 325 or ECE 332 or department approval. (Administered by Department of Astronautics). Sem hrs: 3 spring.

Engr 346. *Engineering Mathematics with Applications.* 3(1). Advanced engineering mathematics concepts, theory, and tools necessary to solve problems in advanced engineering courses. Topics include linear algebra and vector spaces(basis, orthogonality, least-squares approximation, four fundamental subspaces); differential and integral vector calculus (Green's, Stokes', and Divergence Theorems); systems of linear ordinary and partial differential equations (including boundary value problems); linearization and stability; static optimization (KKT conditions, analytically and numerically); orthogonal functions and Fourier series; frequency domain (Laplace and Fourier transformations); and practical numerical methods for solving engineering problems. Final Project. Prereq: Math 245. Sem hrs: 3 fall or spring.

Engr 400. *Divisional Seminar.* 3(1). An interdisciplinary study of engineering concepts, with emphasis on applications of fundamental principles. Includes case study, research, preparation and presentation of at least one major paper. Term paper or final project. Prereq: C1C Honors Degree candidate or approval of the Division Chair. (Administered by a selected engineering department). Sem hrs: 3 spring.

Engr 401. *Engineering Divisional Core Substitute.* 3(0). This course can only be awarded for coursework accomplished during a semester of study abroad (CSSAP), international exchange (CSEAP), or service academy exchange (SAEP). With applicable Department Head or Division Chair approval, this course can fulfill the core requirement for Astr Engr 310, Aero Engr 315, ECE 315, or the Science & Technology Energy/Systems Option. Sem hrs: 3 fall or spring.

Engr 402. *Professional Engineering Development.* 0.5(1). Review of mathematics, chemistry, properties and strengths of materials, statics, dynamics, computers, electricity and magnetism, thermodynamics, fluid mechanics, engineering economics, ethics, and business practices in preparation for the national Fundamentals of Engineering exam administered at the end of the course by the National Council of Examiners for Engineering and Surveying. A fee must be paid by the student to take the exam; therefore, taking the exam is not required. Prereq: C1C standing; accredited engineering major. Pass/fail. Sem hrs: 0.5 spring.

Engr 443. *Advanced Control Theory and Design.* 3(1). Introduction to advanced control techniques. Topics include state-space fundamentals, state feedback control, optimal control methods, estimation theory, and non-linear controls topics. Methods are applied to the design of control systems for aircraft and spacecraft. MatLab™/Simulink™ will be employed in three design projects. Final exam. Prereq: Math 346, Math 356 (or Math 377), and Engr 342 (or ECE 333 or Mech Engr 325 or Aero Engr 457). (Administered by Department of Astronautics). Sem hrs: 3 fall.

Engr 495. *Special Topics in Engineering.* 3(1). Selected topics in engineering, administered by various Engineering departments. Prereq: Approval of controlling department's head. Sem hrs: 3 fall or spring.

ENGLISH

(English)

Offered by the Department of English and Fine Arts (DFEN)

English 111. *Introductory Composition and Research.* 3(1). Teaches fundamentals of written academic inquiry and introduces foundational concepts in argumentation and rhetorical studies. Students learn to read and write across multiple genres, honing their ability to analyze complex texts and write analytic arguments that rely on the use of credible, relevant sources. Students develop their ideas by completing sequenced writing assignments that introduce norms of academic argumentation, including the development, presentation, and documentation of researched materials. Process-oriented writing practice, which includes guided reflection and peer review, provides students with the opportunity to learn revision practices that foster critical thinking and clear communication. Final paper. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Clear Communication outcome.

English 111S. *Introductory Composition and Research.* 3(1). Teaches the fundamentals of written academic inquiry and introduces students to foundational concepts in argumentation and rhetoric. Students learn to read and write across multiple genres, honing their ability to analyze complex texts and compose analytic arguments that rely on the use of credible, relevant sources. Students develop their ideas by completing sequenced writing assignments that introduce the norms of academic argumentation, including the discovery, presentation, and documentation of researched materials. Process-oriented writing practice, which includes guided reflection and peer review, will provide students with the opportunity to learn revision practices that hone critical thinking and clear communication skills. Final paper. Prereq: MHP approval. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Clear Communication outcome.

English 200S. *Literature and the Fine Arts I (Medieval Period to the Enlightenment).* 3(1). Interdisciplinary course that introduces students to the intellectual history of Western civilization through literature and the arts. The course lays the foundation for further study in the disciplines of English and the fine arts, promoting interdisciplinary and critical thinking. English 200S is a core substitute for English 211 and can be taken by cadets enrolled in the Martinson Honors Program or by course director approval. Upon completion of English 200S, students may enroll directly in English 400S. Final project. Prereq: English 111 and Scholar status. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Clear Communication outcome.

English 211. *Literature and Intermediate Composition.* 3(1). Introduces students to literature, an art form requiring a deliberative method of reading that addresses questions of meaning in the context of complex and unfamiliar situations. These are the sorts of situations within which cadets will be charged to provide active leadership as officers and citizens. Accordingly, students learn

to make sense of a text's significant formal aspects; to analyze the concrete details of its contents and contexts; and to argue for its cultural values with rhetorical clarity and intellectual sophistication. The ultimate goal is to develop life-long close readers, well-reasoned and ethical communicators, and officer-citizens who value both clarity and complexity. Final paper. Prereq: English 111. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Clear Communication outcome.

English 211S. *Literature and Intermediate Composition*. 3(1). English 211S meets the goals of English 211 as detailed in the above description, and services cadets in the Martinson Honors Program (MHP). This course is the MHP version of English 211. Introduces students to literature, an art form requiring deliberative method of reading that addresses questions of meaning in the context of complex and unfamiliar situations. The readings thus offer simulations within which cadets will explore their potential for active leadership as officers and citizens. Students learn to make sense of a text's significant formal aspects; to analyze the concrete details of a text's contents and contexts; and to argue for its cultural values with rhetorical clarity and intellectual sophistication. The ultimate goal is to develop life-long close readers, well-reasoned and ethical communicators, and officer-citizens who value both clarity and complexity. Final paper. Prereq: English 111 and Scholars status. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Clear Communication outcome.

English 212. *Literature and Intermediate Composition: Digital Humanities*. 3(1). English 212 is designed primarily for majors in the Engineering and Basic Sciences Divisions, but open to all majors. The course explores Digital Humanities methods for computationally based analysis of literature. As in English 211, students in English 212 will be introduced to literature as an art form, learn to make sense of a text's significant formal aspects, analyze the concrete details of a text's contents and contexts, and argue for its cultural values with rhetorical clarity and intellectual sophistication. The ultimate goal is to develop life-long close readers, well-reasoned and ethical communicators, and officer-citizens who value both clarity and complexity through understanding how to blend various computationally-based methods of analysis with traditional literary methods of analysis. Final paper. Prereq: English 111. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Clear Communication outcome.

English 300. *Literary and Linguistic Problems*. 3(1). A sustained study of a specified literary and/or linguistic problem that presents difficulties and therefore demands careful research methods, special resources, and clear argumentation. Concentrates on close reading and methods of interpretation, surveys various research resources and archives, and develops the ability to formulate and defend a complex argument with compelling evidence. Possible topics include but are not limited to, Russian formalism, poststructural approaches to modern literature, and postcolonial approaches in a global environment. Repeatable once. Final paper or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 303. *Classical Literature.* 3(1). Classical literature encompasses a broad range of texts, authors, and genres from roughly the 8th century BCE through the 4th century CE. The course reflects the vibrant literary exchange of the Mediterranean world in antiquity and may be period-focused or transhistorical. Topics vary but may include mythology, the idea of the hero, tragedy and democracy, imperial epic, literature and material culture in the ancient world, and classical reception. Repeatable once. Final paper, project and/or exam. Prereq: English 211. Sem hrs: 3 fall or spring.

English 308. *Medieval and Renaissance Literature.* 3(1). A study of literature from the medieval and/or early modern period and the cultural and historical contexts shaping it. Through close reading of primary texts, students will study figures, movements, and genres of the period, including but not limited to the relationship between oral and written cultures, the history of the English language, conceptions of authorship, the relationship between print and performance, the emergence of capitalism, the centralization of power and rise of the nation-state, pre-modern histories of race and colonialism, religious conflict and the Protestant reformation, and constructions of gender and sexuality. Repeatable once. Final paper, project and/or exam. Prereq: English 211. Sem hrs: 3 fall or spring.

English 313. *Seventeenth- and Eighteenth-Century Literature.* 3(1). The literature of this period analyzes the transition from the early modern to the modern world, and may focus on one or both centuries, British or American. Literature may engage with national and cultural conflicts, religious wars, capitalism, slavery, colonialism, the English Civil Wars, the Industrial Revolution, the Scientific Revolution, the Enlightenment, philosophies of freedom and democracy, the American Revolution, women's rights, professional armies, and trans-continental wars of Empire. Repeatable once. Final Paper and/or Final Exam. Prereq: English 211. Sem hrs: 3 fall or spring.

English 319. *Nineteenth-Century Literature.* 3(1). A study of literature from the nineteenth century and the cultural and historical contexts shaping it. The course may focus on major movements and historical periods including Romanticism, Victorianism, Transcendentalism, abolitionism, and the Civil War period. Possible topics include but are not limited to literature that treats political radicalism, suffrage, secularism, imperialism, industrialization, U.S. nationalism, scientific and evolutionary theories, race and slavery, Native American and indigenous writing, and democratic politics. Repeatable once. Final paper, project and/or exam. Prereq: English 211. Sem hrs: 3 fall or spring.

English 324. *Twentieth-Century Literature.* 3(1). Twentieth-century literary study captures a changing world in the midst of two world wars and massive industrial, technological, and intellectual innovation. Major movements considered may include modernism, surrealism, Harlem Renaissance literature and music, postmodernism, postcolonialism and others, examining literary strategies that include expressionism, stream of consciousness, Gothic conventions, confessionalism, and realism. Repeatable once. Final paper, project and/or exam. Prereq: English 211. Sem hrs: 3 fall or spring.

English 330. *Twenty-First-Century Literature.* 3(1). This literary study of our contemporary moment includes possible examination of literary texts, cultural objects, and art from the twenty-first century, examining artistic development in a new century and exploring movements and strategies that emphasize form, innovations in realism, and interdisciplinary study. Examinations of literature may be transnational and include writing from the global majority and African and Middle Eastern diaspora, as well as writing from Indigenous, First Nations, LGBTQ+, and Latinx authors. Repeatable once. Final paper, project and/or exam. Prereq: English 211. Sem hrs: 3 fall or spring.

English 335. *Speech and Communication Studies.* 3(1). Considers communication through informative and persuasive speaking/writing; the advanced study of oral and/or written argumentation in a range of academic and professional registers to include a review of argumentation theory and readings in communication, cultural, and critical studies; and/or linguistics, rhetoric and application. Possible topics include, but are not limited to, public speaking and democratic participation; communication across cultural borders; propaganda and the media; the story of English; argument and advocacy; the rhetoric of war; communication, culture, and identity. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 340. *Genre and Form.* 3(1). This course highlights questions of artistic form in literature. Topics vary, but may include the historical development of literary genres, theoretical approaches to aesthetics, readings in narrative and poetic technique, the philosophical underpinnings of art, and interdisciplinary influences on literary forms. Genres studied may include the novel (historical, sentimental, Gothic, picaresque, realist, modernist, postmodern), poetry (epic, lyric, ballad, confessional), drama (Classical, epic, melodramatic, postmodern), and film (German expressionism, Italian neorealism, French new wave). Repeatable once. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 345. *Digital Humanities.* 3(1). This course provides a broad introduction to the intersections of technology and the humanities. The course addresses a wide range of principles and methods of engaging with arts and humanities content in digital environments with a focus on tools and perspectives that assist comprehension of textual and linguistic data. Students will learn to analyze and visualize textual data (literary and rhetorical) to make them communicative and meaningful in electronic venues, with special attention to practical and aesthetic considerations for design. Topics vary by approach and subject and may include text mining, narrative theory and gaming, and the rhetoric of games. Team projects. Final project. Prereq: English 211. Sem hours: 3 fall or spring.

English 350. *World Literature.* 3(1). This course focuses on world literature, which may include Anglophone or literature in translation, with an emphasis on centering non-Western literary traditions across different time periods. Topics may include literature that focuses on the African diaspora, Latin America, the Pacific Islands and South East Asia, and Asian postcolonial studies. Approaches may include comparativist, postcolonial, and translation studies. Repeatable once. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 355. *Literature, Language, and Race/Ethnicity.* 3(1). This course examines the relationship between literature and the history of race and ethnicity as social structures. Topics vary but may include the literary representation of racialized identities; race and canon formation; the history and significance of racialized cultural forms and practices; and the intersection of race, ethnicity, gender, sexuality, colonialism, and place. Specific versions of the course may focus on such topics as postcolonial literature; the Harlem Renaissance; borderlands, migration, and diasporas; Latin American literatures; Native American literature; and narratives of the immigrant experience. Repeatable once. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 360. *Literature, Language, and Gender/Sexuality.* 3(1). This course will focus on how literature and language explore and contribute to understandings of gender and/or sexuality within a culture. Topics may be transhistorical or organized around a specific period or place, so may include questions of identity formation and/or disintegration, overt and covert forms of sexism or discrimination, social status and mobility, gender and socio-linguistics, public rhetoric and the LGBTQ+ community, feminist theory, masculinity studies,; a historical grouping such as Women of Letters in the Enlightenment or Victorian Women Novelists, or a single author. Repeatable once. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 365. *Literature, Language, and Class.* 3(1). This course explores the relationship between literature and the formation, maintenance, and understanding of social and economic class. Topics vary but may include literary representations of distinct class identities; the history of various practices and assumptions that work to reinforce a particular class structure; as well as, the relationship between class as a complex social category and other categories such as race, gender, sexuality, place, and ethnicity. Course may be transhistorical or focus on one key moment in history, such as sentiment and the framing of the working-class subject, morality and class identity, the American dream, the development of the professional class in the 19th century, language variation and change, the politics of class, and the role of cultural taste in class distinction. Repeatable once. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 370. *Special Topics in War and Literature.* 3(1). This course will focus on the ways literature and language explore and contribute to understandings of war. While topics vary, the course invariably examines the formal and linguistic means by which fiction, memoir, poetry, creative nonfiction, film, journalism, drama, documentaries, and biography represent and reveal nuances about the human experience of war. Possible topics include the literature of remembrance and memory, literature of the Holocaust, women and war narratives, the ethics and aesthetics of representing war, war and cultural transformation, 20th- and 21st-century representations of war, literature from the First World War, the Great War and modern memory, World War II literature, the literature of the Vietnam War, the literature of the wars in Iraq and Afghanistan, or ancient war stories. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 375. *Literature, Language, and Science.* 3(1). This course examines the intersection of literary texts with scientific innovation, including invention, medicine, technology, biology, and other scientific study. Topics vary but may include literary representations of the history of clinical

practices, the history of scientific inquiry, the development of ethics, and the relationship between humans and technology. Courses may be transhistorical or focus on a particularly revelatory moment in scientific development, such as environmental studies, posthumanism, medical humanities, and marginalized practices such as alchemy or animal magnetism. Repeatable once. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 380. *Literature, Language, and Politics.* 3(1). This course examines the intersection of literary texts with political history, philosophical approaches to government, and rhetoric of statecraft. Topics treated in this course may include literary engagements with British constitutionalism, the founding of the American nation, English and American civil wars, the history of European colonialism, racial politics in the contemporary world, literature and espionage, or comparative politics. Courses may be transhistorical, or focus on one key moment in the history of literature and politics. Repeatable once. Final paper and/or project. Prereq: English 211. Sem hrs: 3 fall or spring.

English 385. *Literature, Language, and Philosophy.* 3(1). This course will focus on how literature and language explore, critique, and contribute to understandings of philosophy and philosophical ideas. Topics vary but may examine the influence of specific philosophical figures on writers of literature, the means by which literary writers have appropriated and invented philosophy, and the historical role played by literature in popularizing philosophical positions and theories. Final project and/or paper. Possible topics include, but are not limited to, the intellectual history of the "self," the philosophical underpinnings of the Enlightenment and Romanticism; the phenomenological nature of literature; and existential writing. Repeatable once. Prereq: English 211. Sem hrs: 3 fall or spring.

English 400S. *Literature and the Fine Arts II (Enlightenment to the 20th Century).* 3(1). Interdisciplinary course focused on the intellectual history of Western civilization through literature and the arts. English 400S is a core substitute for English 411 and can be taken by cadets enrolled in the Martinson Honors Program (MHP) as well as by approval from the course director. Upon completion of English 200S, cadets may enroll directly in English 400S. Cadets enrolled in the ASP or in one of the Humanities Division majors who did not take English 200S may contact the course director to be placed in English 400S. Final project and/or paper. Prereq: 3.5 cumulative GPA, Scholar status, and course director approval. Sem hrs: 3 fall.

This course contributes to the development and assessment of the Human Condition, Cultures, and Societies outcome.

English 411. *War Stories.* 3(1). An Advanced Sociocultural Option, this course focuses on the moral and intellectual aspects of war as expressed in the literature of our profession: biographical, autobiographical, and fictional accounts, along with documentaries and film. Written and oral assignments give cadets the opportunity to reflect on the inviolable bond that unites successful leadership with its moral, intellectual, and emotional foundations. The text list is composed of important works of fiction, memoir, and film that address the concreteness and complexity of war as well as the ethical issues of leadership. Prereq: English 211 or English 212 or English 200S. Sem hrs: 3 fall or spring.

This course contributes to the development and assessment of the Human Condition, Cultures, and Societies outcome.

English 489. *Capstone Research*. 1.5(1). Part 1 of the Capstone Sequence. In the spring of their junior year, students will submit a statement of interest outlining an area of research they would like to pursue for their capstone project. Capstone projects are long-term research projects; with approval, projects may represent any of the English Department's areas of interest. The goal is for students to develop a depth in an author, topic, problem, or genre. This fall 1.5 credit course affords students the opportunity to do independent research in the content areas and methods the project requires. By the end of the fall semester, students will submit an annotated bibliography and a substantial prospectus outlining the research question their capstone seeks to explore and the provisional claim(s) the project will argue. Prereq: Course director approval. Sem hrs: 1.5 fall.

English 490. *Capstone Colloquium*. 3(1). Part 2 of the Capstone Sequence. The aim of this seminar is to guide students through the writing process as they draft, revise, and complete their capstone projects on the basis of independent research and analytical methods appropriate to the project. Students will present their work-in-progress to the department in order to receive feedback for final revisions. Available to seniors (by application). Prereq: English 489. Sem hrs: 3 spring.

English 495. *Special topics*. 3(1). Selected topics in English. Repeatable once. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

English 499. *Independent Study*. 3(0). Study and research in literature, composition, or creative writing for students who have demonstrated their ability for advanced study in regularly offered enrichment courses and for whom an appropriate enrichment course does not exist. Topics and meetings arranged with the instructor. Final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

- English 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- English 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- English 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

ENGLISH for ACADEMIC PURPOSES

(EAP)

Offered by the Academic Success Center (DFVRL)

EAP 109. *Academic Communication for English as a Second Language Four-year Exchange Cadets*. 3(1). Introduction to academic reading, writing and public speaking for English as a Second Language (ESL) students. Frequent writing assignments emphasize writing for the various core academic communities, which includes a narrative, a literary inquiry, and an academic research paper. All assignments are scaffolded to guide students through the writing and public speaking process. Prerequisite to English 111 for identified ESL students. Final paper and project. Prereq: None. Sem hrs: 3 fall.

EAP 209. *Academic Communication for English as a Second Language Semester-Exchange Cadets.* 3(1). In this course, cadets will use a process approach to write a narrative, a literary inquiry, and conduct academic research of their choice using MLA conventions on the theme of War, Occupation, Culture, and Migration. As their research will culminate in a final paper and public presentation, cadets will be given the opportunity to enhance both their research and public speaking and presentation skills. Cadets will examine the course theme through the critical reading of several novels from diverse authors and advanced perspective taking. Final paper and project. Prereq: None. Sem hrs: 3 fall.

FIRST-YEAR EXPERIENCE **(FYE)**

Administered by the Student Academic Affairs & Academy Registrar (DFVR)

FYE 101. *First-Year Experience 101.* 0(1x). First-Year Experience (FYE) is a one semester hour course spanning the two semesters of a cadet's four-degree year. Designed to develop cadets' personal accountability and self-awareness, the purpose of FYE is to accelerate the development of habits of mind needed to succeed in a college environment. The FYE program focuses on building a strong understanding of academic expectations through exposure to and integration of the USAF Academy Learning Outcomes. Key topics covered in FYE include engaged learning, Academy expectations, time management, learning style assessment, critical thinking, decision making, effective communication, and a passion for lifelong learning. Prereq: None. Sem hrs: 0 fall.

FYE 102. *First-Year Experience 102.* 1(1x). Continuation of First-Year Experience 101 from the fall semester. Prereq: FYE 101. Sem hrs: 1 spring.

FOREIGN AREA STUDIES **(For Ar Stu)**

Offered by the Department of Economics and Geosciences (DFEG), the Department of Languages and Cultures (DFLC), the Department of History (DFHI), and the Department of Political Sciences (DFPS)

For Ar Stu 400. *Intercultural Competence.* 1(0). This course will prepare cadets for participation in the Cadet Semester Study Abroad Program (CSSAP) or Cadet Semester Exchange Abroad Program (CSEAP). This course is designed to teach students how to have successful and meaningful experiences and cultural interactions while traveling and studying abroad through the study of plausibility structures, cognitive dissonance, culture shock, and cultural resolution. Pass/fail. Prereq: DFLCP notification and approval by the Vice Dean and Vice Commandant for participation in CSSAP or CSEAP. Sem hrs: 1 spring.

For Ar Stu 410. *Model Arab League (MAL).* 3(1). Inter-departmental, inter-disciplinary seminar on contemporary issues on the Middle East, preparing Foreign Area Studies majors for regional or national-level competitions of the MAL. Specialists from various departments

introduce historical, geographical, political, socio-economic, cultural, linguistic and literary factors to enhance understanding of a specific region or nation of the Middle East. In addition, enrollees will learn parliamentary and forensic procedures. Portions of the course may be taught in Arabic. Final project or paper. Prereq: C1C or C2C standing, course director's approval. Sem hrs: 3 spring.

For Ar Stu 415. *Advanced Model Arab League (AMAL)*. 3(1). Advanced Inter-departmental, inter-disciplinary seminar on contemporary issues on the Middle East, preparing students for regional or national-level competitions of the MAL. Specialists from various departments introduce historical, geographical, political, socio-economic, linguistic and literary factors to enhance understanding of a specific region or nation of the Middle East. In addition, enrollees serve as class leaders and mentors for students of ForArStu 410, Basic Model Arab League. Enrollees of ForArStu 415 will serve as focal points during the drafting and presentation of point papers and resolutions during the model competitions. Final paper. Prereq: C1C standing, successful completion of ForArStu 410, and course director approval. Sem hrs: 3 spring.

For Ar Stu 420. *Model Organization of American States (MOAS)*. 3(1). Inter-departmental, inter-disciplinary seminar on contemporary issues in Latin America, preparing Foreign Area Studies majors for regional or national-level competitions of the MOAS. Specialists from various departments introduce historical, geographical, political, socio-economic, cultural, linguistic and literary factors to enhance understanding of a specific region or country in Latin America. In addition, enrollees will learn parliamentary and forensic procedures. Portions of the course may be taught in Spanish. Final project or paper. Prereq: C1C or C2C standing, course director's approval. Sem hrs: 3 spring.

For Ar Stu 425. *Advanced Model Organization of American States (AMOAS)*. 3(1). Advanced inter-departmental, inter-disciplinary seminar on contemporary issues on Latin America, preparing students for regional or national-level competitions of the MOAS. Specialists from various departments introduce historical, geographical, political, socio-economic, linguistic and literary factors to enhance understanding of a specific region or nation of Latin America. In addition, enrollees will serve as class leaders and mentors for first-time students of For Ar Stu 420, Basic Model Organization of American States. Enrollees of For Ar Stu 425 will serve as focal points during the drafting and presentation of point papers and resolutions during the model competitions. Final paper. Prereq: C1C standing, successful completion of For Ar Stu 420, course director's approval. Sem hrs: 3 spring.

For Ar Stu 430. *Model African Union (MAU)*. 3(1). Inter-departmental, inter-disciplinary seminar on contemporary issues in Africa, preparing Foreign Area Studies majors for regional or national-level competitions of the MOAU. Specialists from various departments introduce historical, geographical, political, socio-economic, cultural, linguistic and literary factors to enhance understanding of a specific region or country in Africa. In addition, enrollees will learn parliamentary and forensic procedures. Final project or paper. Prereq: C1C or C2C standing, course director's approval. Sem hrs: 3 spring.

For Ar Stu 435. *Advanced Model African Union (AMAU)*. 3(1). Advanced Inter-departmental, inter-disciplinary seminar on contemporary issues on Africa, preparing students for regional or national-level competitions of the MOAU. Specialists from various departments introduce historical, geographical, political, socio-economic, linguistic and literary factors to enhance understanding of a specific region or nation of Africa. In addition, enrollees will serve as class leaders and mentors for first-time students of For Ar Stu 430, Basic Model Organization of African Unity. Enrollees of For Ar Stu 435 will serve as focal points during the drafting and presentation of point papers and resolutions during the model competitions. Final paper. Prereq: C1C standing, successful completion of For Ar Stu 430, course director's approval. Sem hrs: 3 spring.

For Ar Stu 440. *Model European Organizations*. 3(1). Interdepartmental, interdisciplinary seminar on contemporary issues in Europe. This course prepares cadets for regional or national-level competitions of the Model NATO and/or Model EU. Specialists from various departments introduce historical, geographical, political, socio-economic, cultural, and civil-military factors to enhance understanding of a specific country or countries in Western Europe. In addition, enrollees will learn parliamentary and forensic procedures. Final Exam, Project, or Paper. Prereq: C1C or C2C standing, course director's approval. Sem hrs: 3 fall or spring.

For Ar Stu 445. *Advanced Model North Atlantic Treaty Organization (AMNATO)*. 3(1). Advanced Inter-departmental, inter-disciplinary seminar on contemporary North American and West European issues, preparing students for regional or national-level competitions of the MNATO. Specialists from various departments introduce historical, geographical, political, socio-economic, linguistic and literary factors to enhance understanding of a specific region or nation of Europe. In addition, enrollees will serve as class leaders and mentors for first-time students of For Ar Stu 440, Basic Model North Atlantic Treaty Organization. Enrollees of For Ar Stu 445 will serve as focal points during the drafting and presentation of point papers and resolutions during the model competitions. Final paper. Prereq: C1C standing, successful completion of For Ar Stu 440, course director's approval. Sem hrs: 3 spring.

For Ar Stu 491. *Culture and the Military Profession*. 3(1). This course presents an overview of the study of cultural concepts, methodologies, and applications pursuant to the roles and missions of the military profession. It addresses culture on multiple levels and across disciplinary boundaries – drawing on the knowledge, literature, and practices of several informed perspectives. The course includes discussion of the heritage of the US military's application of cultural and ethnographic knowledge; outlines contemporary models for cultural observation, analysis and conclusion; presents theoretical foundations for the various levels of cultural learning (general-, regional-, and specific-culture); applies concepts of cultural study within various case studies and discussion examples; and outlines relevant methodologies drawn from several traditional academic disciplines in the areas of cultural geography, cross-cultural study as a unique interdisciplinary construct with strong application to the US military profession across a broad spectrum of operations and activities. Final exam. Sem hrs: 3 fall or spring.

For Ar Stu 495. *Special Topics in Foreign Area Studies*. 3(1). Interdisciplinary course for Foreign Area Studies majors. (The following suffixes indicating geo-cultural region of course

specialization apply: “A” for Asia, “E” for Eastern Europe, “F” for Africa, “L” for Latin America, “M” for the Middle East, “S” for Russia or Slavic regions, and “W” for Western Europe.). Cultural, literary, linguistic, historical, political, social, economic, geographical, and other pertinent factors bearing on an understanding of the particular region involved are treated by specialists from relevant departments. Portions of the course may be taught in the relevant foreign language. Final paper or final exam. Prereq: C1C or C2C standing, course director’s approval. Sem hrs: 3 fall or spring.

For Ar Stu 499. *Independent Study*. 3(0). Independent study or research in foreign area studies. Topic or area of study/research must be approved by the Foreign Area Studies Working Group or DFLC Department Head. Final exam, project, or paper. Sem hrs: 3 fall or spring.

- For Ar Stu 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- For Ar Stu 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- For Ar Stu 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

FOREIGN LANGUAGES

(For Lang)

Offered by the Department of Languages and Cultures (DFLC)

Foreign Language Placement:

All cadets who have a background in one of the foreign languages offered at USAF Academy will be administered a placement examination upon arrival. Based on the results of their examination, cadets will be placed into an appropriate course and level. Cadets without prior language background and cadets who score low on a placement examination will be placed into For Lang 131/132 (Basic Sequence). All 100-level foreign language courses will meet every day. Cadets who place into the 221/222 level will receive 131/132 validation credit. Note: Cadets placed into Portuguese 211/212 (a different course than Portuguese 221/222) do not receive validation credit for Portuguese 131/132. In sum (with the exception of Portuguese 211/212), cadets who place at or above the 200 level will receive validation credit for up to four language courses. See below for possible placement/validation scenarios, using Spanish as an example:

Spanish 131/132 placement: Cadet receives no validation credit.

Spanish 221/222 placement: Cadet receives Spanish 131/132 validation credit.

Spanish 222/321 placement: Cadet receives Spanish 131/132/221 validation credit.

Spanish 321/322 placement: Cadet receives Spanish 131/132/221/222 validation credit.

Spanish 365/410 placement: Cadet receives Spanish 221/222/321/322 validation credit.

Language	Typical Course Sequence							
		Fall	Spring	Fall	Spring	Fall	Spring	Fall
Arabic		131	132	221	222	321	322	365
Chinese		131	132	221	222	321	322	365

French		131	132	221	222	321	322	365
German		131	132	221	222	321	322	365
Japanese		131	132	221	222	321	322	365
Portuguese		131	132	221	222	321	322	365
Portuguese		---	---	211	212	321	322	365
Russian		131	132	221	222	321	322	365
Spanish		131	132	221	222	321	322	365

For Lang 131-132. (Basic Sequence). 3-3(2'-2'). Basic foreign language and culture study. Introduction to the language, culture, and societies. Students will explore language and also compare and contrast societal themes as they relate to cultures speaking that foreign language. Students are placed in the course on the basis of no prior language background or low placement examination scores. Final exam both semesters. Must be taken sequentially. Sem hrs: For Lang 131 - 3 fall; For Lang 132 - 3 spring.

Arabic 131-132	Basic Arabic	(Fall – Spring)
Chinese 131-132	Basic Chinese	(Fall – Spring)
French 131-132	Basic French	(Fall – Spring)
German 131-132	Basic German	(Fall – Spring)
Japanese 131-132	Basic Japanese	(Fall – Spring)
Portuguese 131-132	Basic Portuguese	(Fall – Spring)
Portuguese 211-212	Accelerated Basic Portuguese	(Fall – Spring)
Russian 131-132	Basic Russian	(Fall – Spring)
Spanish 131-132	Basic Spanish	(Fall – Spring)

These courses contribute to the development and assessment of the Human Condition, Cultures, and Societies outcome.

Portugse 211. Accelerated Basic Portuguese I. 3(1). Introduction to the language, culture and civilization. Language Learning Center (LLC) supplements classroom instruction. Students are placed into the course on the basis of prior Spanish language background—level to be determined by the Department of Languages and Cultures. Cadets who successfully complete Portuguese 211 will enroll next in Portuguese 212. Final exam. Sem hrs: 3 fall.

Portugse 212. Accelerated Basic Portuguese II. 3(1). Refinement of communication in the target language. Intensification of aural and reading comprehension. Student presentations and classroom discussions based on readings/topics in culture and civilization of Portuguese. Language Learning Center may supplement classroom instruction. Cadets who successfully complete Portuguese 212 will likely enroll into Portuguese 321 allowing them to bypass Portuguese 221/222. Final Exam. Prereq: Successful completion of Portuguese 211 or placement into this level by DFLLC. Sem hrs: 3 spring.

For Lang 221. 3(1). Refinement of communication in the target language. Intensification of aural and reading comprehension. Student presentations and classroom discussions based on selected readings/topics in culture and civilization of language studied. Language Learning Center

may supplement classroom instruction. Final exam. Prereq: Normally for students who have taken For Lang 131-132, or placement into this level by DFLC. Sem hrs: 3 fall.

Arabic 221	Intermediate Arabic I	(Fall)
Chinese 221	Intermediate Chinese I	(Fall)
French 221	Intermediate French I	(Fall)
German 221	Intermediate German I	(Fall)
Japanese 221	Intermediate Japanese I	(Fall)
Portuguese 221	Intermediate Portuguese I	(Fall)
Russian 221	Intermediate Russian I	(Fall)
Spanish 221	Intermediate Spanish I	(Fall)

For Lang 222. *Continued refinement of target language.* 3(1). Emphasis on conversational practice and aural comprehension of contemporary spoken language. Student presentations and classroom discussions based on culture and civilization readings/topics in target language. Language Learning Center may supplement classroom instruction. Final exam. Prereq: Successful completion of For Lang 221 or placement into this level by DFLC. Sem hrs: 3 spring.

Arabic 222	Intermediate Arabic II	(Spring)
Chinese 222	Intermediate Chinese II	(Spring)
French 222	Intermediate French II	(Spring)
German 222	Intermediate German II	(Spring)
Japanese 222	Intermediate Japanese II	(Spring)
Portuguese 222	Intermediate Portuguese II	(Spring)
Russian 222	Intermediate Russian II	(Spring)
Spanish 222	Intermediate Spanish II	(Spring)

For Lang 321. 3(1). A capstone communication course designed to enhance the students' ability in the language and culture. Final exam. Prereq: For Lang 222 or placement into this level by DFLC. Sem hrs: 3 fall.

Arabic 321	Advanced Arabic I	(Fall)
Chinese 321	Advanced Chinese I	(Fall)
French 321	Advanced French I	(Fall)
German 321	Advanced German I	(Fall)
Japanese 321	Advanced Japanese I	(Fall)
Portuguese 321	Advanced Portuguese I	(Fall)
Russian 321	Advanced Russian I	(Fall)
Spanish 321	Advanced Spanish I	(Fall)

For Lang 322. 3(1). A follow-on capstone communication course to For Lang 321 designed to further hone the students' ability in the language and culture. Final exam. Prereq: For Lang 321 or placement into this level by DFLC. Sem hrs: 3 spring.

Arabic 322	Advanced Arabic II	(Spring)
Chinese 322	Advanced Chinese II	(Spring)
French 322	Advanced French II	(Spring)
German 322	Advanced German II	(Spring)

Japanese 322	Advanced Japanese II	(Spring)
Portuguese 322	Advanced Portuguese II	(Spring)
Russian 322	Advanced Russian II	(Spring)
Spanish 322	Advanced Spanish II	(Spring)

For Lang 365. 3(1). Oral discussion of civilization, culture, and contemporary issues (military, political, economic) of the country or countries concerned. Discussion is in the target language and is based on selected readings in that language. This course is a prerequisite for subsequent language courses unless waived by DFLC. Final exam, project, or paper. Prereq: Successful completion of For Lang 322 or department approval. Sem hrs: 3 fall.

Arabic 365	Arabic Civilization and Culture	(Fall)
Chinese 365	Chinese Civilization and Culture	(Fall)
French 365	French Civilization and Culture	(Fall)
German 365	German Civilization and Culture	(Fall)
Japanese 365	Japanese Civilization and Culture	(Fall)
Portuguese 365	Portuguese Civilization and Culture	(Fall)
Russian 365	Russian Civilization and Culture	(Fall)
Spanish 365	Spanish Civilization and Culture	(Fall)

For Lang 400/401. *Intensive Language Study.* 3(0). Intensive foreign language and culture study, commonly known as CSLIP (Cadet Summer Language Immersion Program). The course counts toward a foreign language minor. Enrollment in the appropriate follow-on language course during the fall semester immediately following CSLIP is mandatory. Cadets who do not enroll in the appropriate follow-on language course during the fall semester, or who do not earn a minimum of C in this follow-on language course, will be awarded a grade of Withdraw Fail (WF) for For Lang 400/401. Department Head may award Pass/Fail credit for For Lang 400/401 as a separate entity in exceptional circumstances when cadet cannot register for the follow-on language course. For Lang 401 applies to cadets who have previously earned For Lang 400 credit. Pass/fail. Prereq: DFLCP selection. Sem hrs: 3 summer.

Arabic 400/401	Arabic Summer Language Immersion	(Summer)
Chinese 400/401	Chinese Summer Language Immersion	(Summer)
French 400/401	French Summer Language Immersion	(Summer)
German 400/401	German Summer Language Immersion	(Summer)
Japanese 400/401	Japanese Summer Language Immersion	(Summer)
Portuguese 400/401	Portuguese Summer Language Immersion	(Summer)
Russian 400/401	Russian Summer Language Immersion	(Summer)
Spanish 400/401	Spanish Summer Language Immersion	(Summer)

For Lang 402. 3(0) Experiential language credit for cadets participating in Cadet Semester Study Abroad Program (CSSAP) or Cadet Semester Exchange Abroad Program (CSEAP). This course provides cadets who successfully complete CSSAP or CSEAP with course credit for the relevant language corresponding to the program in which they participate. Pass/fail. Prereq: DFLCP selection. Sem hrs: 3 fall.

Arabic 402	Arabic Semester Abroad Language Credit	(Fall)
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Chinese 402	Chinese Semester Abroad Language Credit	(Fall)
French 402	French Semester Abroad Language Credit	(Fall)
German 402	German Semester Abroad Language Credit	(Fall)
Japanese 402	Japanese Semester Abroad Language Credit	(Fall)
Portugse 402	Portuguese Semester Abroad Language Credit	(Fall)
Russian 402	Russian Semester Abroad Language Credit	(Fall)
Spanish 402	Spanish Semester Abroad Language Credit	(Fall)

For Lang 410. 3(1). Cadets will experience a semester-long survey of significant current events in those regions relevant to the target language. They will study and research the cultural, political, economic, and historic factors that affect current reality. The course uses available sources from the internet, newspapers, television, radio broadcasts, etc. to carry out its objectives. Most of the activities of this course are in seminar format, and emphasis is placed in oral discussions and written production. All class activities are conducted in the target language. Final exam, project, or paper. Prereq: For Lang 365 or placement into this level by DFF. Sem hrs: 3 spring.

Arabic 410 Current Events in the Arabic-Speaking World (Spring)
Chinese 410 Current Events in the Chinese-Speaking World (Spring)
French 410 Current Events in the French-Speaking World (Spring)
German 410 Current Events in the German-Speaking World (Spring Odd Years)
Japanese 410 Current Events in the Japanese-Speaking World (Spring)
Portugse 410 Current Events in the Portuguese-Speaking World (Spring)
Russian 410 Current Events in the Russian-Speaking World (Spring Odd Years)
Spanish 410 Current Events in the Spanish-Speaking World (Spring)

German 411. *Germany from Unification to Reunification.* (3)1. Overview and exploration of German cultural expressions from the first national unification in 1871 to the reunification in 1990. Topics include: roots of German imperialism; social and religious politics of the German empire; rise of new mass movements; the first World War; the Weimar Republic; Nazi Germany; the Holocaust and other racial and political mass murders; divided Germany; the fall of the Wall and reunification. Attention will be given to major cultural controversies accompanying these events, including the *Sonderweg* debate, issues of *Vergangenheitsbewältigung*, and the question of what is or should be *Deutschland*. Readings and discussions in German. Final exam, project, or paper. Prereq: German 365. Sem hrs: 3. spring of even years.

Russian 411. *The Era of the Soviet Union.* 3(1). A survey of the major events, individuals, and institutions of the period roughly from the October Revolution in 1917 to the disintegration of the Union of Soviet Socialist Republics in 1991. Students will analyze primary sources such as articles, diaries, films, interviews, photographs, and speeches. Through the close reading and discussion of these texts, students will converse in an informed way about topics such as the October Revolution, New Economic Policy, Soviet Industrial Revolution, Gulags, Purges, Great Patriotic War, Cold War, Thaw, Space Race, Stagnation, Perestroika, and collapse of the Soviet Union. Final exam, project, or paper. Prereq: Russian 365. Sem hrs: 3 spring of even years.

For Lang 420. 3(1). Survey of important writers, their works, and influences on their societies. Students are provided cultural insights through literature. Discussions are conducted in the target language and based on selected literary works ranging from early times to contemporary periods. All class activities are conducted in the target language. Final exam, project or paper. Prereq: For Lang 365 or placement into this level by DFF. Sem hrs: 3 fall.

Arabic 420 Introduction to Literature (Fall) Chinese

420 Introduction to Literature (Fall) French 420

Introduction to Literature (Fall)

German 420 Introduction to Literature (Fall Odd Years) Japanese

420 Introduction to Literature (Fall)

Portugse 420 Introduction to Literature (Fall Odd Years) Russian

420 Introduction to Literature (Fall Odd Years)

Spanish 420 Introduction to Literature (Fall)

German 421. *German Thought.* (3)1. Investigation of key intellectual discussions in the German-speaking world since the Enlightenment that have helped shape the intellectual contours of the humanities, the social sciences, and the natural sciences today. The focus is on very short texts (or short selections of longer works) that continue to exert an impact, from Kant and Clausewitz through such thinkers as Marx, Nietzsche, Weber, Freud, Einstein, Bonhoeffer, Benjamin, Arendt, Habermas and others. The specific authors studied may depend in part on students' majors and interests. Texts are analyzed in terms of their conceptual claims, their forms of knowledge production, and their responsiveness to the cultural and historical contexts in which they emerged. Students develop a critical-analytical toolkit for understanding, discussing, and responding to complex ideas and gain an appreciation of the many profound German contributions to modern ways of thinking. Readings and discussions in Germ an. Final exam, project, or paper. Prereq: German 365. Sem hrs: 3 fall of even years.

Russian 421. *Modern Russian Literature.* 3(1). A survey of the major authors, movements, and texts in the long twentieth century, roughly from the assassination of Tsar Alexander II to the election of President Vladimir Putin in 2000. Through the close reading and discussion of primary sources, students will examine the role of modern artists in creating the vanguard of the Revolution, compare the waves of enthusiasm for and disenchant with the Soviet regime, and analyze how artists helped create the atmosphere that led to the dissolution of USSR. Final exam, project, or paper. Prereq: Russian 365. Sem hrs: 3 fall of even years.

Spanish 421. Introduction to Latin American Literature. 3(1). Primary focus is a survey of important Latin American writers, their works, and influences on their societies. Students are provided cultural insights through literature. Discussions are conducted in the target language and based on selected literary works ranging from early times to contemporary periods. All classes will be conducted in the target language. All assignments will be conducted in the target language. Final exam, project, or paper. Prereq: Spanish 365. Sem hrs: 3 spring.

Chinese 430. *Exploring Chinese Culture through Formulaic Expressions.* 3(1). This course helps the advanced language learners explore Chinese formulaic expressions, which is a significant part of Chinese lexicon ranging from the 4-character-set words to buzz words, common sayings, idioms, proverbs and slangs. The awareness and mastery of this group of lexicon will enable Chinese advanced learners to comprehend linguistic and cultural nuances embedded in both oral and written modes to improve their communication competence. Authentic materials from various audio and written sources will be used to generate class discussions in the target language. Final exam, project or paper. Prereq: Chinese 365. Sem hrs: 3 fall of even years.

German 430. *German Cinema.* (3)1. Introduction to film analysis and a survey of German film history from its beginnings to today. Study of masterpieces of German film in order to develop awareness of film techniques; genres; tools of analysis; the history, politics, and culture in which each film was produced; and critical and theoretical discussions of film. Films, readings, and discussions in German. Final exam, project, or paper. Prereq: German 365. Sem hrs: 3 spring of even years.

Chinese 431. *Culture and Knowledge of the Chinese Military.* 3(1). Provides an introduction to the Chinese People's Liberation Army and its military service components. Students will be introduced to contemporary military vocabulary and terminology from the Army, Navy, and Air Force, with an emphasis on the Air Force. Students will also learn to identify uniforms and recognize Chinese rank structure, as well as gain a basic understanding of Chinese aircraft, military organizations, and military structure. Discussion topics include the role of women in the Chinese military, an introduction to Chinese military service academies, military law and discipline, and qualifications for Chinese military service. This course describes China's politico-military structure and will examine China's philosophy and approach to ancient and contemporary warfare. The course will be taught entirely in Chinese, and course materials will be derived from authentic newspapers, magazines, and other texts, as well as from audio and video clips. Final exam and/or final project. Prereq: Chinese 322 or equivalent. Sem hrs: 3 spring.

French 430. *French Film and Media.* 3(1). A survey of the major works in French films and/or various media (including internet, art, television and press). Students will make cultural connections via authentic materials and guided discussions in French. Final exam, project, or paper. Prereq: French 365. Sem hrs: 3 spring of even years.

German 431. *German Art and Media.* 3(1). Exploration of major trends and tensions that have informed media and the arts (e.g. visual art, photography, architecture, music, dance, television, radio, computer media or other) in the German-speaking lands. Study of the forms of expression; of cultural, political, social, economic, philosophical, and historical contexts; and of the continued relevance for the world today. Readings and discussions in German. Final exam, project, or paper. Prereq: German 365. Sem hrs: 3 spring of odd years.

Portuguese 430. *Cinema across Portuguese-Speaking Cultures.* 3(1). Introduction to the cinematic production of Brazil, Lusophone Africa, Portugal, and diaspora communities from the twentieth century to the present. Classes are seminar format with a focus on active discussion,

debate, and interpretation by students. Topics will include a range of culturally significant themes such as social inequality, economic development, decolonization, family, and politics. Final exam, project, or paper. Prereq: Portuguese 365. Sem hrs: 3 fall or even years.

For Lang 495. *Special Topics*. 3(1). Selected topics in foreign languages. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

For Lang 499. *Independent Study*. 3(0). Individual study or research conducted on a tutorial basis. Study may be in any of the seven languages offered by the department. Topic or area of study/research must be approved by the department head. Final exam project, or term paper. Prereq: DFLC approval. Sem hrs: 3 fall or spring.

- For Lang 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- For Lang 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- For Lang 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

GEOSPATIAL SCIENCE

(Geo)

Offered by the Department of Economics and Geosciences (DFEG)

Geo 250. *Human Geography: A Global Cultural Awareness*. 3(1). This course will introduce students to major ideas, concepts, institutions, and events that shape human cultures and societies. Cadets will develop an understanding of the complex relationship between humans and the environment through the study of human movement, language, religion, race, economic activities, and urban development. A major objective of the course is for cadets to be able to compare and appreciate global cultures in a spatial context. To help cadets achieve this cultural understanding the course uses a comparative approach to the study of global cultures focusing on religions, languages, traditions, ways of life and perceptions. Each cadet should develop a strong appreciation and comprehension of the never-ending and dynamic processes that are continually shaping the Earth, its peoples, and their cultures. Final exam or final project. Prereq: None. Sem hrs: 3 fall or spring.

Geo 310. *Map Design and Graphic Communication*. 3(1). The art, science, technology, and process of cartographic design and spatial thinking. Fosters map literacy and geographic reasoning skills through the investigation of map-making decisions. Students use digital tools to transform the earth into two-dimensional graphic representations and to map the Earth's surface and phenomena with a spatial component. Students create and evaluate digital and paper cartographic products to demonstrate their ability to organize information and use maps for effective communication. Final exam or final project. Prereq: None. Sem hrs: 3 fall.

Geo 340. *Introduction to Geographic Information Systems*. 3(1). Introduction to the use of geographic information systems (GIS) for collection, digitization, storage, display, modeling, and analysis of spatial data. In this course, students will develop proficiency in the use of current GIS software and basic data flow in GIS applications. Special emphasis will be on data management,

analytical techniques, and data visualization that facilitates decision-making through the communication of geospatial data. By the end of the course, cadets will be able to transform data into geospatial intelligence. Final exam or final project. Prereq: Geo 310 or Course Director Approval. Sem hrs: 3 spring.

Geo 351. *Physical Geography.* 3(1). The study of the Earth System (atmosphere, hydrosphere, biosphere, and lithosphere). Focuses on the spatial distributions within the system, the use of maps to explain the distributions, origins and processes shaping the Earth's surface, and the influence of humans on the Earth system. Final exam or final research project. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Geo 353. *Geomorphology.* 3(1). An analysis of the dynamic processes, distribution, and structure of the Earth's physical features. Focuses on fundamental concepts of physical geology, climate, soils, and vegetation. Final exam or final project. Prereq: Geo 351. Sem hrs: 3 spring.

Geo 355. *Field Experience in the Geosciences.* 3(1). This course provides the opportunity for advanced learning in a specific aspect of the Geosciences. Cadets apply prerequisite knowledge to a field-based, practical problem. The course is a combination of classroom instruction and problem design with extensive field experiences addressing the problem. Topics and study sites are variable and determined by the course director. Final exam. Prereq: Geo 200, Geo 250, and Geo 351; or course director approval. Sem hrs: 3 summer.

Geo 360. *Economic Geography.* 3(1). This course is designed to provide students with a solid foundation in the concepts, theories, and approaches on which the field of economic geography is based. This includes the location of economic activities over the earth's surface, the distribution of agriculture, manufacturing and transportation, and the economic growth of areas. This disciplinary overview will be presented in the context of the contemporary world economy and environmental constraints. The course is divided into five parts. Part I surveys the geographic patterns and processes which characterize the international economic system. Part II studies issues of production, and how firms and industries organize across geographic space to design, build, and distribute a product or service. Part III examines the global economy as a landscape of places and spaces through which streams of capital, labor, and knowledge flow and interact. Part VI, focuses on using the theories, techniques, and tools learned in class to help students develop their own real estate investment strategy. Part V focuses on cost benefit analyses and basic life cycle costing in the context of sustainable development. By the conclusion of the course, the student will be prepared to apply geographic principles to economic processes and systems. Final project. Prereq: Econ 201. Sem hrs: 3. Offered once per year in the Fall.

Geo 365. *Sustainable Development.* 3(1). This course will introduce students to the concepts of sustainable development, its origins, and the global conventions associated with it. A major objective of this course is using indicators of human well-being, governance, environmental conservation, social inclusion, and economic prosperity to evaluate how countries are making their

development trajectories more sustainable. Although most of the discussion will adopt a global perspective, the research conducted by students will be focused on the challenges for implementing sustainable development policies in tropical and sub-tropical countries. Final project. Prereq: None. Sem hrs: 3 spring.

Geo 366. *Introduction to Urban Planning*. 3(1). Introduction to the purposes and possibilities of urban and regional planning. Topics include historical development of planning, theoretical rationale for planning, major analytical and legal tools and techniques available to planners at urban and regional levels, as well as policy and design strategies for addressing urban problems. Lastly the course surveys contemporary urban issues and areas of planning specialization, including low impact development, new urbanism, and conservation subdivisions. This course prepares cadets with fundamental concepts and skills for overseeing planning efforts undertaken on all U.S. Air Force installations. Final Project. Prereq: None. Sem hrs: 3. Offered every other Spring (odd years).

Geo 375. *Geography of International Conflicts*. 3(1). This course will introduce a geographic perspective to aid in understanding the dynamics of contemporary global conflicts, including issues related to global power struggles, persistent nationalist conflicts, border dynamics, the global military actions of the U.S., terrorism, insurgencies, peace movements, resource conflicts, and the politics of climate change. Students will develop this perspective by focusing on key concepts, such as place, region, scale, territory, networks, and boundaries, and use them to better understand why certain people, groups, or countries act in certain ways in certain situations. Students will also use a particular theoretical idea, structure and agency, in conjunction with the other concepts to situate conflicts and those involved in them. The goal is to contextualize these issues and try to understand the limits and possibilities faced by diverse political actors as they negotiate, initiate, or try to avoid conflict. Final Project. Prereq: None. Sem hrs: 3 fall or spring.

Geo 380. *Geography of Travel and Culture*. 3(1). This course is designed to teach students how to have successful and meaningful experiences and cultural interactions while on military assignments and traveling abroad through the study of plausibility structures, cognitive dissonance, culture shock, and cultural resolution through various methods and exercises. The course will be divided into four modules. First, this course will explore how theories of geography are intrinsic in having successful experiences abroad. Second, the course will delve into travel theory as it has been developed by the professor and other scholars. Third, the course will explore cultural training and coaching techniques used to prepare students and professionals for intercultural experiences. Fourth, this course will teach students how to leverage material learned in this course and experience abroad in future positions/appointments/jobs. Final project. Prereq: None. Sem hrs: 3. Offered when faculty scheduling and availability allows.

Geo 382. *Remote Sensing and Imagery Analysis*. 3(1). Mechanisms for exploiting the electromagnetic radiation spectrum are investigated using particle and wave theory equations. Digital image processing techniques are presented and applied using the Applied Geography Laboratory facilities and raster data from commercial spaceborne sensing systems. Final exam or final project. Prereq: Physics 215 recommended but not required. Sem hrs: 3 fall.

Geo 385. *Applied UAS Photogrammetry.* 3(1). This course teaches cadets the fundamentals of deriving high resolution aerial imagery and 3D digital models of the earth's surface from photos acquired from multi-rotor and fixed-wing mounted sensors using high tech state of the art software. Cadets learn to plan flight missions, layout ground control using GPS, fly the UAS, and download, process and analyze the imagery. The science behind creating highly accurate images is taught, and cadets will learn to create local 3D topographic fly-throughs and analyze visible spectrum, NIR and thermal imagery. Students will employ advanced geospatial processing techniques to solve current, multi-disciplinary geographic problems. The course is divided into lecture and laboratory periods. Students will complete practical exercises, GRs, and a final project. Final project. Prereq: None. Sem hours: 3 spring.

Geo 391. *Capstone Seminar in Geospatial Science: Military Geography.* 3(1). This course is the culmination of the geospatial science curriculum. Military geography considers the influence of geography on military operations and the impacts of military activities on places and the environment. Topics include accounting for physical and cultural geography in operational planning, spatial variability in military-civil society relations, and the effect of military activities at a variety of scales on places. Final project. Prereq/Coreq: Geo 250, Geo 310, or Geo 351, or Course Director approval. Sem hrs: 3 spring.

Geo 412. *World Cultural Geography.* 3(1). This course will introduce students to systematic methods for analyzing and assessing world cultural regions while also exploring the causes of important cultural groupings around the world, their attributes, and patterns of interaction. The main objective of this course is to give students a better understanding of the world they live in by challenging their pre-existing cultural stereotypes and strengthening their mental map of global cultures. Throughout the world, an increase in the number of regional conflicts coupled with recent geopolitical shifts has highlighted the need to understand cultural geographic relationships. Each geographic region will be examined for the impact of human-cultural and physical-environmental attributes, assets, liabilities, linkages, barriers, and potential prospects. The various sub-disciplines of geography (culture and ethnicity, levels of economic development, industrial and agricultural bases, population demographics, and the physical environment) will be used to explore connections within and between regions. The overall theme emphasizes the interconnectivity and globalization of all the regions of the world. Final paper. Prereq: None. Sem hrs: 3 fall or spring.

These courses contribute to the development and assessment of the Human Condition, Cultures, and Societies outcome.

Geo 440. *Advanced Geospatial Analysis.* 3(1). This course equips students with advanced analytical skills to understand and resolve complex geospatial problems. Discussion and projects will integrate advanced geospatial analysis techniques with real world data to address problems similar to those officers may encounter in the operational Air and Space Forces. Building on knowledge and expertise learned in Introduction to Geospatial Information Systems (Geo 340), students will integrate theoretical geoscience concepts with data analysis and information-extraction techniques. Final exam or final project. Prereq: Geo 340. Sem hrs: 3 fall.

Geo 452. *Physical Geography of Volcanic Landscapes.* 3(1). The course addresses aspects of the physical geography and environments of landscapes created and/or dominated by volcanism and other igneous processes. Topics include causes of volcanism and volcanic processes, volcanic landforms, volcanic hazards, and microclimates of volcanic landforms and features, among others. The course includes optional weekend field trips to sites in the region. Students will engage in both theory and concepts, and apply these to case studies and collected datasets for hypothesis testing. Final Project. Prereq: Geo 351. Sem hrs: 3 fall of even-numbered years.

Geo 470. *Geography of Europe and Russia.* 3(1). This course is designed to provide a geographical analysis of the diverse regional-cultural landscapes of Europe, Russia, and Central Asia. This is an advanced human geography course focusing on the complex human interaction with the physical environment. Special attention will be paid to the formation and current status of the entire European cultural area to improve cadet understanding and cultural awareness of topical analysis regarding demography, language, religion, economics, geopolitics, and relations with the rest of the world, to include the United States. Final exam or final project. Prereq: None. Sem hrs: 3 (offering times determined by DFEG).

Geo 471. *Geography of the Americas.* 3(1). This course is designed to provide a geographical analysis of the diverse regional-cultural landscapes of North America, South America, and Caribbean regions. This is an advanced human geography course focusing on the complex human interaction with the physical environment. Special attention will be paid to the formation and current status of the entire regional-cultural area to improve cadet understanding and cultural awareness of topical analysis regarding demography, language, religion, economics, geopolitics, and relations with the rest of the world, to include the United States. Final exam or final project. Prereq: None. Sem hrs: 3 (offering times determined by DFEG).

Geo 475. *Geography of Asia.* 3(1). This course is designed to provide a geographical analysis of the diverse regional-cultural landscapes of East Asia, Southeast Asia, and the South Asia regions. This is an advanced human geography course focusing on the complex human interaction with the physical environment. Special attention will be paid to the formation and current status of the entire regional-cultural area to improve cadet understanding and cultural awareness of topical analysis regarding demography, language, religion, economics, geopolitics, and relations with the rest of the world, to include the United States. Final exam or final project. Prereq: None. Sem hrs: 3 (offering times determined by DFEG).

Geo 480. *Geography of the Middle East and Africa.* 3(1). This course is designed to provide a geographical analysis of the diverse regional-cultural landscapes of the Middle East and African regions. This is an advanced human geography course focusing on the complex human interaction with the physical environment. Special attention will be paid to the formation and current status of the entire regional-cultural area to improve cadet understanding and cultural awareness of topical analysis regarding demography, language, religion, economics, geopolitics, and relations with the rest of the world, to include the United States. Final exam or final project. Prereq: None. Sem hrs: 3 (offering times determined by DFEG).

Geo 482. *Advanced Remote Sensing.* 3(2). Students will explore advanced analysis techniques for extracting information from satellite imagery. Imagery of various spatial and spectral scales will be used, including thermal-infrared and radar imagery. The goal of this course is to provide students with experience in tackling geospatial problems with remote sensing data—from development of the questions, to identification of the necessary data, and finally selection and execution of appropriate analysis techniques. The course will include several case studies. Final project. Prereq: Geo 382. Sem hrs: 3 spring.

Geo 488. *Geospatial Intelligence.* 3(1). This course will introduce students to the crucial role of geography in national security and intelligence. Students will conduct an in-depth exploration of processes, products, and members of the Geospatial Intelligence (GEOINT) Enterprise, investigating how GEOINT serves stakeholders and decision makers. Students will gain insight into the history and development of GEOINT. They will examine imagery, spatial data, and analytical practices across a range of military and intelligence applications. Students will discover the emerging possibilities of GEOINT technologies towards solving national security priorities with an applied exercise and presentation of their work. Final Project. Prereq: None. Sem hrs: 3 fall.

Geo 495. *Special Topics.* 3(1). Selected topics in geospatial science. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Geo 498. *Research in Geospatial Science.* 3(0). The course is a research-based option for the capstone. It is designed to integrate and synthesize geoscience knowledge, analytical techniques, and research methods using geospatial research tools. A research project will be conducted on topics related to Geospatial Intelligence (GEOINT), human geography, physical geography, sustainability, planning, and/ or regional geography. Final project or report. Prereq: Department approval. Offering time determined by DFEG.

DFEG.Geo 499. *Independent Study.* 3(0). Independent research under the direction of a faculty member. Research paper or final project. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Geo 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Geo 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Geo 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

HISTORY

(History)

Offered by the Department of History (DFHI)

History 100. *The History of Modern Warfare.* 3(1). Cadets will develop a greater understanding of the Warrior Ethos by deepening their comprehension of the profession of arms and how it struggles to win wars. In order for cadets to comprehend the profession of arms and gain an understanding of the nature and character of wars, this course will develop in them the ability to critically assess the factors that have led to success and failure in war through a thoughtful

consideration of warfare's evolution at each of its three levels: strategic, operational, and tactical. The course covers evolving ideas and methods of warfare from the twentieth century to the present. The course also demonstrates the critical importance of certain professional qualities required to serve honorably and successfully in the profession of arms. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

History 100S. *The History of Modern Warfare (Scholars).* 3(1). This reading, writing, and discussion intensive course covers the evolving ideas and methods of waging war from the twentieth century to the present. Select academically gifted cadets will develop a greater understanding of the Warrior Ethos by deepening their comprehension of the profession of arms, its development over time, and its relationship to warfare. Most especially, they will gain greater knowledge of how military professionals have sought victory at the various levels of war, and enhance their understanding of why various military forces, states, and entire alliance networks have succeeded and failed in war. The course will also demonstrate the critical importance of certain professional qualities required to serve honorably and successfully in the profession of arms. Prereq: None. Final exam or final paper. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

History 200. *The Historian's Craft: Introduction to Historical Methodology.* 3(1). A history practicum that is the "how to" course for history majors. The course is devoted to practicing historical methodology, including historical "detective work," critical analysis of evidence, asking and answering historical questions, and oral and written presentation skills. Each student will write and present a major research paper on a topic of his or her choice. Final paper. Prereq: History 100 or department approval. Sem hrs: 3 fall or spring.

History 210. *The Foundations of Modern America.* 3(1). This course examines the political, intellectual, social, and economic origins and development of the United States from the first settlements through the Reconstruction period (1865-1877). Course readings will emphasize the importance of the colonial experience, the American Revolution, the early national period, the growth of democracy, Westward expansion, and the Civil War and Reconstruction in shaping modern America. Final exam and/or final project. Prereq: None. Sem hrs: 3 fall.

History 220. *Let Freedom Ring?: American History since Reconstruction.* 3(1). This course continues the examination of the political, intellectual, social, and economic development of the United States from the late nineteenth century to the present and concentrates on the growth of the United States as a major economic and political power. Special attention is given to the impact of industrialization, urbanization, immigration, reform movements, mass culture, domestic economic fluctuations, governmental expansion, and military involvements during the twentieth century. Final exam and/or final project. Prereq: None. Sem hrs: 3 spring.

History 230. *Bastille to Brexit: Introduction to Modern European History.* 3(1). A survey of the political, social, and cultural history of modern Europe since the Enlightenment. The course will examine major themes in European history, including: clashing currents of war and peace; dictatorship and democracy; racism/genocide and human rights; the state and the people; regionalism and integration. Major eras include Napoleon's wars for empire, industrial revolutions, European nationalist movements, World War I, the inter-war years, World War II, the decline of the European empires, and the Cold War. This course concludes with a study of the legacies of the Cold War and the advent of the European Union. Final exam and/or final project. Prereq: None. Sem hrs: 3 fall.

History 240. *Steppes, Stalin, and Sputnik: Introduction to Russia and Eurasia.* 3(1). Comprising roughly 35 percent of the world's landmass and millions of people, Eurasia has long been an important and influential force in history. Migrations, dictatorships, civil war, displacement, religious diversity, and the rise and fall of empires are but a few of the pieces in a transnational history that spans Russia, Eastern Europe, and Central Asia. Examining vast yet interconnected spaces and peoples, this course will first consider social, economic, and political developments across the region since Ivan Grozny, Russia's first Tsar, consolidated power and land. Taking into account modern statehood, nationalism, and the rise of twentieth-century empires, it will delve into such topics as the Silk Road, the Steppe populations, the influence of the Mongols, life under Soviet and Chinese authoritarianism, independence movements, security issues, and the region's unique experience as both part of and a buffer between Europe and Asia. Through varied sources and assignments, this course will highlight new perspectives and sharpen analytical skills. Final exam and/or final project. Prereq: None. Sem hrs: 3 fall.

History 250. *Introduction to the History of the Middle East and North Africa.* 3(1). This course will explore the development of the modern Middle East and North Africa from the origins of Islam to the Arab Spring. Through a combination of lecture, analysis, discussion, and debate, cadets will develop a more in-depth understanding of this critical and dynamic region. Potential areas of focus will include the role of Islam in the development of the early caliphates; the impacts of the Crusades and cross-cultural contact; the establishment and expansion of major empires; the role of different groups and religions in Islamic states. The course will consider important changes, including: the impacts of European colonialism, the spread of ideas like nationalism, constitutionalism, modernization, and reform; independence and nationalist movements and the creation of modern states; the origins of the Arab-Israeli conflict; the United States' influence in the region; and other contemporary trends, challenges, and opportunities facing the people of the region. Final exam and/or final project. Prereq: None. Sem hrs: 3 spring.

History 260. *Historia Pasada y Presente: Introduction to Modern Latin American History.* 3(1). This course will examine Latin American history from the Wars of Independence in Mexico, Argentina, and Central America to present. Through a combination of lecture, analysis, discussion, and debate, cadets will develop an understanding of the rich, and at times turbulent, history of the region and the individual societies in it. The course will examine the roles and consequences of European colonization and then move on to such topics as revolution, slavery, indigenous and African cultures, and modernization. The course will consider the diverse ethnic

makeup of this geo-political region, identity politics, the clash between democracy and dictators such as Pinochet or Trujillo, and Latin America's role in the global economy. Cadets will examine the idea of 'Latin America' over time and the region's evolving relationship within the Western Hemisphere and the world more broadly. Through a variety of approaches and source material, it will deepen historical understanding and critical thinking skills. Prereq: None. Final exam and/or final project. Sem hrs: 3 spring.

History 270. *Modern East Asian History.* 3(1). This course is a survey of the key developments in the history of China, Japan, and Korea from the nineteenth century to the present day. It begins with background topics such as the traditional foundations of East Asian society, the structure of the East Asian world order, and the impact of cultural exchange on the early history of the region. The course then examines internal developments and the external relations of China, Japan, and Korea since 1800, including topics such as the impact of Western imperialism, the influence of Western ideologies such as nationalism, the nature of technological and economic change, the significance of political and cultural leaders, and the role China, Japan and Korea have played in shaping the post-World War II world. In this way, the course provides a basic background on the major political, economic, and socio-cultural developments in this vital area of the world. Final exam and/or final project. Prereq: None. Sem hrs: 3 fall.

History 280. *Africa South of the Sahara.* 3(1). This survey of African history focuses on the eras following Africa's integration into the global economy in the fifteenth century. It explores African societies prior to colonialism, the brief period of European colonial domination, and the challenges of post-colonial independence. The course will help students understand the influence of historical forces such as geography and climate, disease, religion, warfare, economics and trade, and domestic and international politics on African societies over time. Through such topics as the Atlantic World, European imperialism, colonialism, modernization, Pan-Africanism, military and political dictatorships, postcolonialism, and national self-determination, cadets will consider Africa's changing politics, economics, and culture over time. Cadets will practice critical thinking, writing, and oral communication skills. Final exam and/or final project. Prereq: None. Sem hrs: 3 spring.

History 290. *Global Contact and Local Responses in South and Southeast Asia.* 3(1). This course is a survey of key developments in the history of South and Southeast Asia from the sixteenth century to the present. It will begin with background topics such as the development and spread of religions, the importance of trade and economic connections, early states, empires, political formation, and the critical role of cultural exchange. The course then examines the region since 1500, including topics such as the spread of Islam, the impact of Western imperialism, the influence of Western ideologies such as nationalism, the nature of technological change, the significance of political and cultural leaders such as Mohandas K. Gandhi and Sukarno, and the role these regions played in shaping the post-1945 world, paying special attention to the importance of decolonization and the Non-Alignment Movement. In this way, the course provides a basic background on the major political, economic, and socio-cultural developments in these vital areas of the world. Final exam and/or final project. Prereq: None. Sem hrs: 3 fall of even-numbered years.

History 300. *World History*. 3(1). A comprehensive global survey of human civilization and its significant changes over time. This course will ensure that cadets have the ability to identify, describe, and explain the uniqueness and interconnectedness of people, cultures, and societies in both their spatial and temporal contexts. In order to better understand the evolution and interconnectedness of human history, the course will utilize a framework of transculturation. Through an analysis of world history, cadets will have the ability to better understand how the modern world came into existence. This course highlights the global impacts of political, religious, ideological, military, economic, and social development. This course will challenge cadets to analyze their own identities and origins, their relationships to different groups and peoples, and human interaction in a global context. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Human Condition, Cultures, and Societies outcome.

History 300S. *Scholars World History*. 3(1). This course is the Martinson Honors Program version of History 300, Introduction to World History. Through the use of major works of world history, cadets examine and analyze several major themes of world history focusing on the role that the interaction of people and societies, technological advances, and environmental factors such as disease, geography, and energy have played in shaping world history. Discussion forms the bedrock of this course and Scholars will actively participate. Final exam. Prereq: History 100 or 100S and Scholar status. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Human Condition, Cultures, and Societies outcome.

History 320. *Winged Defense: The History of Airpower*. 3(1). Cadets will engage with the history and development of airpower considering its tactical, operational, and strategic employment as well as important airpower leaders. This course pays particular attention to the global development of military airpower, stressing the constant interplay among personalities, institutions, theories, technology, combat experience, and the evolution of doctrine. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 spring.

History 321. *STEM at War: History of Technology and Warfare*. 3(1). Examines the relationship of technology to warfare on land, at sea, and in the air from antiquity to the present. Investigates the roots of weapons technology in social, political, economic, and environmental context. Special treatment is afforded to the impact of engineering and the Industrial Revolution on the development of technology and its subsequent impact on warfare. The interrelationship of technology, tactics, and strategy provides the thematic framework. Several lessons are devoted to case studies of battles and campaigns that illustrate significant developments. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall of even-numbered years.

History 322. *Conquest of the New Frontier: A History of Space Power*. 3(1). Examines a history of space power focusing on the development and evolution of technology and doctrine from its origins in the German V-programs to the Cold War and beyond. Topics include ICBMs, satellites, the electronics revolution, and the manned space programs. Course themes include the

interplay between individuals, organizations, technology, politics, and global events with an emphasis on USAF and Soviet military space and ICBM programs' doctrinal and technological challenges. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall.

History 323. *Sea Power and Modern Warfare.* 3(1). This course surveys the history of war at sea from the Age of Sail to the present. Cadets will examine the evolution of sea power theory and practice throughout history. While this course aims to be global in context, it will focus most closely upon developments in Britain (1588-present) and the United States (1776-present). Specifically, cadets will explore the ascendancy of England/Britain as the world's foremost maritime power until being supplanted by the United States during the Second World War and Cold War. By the end of the course cadets should understand the development of sea power as an instrument of national policy in war and peace, and the factors that have led to success and failure in naval warfare, considering the three levels of war: strategic, operational, and tactical. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall of even-numbered years.

History 324. *The History of Unconventional Warfare.* 3(1). Surveys the practice of guerrilla, irregular, and unconventional warfare, to include discussion on terrorism, throughout human history and across various regions and cultures. Examines counterinsurgency efforts and special operations. Special attention is given to the twentieth century. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall of odd-numbered years.

History 325. *Ancient and Medieval Warfare.* 3(1). A broad survey providing a deeper background for the understanding of modern war. The course begins with the rise of organized warfare in the Near East, focusing on the Assyrian and Persian military systems, traces the development and operations of the Greek and Roman military systems, and then moves to the evolution of feudal warfare and its eventual metamorphosis into the earliest forms of modern war, culminating in the Thirty Years War. Cadets will also consider Middle Eastern, Byzantine, Chinese, and Japanese forms of warfare to complete a general survey of the roots of modern warfare. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall of even-numbered years.

History 326. *The Rise of Gunpowder: The Western Way of War from 1618-1905.* 3(1). Cadets will develop a greater understanding of the Western profession of arms as it evolved through times dominated by mercenaries, armed with pikes and early black powder weapons, to the days of mass armies of citizen soldiers fighting with an increasing array of sophisticated weapons made possible by industrialization. In this course, cadets will gain a greater comprehension of the modern profession of arms through a thoughtful consideration of warfare's evolution at each of its three levels: strategic, operational, and tactical. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 spring of odd-numbered years.

History 327. *The Great War: The History of World War I.* 3(1). A study of the epochal event of the twentieth century. Students will explore the war's causes, conduct, and consequences, covering the war from the perspective of all the major belligerents, Entente and Central Powers. Students will also conduct detailed analysis of the role ideology, strategy, technology, colonialism,

race, gender, and other social factors played on both the battlefields and home fronts of the First World War. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall of even-numbered years.

History 328. *Axis and Allies: The History of World War II.* 3(1). A study of the largest conflict in human history. Students will explore the war's causes, conduct, and consequences, covering the war from the perspective of all the major belligerents, Axis and Allied. Students will also conduct detailed analysis of the roles ideology, strategy, technology, colonialism, race, gender, and other social factors played on both the battlefields and home fronts of World War II. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 spring.

History 329. *Korean War and the Cold War.* 3(1). This course will examine the foundations of the Cold War and the U.S. strategy of containment that evolved during it. Within the context of this superpower system and the beginning of a nuclear arms race, America's war in Korea showcases a new pattern of limited warfare in the twentieth century. Studies will place special emphasis on the role of foreign policy, domestic social and political climates, technology, and the long-term implications of American strategy and policymaking. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall of odd-numbered years.

History 330. *The Vietnam War.* 3(1). This course examines the origins, actions, and consequences of the Indochina wars fought by the French, Japanese, and Americans during the last century. The course gives particular attention to the American experience in Southeast Asia. Within the context of the superpower system and the beginning of a nuclear arms race, the United States tried to fight a war to achieve limited aims with limited means. Studies will place special emphasis on the role of technology, foreign policy, domestic social, and political climates, cultural influences, and the political and cultural legacies of American strategy and policymaking. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 spring of even-numbered years.

History 331. *The History of War and Society.* 3(1). The History of War and Society expands the study of warfare beyond its military, diplomatic, and political dimensions by examining the social and cultural aspects of how societies go to war, experience war, and live with its consequences. Emphasis will be placed on the influence of societal and cultural beliefs on warfare, national military policies, the impact of war on social and cultural institutions, values, and practices, and the interaction between the home front and the battlefield. Cadets may also explore the relationships between war, identity, and historical memory. Repeatable. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall of even-numbered years.

History 332. *Great Commanders.* 3(1). This course explores the role of history's finest military leaders in their pursuit of victory. History 332 will address the challenges of command throughout the history of conflict on the land, at sea, and in the air. Cadets will learn to evaluate the character and characteristics of individuals whose presence made the difference between victory and defeat while earning them a place in the pantheon of history's most capable military leaders. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall of even-numbered years.

History 333. *History of Military Thought and Strategy.* 3(1). An investigation of the ideas of selected military thinkers and strategists from across the ages and around the globe. Emphasis is on those writers whose impact on evolving ideas of strategy and doctrine, whether on land, sea, or air, has been most far-reaching. The history of military thought is the study of the development of competing ideas about the employment of armed force. In this course cadets will study influential military thinkers and investigate several overarching questions: What is the nature of war? How have major military theorists proposed to use military force? How influential have their thoughts been on the practice of warfare and on subsequent military theory? What factors rival military theory in shaping the formation and employment of military forces? This investigation should inform your own understanding of war, especially as it applies to your future as a military professional. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 spring of odd-numbered years.

History 340. *America and the World.* 3(1). This course will expose cadets to the interconnected facets of global America, overlaying the foreign relations of the United States onto its domestic history. It will pay specific attention to networks, identities, and processes that transcend the nation-state, demonstrating how quintessential American events both shaped, and were shaped by, the global environment. Potential topics include the American Revolution, slavery and abolitionism, labor activism, economic connectivity, the American Civil War, suffrage and women's rights, Wilsonian internationalism and isolationism, the World Wars and interwar period, the Civil Rights Movement, and the Cold War. Course may include a combination of lecture, seminar, cadet presentations, and debate. Final exam and/or final project. Prereq: None. Sem hrs: 3 fall.

History 341. *American Regional Identities.* 3(1). The United States is a rich tapestry of diverse regional identities that have been subsumed within the national character. This course will examine how the history, ideology, economies, demographics, and environment of one of these various regions shaped its identity and how that identity has influenced the nation as a whole. The major regions for study will be New England, the South, the Midwest, the West, and the West Coast on a rotating basis. Repeatable. Final exam and/or final project. Prereq: None, but completion of History 210 and 220 is recommended. Sem hrs: 3 spring of odd-numbered years.

History 342. *Early Modern Warfare in the Atlantic World.* 3(1). A comprehensive examination of the competition and conflicts that resulted from European explorations and conquests of the fifteenth, sixteenth, and seventeenth centuries that erupted into serial warfare in the eighteenth century. These conflicts exposed all sides to different modes of warfare that would shape future combat. This course examines the causes for these wars (with an emphasis on the conflicts in North America) and the changes in tactics and strategy that resulted. Final exam and/or final project. Prereq: None, but completion of History 210 is recommended. Sem hrs: 3 spring of even-numbered years.

History 343. *The American Revolution.* 3(1). A comprehensive examination of the American Revolution and the War for Independence that it spawned from the conclusion of the French and Indian War in 1763 to the Treaty of Paris in 1783. This course will evaluate the political,

ideological, economic, and religious causes for the rupture with Great Britain, provide in-depth coverage of the course of the war, as well as the enduring significance of the colonists' improbable victory on United States' nationalism and its military establishment. Prereq: None, but completion of History 210 is recommended. Sem hrs: 3 fall of odd-numbered years.

History 344. *The American Civil War.* 3(1). A multidimensional examination of the causes, conduct, and legacy of the American Civil War. An in-depth analysis of Southern sectionalism will precede a comprehensive discussion of all aspects of the war itself: military, economic, cultural, social, political, technological, and ideological. The course will conclude by describing the short and long-term effects of the war. Final exam and/or final project. Prereq: None, but completion of History 210 is recommended. Sem hrs: 3 spring of even-numbered years.

History 345. *The American Way of War.* 3(1). This course surveys the history of American warfare from the colonial period to the present and examines the history of American national security. It focuses primarily on the character of American warfare and addresses the question of whether there is a peculiar American way of war or approach to national security. The course deals with such issues as the American attitude towards war, civil-military relations, force structure, the role of professional leadership, national security issues, and the impact of technology. Final exam and/or final project. Prereq: History 100. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the National Security of the American Republic outcome.

History 346. *Great Americans.* 3(1). Examines the role of individual persons in American history. This course will use biographies of selected prominent Americans to understand the unique personal qualities that contributed to their success and to determine the extent to which individual actions impact the course of history. Cadets will meet political, military, business, labor, scientific, and literary figures. Final exam and/or final project. Prereq: None, but completion of History 210 and 220 is recommended. Sem hrs: 3 spring of odd-numbered years.

History 347. *Power to the People: American Culture in the 1960s and 1970s.* 3(1). This course examines the significant cultural, economic, and social upheavals in American society during the turbulent 1960s and 1970s. Politically, it will address the numerous Civil Rights movements of the period as well as grassroots opposition to the Vietnam War. Culturally, it will explore topics such as Hippies, the sexual revolution, counter-culture, suburbanization, and rock n' roll. Finally, it will examine the economic impact of inflation, deindustrialization, and oil shortages. Final exam and/or final project. Prereq: None, but completion of History 220 is recommended. Sem hrs: 3 fall of even-numbered years.

History 360. *Topics in Regional History: Eastern/Western Europe; Russia; Latin America.* 3(1). This upper-division seminar will provide cadets the opportunity to dive into historical topics with a regional theme, which will vary by instructor expertise, and will provide forums for close analysis of primary and secondary sources or engaged debate of ideas. They will develop writing, communication, and critical thinking skills. Repeatable. Final exam and/or final project. Prereq:

None, but completion of the appropriate 200-level regional survey course is recommended. Sem hrs: 3 fall of odd-numbered years.

History 361. *Topics in Regional History: Eastern, Central, or Western Asia; Africa.* 3(1). This upper-division seminar will provide cadets the opportunity to dive into historical topics with a regional theme, focusing on Eastern, Central, or Western Asia, or on Africa. The topic will vary by instructor expertise and will provide forums for close analysis of primary and secondary sources or engaged debate of ideas. They will develop writing, communication, and critical thinking skills. Repeatable. Final exam and/or final project. Prereq: None, but completion of the appropriate 200-level regional survey course is recommended. Sem hrs: 3 spring of odd-numbered years.

History 362. *Comparative Empires in World History.* 3(1). Empires rise and fall. Size. Military power. Governance. Reach. Context matters. This course will offer cadets the opportunity to compare and contrast empires across centuries and locations. Potential topics include the Persian, Roman, Mongol, Aztec, Portuguese, Mughal, Ottoman, Comanche, British, Chinese, and Japanese empires. It will challenge cadets to engage questions of difference, the complexity of the colonizer/colonized relationship, and the evolving connections between colony, metropole, and the wider world. Course may include a combination of lecture, seminar, cadet presentations, and debate. Repeatable. Final exam and/or final project. Prereq: None, but completion of History 300 is recommended. Sem hrs: 3 spring.

History 363. *Modern Colonial Empires and Decolonization.* 3(1). The spread of European maritime empires after the fifteenth century fundamentally shaped the modern world. However, the relationship between colonizer and colonized was never stable or consistent. This course will expose cadets to the vast array of interactions and the impacts of these contacts, both in the metropole and the colony. The course will also highlight colonial critiques of empire, building towards the era of rapid decolonization. It will analyze the challenges and opportunities facing both newly independent nation-states and their former colonizers as they faced a new postcolonial world. Final exam and/or final project. Prereq: None, but completion of History 300 is recommended. Sem hrs: 3 fall.

History 364. *Gender and Sexuality in History.* 3(1). This course will expose cadets to the origins and evolution of gender history and the history of sexuality. It will first explore changing methodological approaches and perspectives that have developed since the 1960s. It will then place these topics in their global context, recognizing the importance of cross-cultural contact on concepts of identity and sexuality. The specific focus of the course will depend on instructor, pursuing thematic, regional, or chronological approaches. Cadets will engage the topic through a combination of seminar discussion, debate, group projects, and lecture. Final exam and/or final project. Prereq: None, but completion of History 300 is recommended. Sem hrs: 3 spring of even-numbered years.

History 365. *Topics in Ancient and Early Modern World History.* 3(1). From Hammurabi and Charlemagne to the Aztecs and the Ming Dynasty, the world bore witness to the growth of human interaction and unique quests for stability and growth. At the same time, cultural and intellectual

life flowered, adding complexity and depth to interconnected world societies. Each step of the way, diverse civilizations and cultures interacted with others near and far, affecting their development and longevity. Through a variety of approaches and methodologies, cadets will consider the experiences of ancient and early modern societies in a comparative context that spans centuries and continents. Varying in topic and focus, this course will deepen cadet understanding of the complex and intertwined nature of world history. Repeatable. Final exam and/or final project. Prereq: None, but completion of History 300 is recommended. Sem hrs: 3 spring of odd-numbered years.

History 366. *Race, Nationalism, and Ethnicity in History.* 3(1). Using primary sources, images, film, and journals, this course will explore the foundations and manifestations of race, national identity, and ethnicity in an international context. First considering the theoretical frameworks and early figures influencing the constructions of racial, nationalist, and ethnic thinking, cadets will examine their complex social and political consequences across space and time. After setting this foundation, cadets will have the opportunity to grapple with and compare specific cases, such as the Khmer Rouge, the Yugoslav and Rwandan crises, and eugenic movements in North America, Eurasia, and Australia. The course will also consider the many faces of resistance to oppression, both formal and informal. Final exam and/or final project. Prereq: None, but completion of History 300 is recommended. Sem hrs: 3 fall of odd-numbered years.

History 367. *Oceanic Systems.* 3(1). This course will emphasize the importance of studying oceanic histories and the connections they help develop between groups once perceived as geographically separate. This course will challenge cadets to recognize the richness of global history and connections, even when they are separated by expansive seas and crashing waves. It will expose them to the rich history of cultural, diplomatic, military, economic, and political exchange across maritime systems. Potential areas include the Indian Ocean, the Atlantic World, the Pacific World, and the South China Sea. Course may include a combination of lecture, seminar, cadet presentations, cultural experiences, and debate. Repeatable. Final exam and/or final project. Prereq: None, but completion of History 300 is recommended. Sem hrs: 3 fall of odd-numbered years.

History 368. *Big Ideas: Intellectual Trends in World History.* 3(1). This course will trace world history through the evolution of ideas. It will engage how individuals have understood, reacted to, and participated in such developments as the creation and expansion of philosophy and religion, the evolving nature of economic theory, the role of political philosophy and the state, and the influence of global contact on ideas like race, gender, and class. It will engage cadets on these ideas and place them in their historic context, engaging both primary sources and secondary literature. Course will include a combination of seminar discussion, debate, and lecture. Repeatable. Final exam and/or final project. Prereq: None, but completion of History 300 is recommended. Sem hrs: 3 spring of odd-numbered years.

History 369. *Globalization: The History of People, Products, Ideas, and Systems in Motion.* 3(1). What is globalization? Who is global? Is the world really becoming more global or is it a matter of how we examine the past and present? A word oft-used, but little understood,

"globalization" represents many, at times conflicting, images and ideas. Considering such examples as the Atlantic World, the ubiquitous McDonalds, Coke, and Starbucks in Europe and China, and migration patterns, cadets will grapple with the theory and consider disparate examples to understand the meanings of globalization and its consequences, including intense local backlash. As the question of globalization is not confined to historians, this course will consider how borrowing from other disciplines supports and enhances historical inquiries. Cadets will delve into the sociological, economic, political, cultural, and historical aspects of globalization and its meaning over time, analyzing diverse sources and arguments. Final exam and/or final project. Prereq: None, but completion of History 300 is recommended. Sem hrs: 3 fall of even-numbered years.

History 380. *Film in History.* 3(1). Movies captivate our imagination and transport us to places unfamiliar or unknown. Film also can act as a moral witness and reflect varying interpretations of the past in portrayals of history. Through a combination of film, discussion, and analysis of historical developments, this course will explore the many facets of history on the big screen. Organized thematically or geographically and depending on instructor, this course may cover such topics as warfare, resistance, race, memory, gender, or global diasporas. First equipped with needed historical context and criticism techniques, cadets will analyze films that span perspectives, genres, and eras to analyze the ways in which movies depict the past, deepen our understanding of history, and reflect contemporary issues and narratives. They may also consider such issues as censorship, propaganda, and manipulation of ideas. They will develop writing, communication, and critical thinking skills. Repeatable. Final exam and/or final project. Prereq: None. Sem hrs: 3 spring of even-numbered years.

History 400. *Advanced Seminar: Historiography.* 3(1). This is the first of two required seminars for the senior thesis/project in the History program. Students will work with a faculty advisor to immerse in literature that surrounds a particular temporal or thematic concept. With a number of preliminary assignments, students will practice historical methodology, the ways historians gather information and formulate hypotheses. They will also use primary and secondary sources to wrestle with the challenges of objectivity, selectivity, and bias in historical interpretation. Final project. Prereq: History 200 and C2C standing. Sem hrs: 3 spring.

History 401. *Senior Seminar: Research/Senior Thesis or Project.* 3(1). Building on their preliminary work in History 400, students will work with a faculty advisor to research and develop a capstone project or write a senior thesis. The senior thesis/project will be based on a well-developed research question, demonstrate a sound understanding of the historiography of the thesis topic, engage primary and secondary sources in the research, and present a compelling historical argument/interpretation. Prereq: History 400 and C1C standing. Sem hrs: 3 fall.

History 402. *Global Dimensions of History: Capstone for FAS History Majors.* 3(1). An examination of the dynamic forces influential in shaping the history of the regions of the world. Explores time, space, politics, economics, and society in the context of world history. Special attention is given to the impact of varying cultural perspectives upon individual historical

understanding. The historical dimensions of globalization and its challenges are also examined. Final exam and/or final project. Prereq: History 200 and C1C standing. Sem hrs: 3 spring.

History 495. *Special Topics.* 3(1). Selected topics in history. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

History 499. *Independent Study.* 3(0). Reading and research in any recognized area of historical study. Areas selected by instructor depend on student interest. Research paper or intensive reading program with written analysis of assigned works. Prereq: Department approval and 3.0 cum GPA. Sem hrs: 3 fall or spring.

- History 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- History 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- History 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

HUMANITIES

(Hum)

Offered by the Departments of the Humanities Division

Hum 200S. *Introduction to the Humanities.* 3(1). Interdisciplinary course. A seminar-style introduction to the intellectual history of Western Civilization through literature, philosophy, the fine arts, and the history of law and science. The course aims to lay the foundation for further study in the disciplines of the humanities, to enhance integrated knowledge and critical thinking, and to prepare students for advanced study. Final project. Prereq: Course director approval. (Administered by the Humanities Division Chair). Sem hrs: 3 spring.

Hum 400S. *Humanities Seminar.* 3(1). Interdisciplinary course. A seminar focused on the history of Western Civilization through literature, the arts, and philosophy. Related topics include the history of law and history of science, and their impact on trends in the humanities. This approach is invaluable for enhancing integrated knowledge and critical thinking, and is excellent preparation for cadets wishing to pursue graduate studies in the humanities. Cadets enrolled in the Martinson Honors Program (MHP) who completed Hum 200S may elect to take Hum 400S with approval of the course director. Final project. Prereq: 3.0 cum GPA and course director approval. (Administered by the Humanities Division Chair). Sem hrs: 3 fall.

Hum 401. *Humanities Divisional Core Substitute.* 3(0). This course can only be awarded for coursework accomplished during a semester of study abroad (CSSAP), international exchange (CSEAP), or service academy exchange (SAEP). With applicable Department Head or Division Chair approval, this course can fulfill the core requirement for Philos 210 or for English 411 as the Advanced Sociocultural Option. (Administered by the Department of Foreign Languages). Sem hrs: 3 fall or spring.

Hum 402. *Scholarship Studies.* 2(1). Scholarship Studies is an interdisciplinary course designed to prepare cadets for the rigors of Rhodes, Marshall, Gates, and Churchill scholarship application

processes. The course helps cadets to focus on refining their leadership skills, increase awareness of application and interview subjects, and develop the intellectual methods required to articulate the complexities of modern problems. The course further prepares scholarship applicants for advanced academic studies. Enrollment consists primarily of first-class cadets. Pass/fail. Prereq: GSC approval. (Administered by the Graduate Studies Office of Student Academic Affairs). Sem hrs: 2 fall.

Hum 430. *The Holocaust*. 3(1). The subject of the Holocaust, the destruction of the Jews of Europe and others at the hands of the Nazis and their collaborators, is of great significance in the history of human civilization. The extensive documentation of this systematic genocide lends itself to a pedagogical examination of critical lessons in the study of human history and behavior, as well as ethical issues. Through this investigation, cadets can also understand what it means to be a responsible citizen and soldier. Final exam. Prereq: History 300 or divisional approval. (Administered by the Department of History). Sem hrs: 3 spring of even-numbered years.

Hum 461. *Russian Literature*. 3(1). A study of representative Russian authors and their works (e.g., Pushkin, Chekhov, Dostoevsky, Tolstoy, Babel, Pasternak, and Solzhenytsyn) in their historical and cultural settings and their impact on the shaping of the national character of the Russian people. Final project, research paper, and/or final exam. (Administered by the Department of Foreign Languages). Sem hrs: 3 fall of odd-numbered years.

Hum 463. *Far Eastern Literature*. 3(1). An historical survey and analysis of major literary works of the Far East with emphasis on China and Japan. Final exam. (Administered by the Department of Foreign Languages). Sem hrs: 3 fall or spring.

Hum 495. *Special Topics*. 3(1). Selected topics in humanities. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

INTERDISCIPLINARY **(INTERDIS)**

Offered by the Vice Dean for Academics (DFW)

INTERDIS 463S. *Reflecting on Wicked Problems*. 3(1). This course will serve as a capstone seminar for Scholars students concluding their time in the Martinson Honors Program. The course focuses on two interrelated tracks of research and self-reflection to encourage students to recognize the connection between individual interests, background, environment, and problem-solving techniques. Students will work in small teams to solve difficult problems they have identified in a variety of different mediums, from film to fabrication, which reinforce the skills they have built through the USAFA Outcomes. At the same time, students will generate self-reflection in both individual and group settings to build their understanding of their own experiences as well as those of their peers. Final Project. Sem hrs: 3 fall/spring.

INTERDIS 495. *Interdisciplinary Special Topics.* 3(1). Selected interdisciplinary topics, taught in seminar format. One field trip per semester when appropriate destinations are available. Final exam or final report. Prereq: None. Sem hrs: 3 fall or spring.

LAW

Offered by the Department of Law (DFLA)

Law 220. *Law for Department of the Air Force Officers.* 3(1). A core course utilizing case law and texts to cultivate habits of critical thinking within cadets. The course also develops in cadets the legal knowledge and selected skills necessary to be an educated Air Force officer and citizen. This is accomplished by examining the nature of law, the military justice system, constitutional law, criminal law, and the law of armed conflict. Critical thinking is developed within multiple contexts, potentially including: in-class debate, Socratic discussions, oral exercises, and written assignments. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Critical Thinking outcome.

Law 220S. *Law for Department of the Air Force Officers.* 3(1). A core substitute for cadets in the Martinson Honors Program, introducing them to the discipline of Law through readings from original classic works and appellate court opinions exploring principles they will apply as Air Force officers and educated citizens. Examining the nature of law and its role in American society and the military, the course emphasizes enrichment in critical thinking and verbal and written expression by addressing foundational principles of constitutional, criminal, military, and international law. Classroom discussion and debate are the primary pedagogies and written works are the significant assessments. Final paper, project, report, or exam. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Critical Thinking outcome.

Law 221. *Legal Research and Writing.* 3(1). This gateway course is designed to introduce Legal Studies majors to the research and communication skills they will need to be successful in this major. Following an introduction to the fundamentals of legal reasoning and legal research, students will conduct research related to one or more legal problems based on fact scenarios that present ill-defined issues of law and learn to write legal memoranda in which they predict the outcome on a current legal problem. Related to the legal memoranda, students will participate in exercises that will assist them with organization, content, critical-thinking, citation, and proper usage and style. Final paper. Coreq: Law 220. Sem hrs: 3 fall or spring.

Law 321. *Legal Advocacy.* 3(1). Building on the fundamental skills learned in Law 221, this course reinforces and develops the additional skills needed to effectively advocate a position orally and in writing. Students will enhance their ability to organize a legal argument, analyze facts critically, identify the important issues, cite to legal authorities, and sharpen their oral and written advocacy skills. Advocacy will take place in the context of appellate proceedings. In preparation for appellate arguments, students will study complex cases involving important issues of constitutional law, write analytical case briefs and two appellate briefs, and participate in graded

oral arguments on both sides of the issue. Final paper, project, report or exam. Prereq/Coreq: Law 221. Sem hrs: 3 fall.

Law 331. *Criminal Law and Procedure.* 3(1). This course examines selected crimes and defenses and focuses on how and why selected constitutional rights constrain the government and protect individual liberties in the context of criminal law and procedure. Skills emphasized include critical thinking, legal problem-solving, and oral and written communication. Final paper, project, report, or exam. Prereq: Law 220 or department approval. Sem hrs: 3 spring.

Law 340. *Business Law.* 3(1). An in depth study of law governing commerce and business organizations in the United States. Emphasis will be placed on contracts, formation of business organizations, agency, intellectual property, product liability, Internet law and laws which regulate the workplace environment. Final paper, project, report, or exam. Prereq: Law 220 or department approval. Sem hrs: 3 fall odd-numbered years.

Law 351. *U.S. Constitutional Law.* 3(1). This course is an in-depth analysis of selected provisions of the U.S. Constitution and Supreme Court decisions interpreting them. Topics include powers of the branches of the federal government, federal-state relations, and individual rights as limitations on governmental power. Skills emphasized include critical thinking, legal problem-solving, and oral and written communication. Final paper, project, report, or exam. Prereq: Law 220 and C1C or C2C standing. Sem hrs: 3 spring.

Law 360. *Law and Literature.* 3(1). This interdisciplinary seminar entails the in-depth study of selected literary works that provide insights and raise questions concerning important legal issues and the nature and purposes of law. Emphasis will be placed on developing critical reading, speaking, and writing skills. Final paper, project, report, or exam. Prereq: English 211 and Law 220. Sem hrs: 3 fall of even-numbered years.

Law 363. *International Law.* 3(1). A course studying the legal principles which govern relations among nations. Students will study the historical development of international law and important principles which govern relations among nations today. Topics may include sources of International Law, statehood, sovereign immunity, diplomatic relations, the United Nations and other international organizations, treaties, extraterritorial jurisdiction, international courts, law of the sea, the UN Charter, and peacekeeping operations. Final paper, project, report, or exam. Prereq: Law 220 or department approval. Sem hrs: 3 spring.

Law 414. *Race, Sex, and Justice.* 3(1). This course uses the topics of race and sex to explore critical legal concepts in the areas of Constitutional and Criminal law. In the area of Constitutional law, the course examines the development of the substantive due process doctrine as it relates to marriage, reproductive rights, abortion, and the right of individuals to engage in private sexual conduct while also examining the cultural context of decisions and the impact of race and sex. In addition, the course will explore the evolution of the Equal Protection clause and statutory guidance in the area of racial and gender equality, to include the rights of the LGBTQ+ community. Finally, in the area of Criminal law, the course will explore the role of race and sex in the legislation

and enforcement of criminal laws. The course will examine these concepts not only in the context of society at large, but also their unique application to the military and in many instances USAF Academy. Final paper, project, report, or exam. Prereq: Law 220 or department approval. Sem hrs: 3 fall, odd-numbered years.

Law 419. *Space Law.* 3(1). This course examines the role of international law, U.S. domestic laws, and U.S. policy in the regulation of outer space activities. As the U.S. and its military becomes more and more dependent on outer space, the need for leaders with an understanding of the laws that apply to the space domain is rapidly growing. This course seeks to provide this necessary understanding by taking a practical approach to the material, framing it in the context of U.S. civil, national security, and commercial space activities. In doing so, the course provides an overview of current international law contained in U.N. resolutions, treaties, and customary international law, as well as domestic law and policy, identifying legal theory and principles affecting space activities. The course also covers principles of air law, the law of the sea and the laws of war that intersect with space law. It is an essential course for future U.S. space operators, commanders, and policy makers. Final paper, project, report or exam. Prereq: Law 220. Sem hrs: 3 spring.

Law 421. *Law for Commanders.* 3(1). This course is more than just a continuation and expansion of Law 220, Law for Department of the Air Force Officers. The focus is on using real-world scenarios to help students think like a commander who has respect for the rule of law, knows how to evaluate basic legal advice about a problem, and appropriately uses it to make good decisions for the Air Force. Cadets will examine command authority over AF personnel, the extent of that authority to accomplish the mission and instill good order and discipline, the effective use of disciplinary tools, and common command/legal concerns facing leaders. This is a hands-on, application class that allows students to practice problem-solving skills and to communicate solutions and rationale in an appropriate manner. Cadets cannot earn credit for both Law 421 and Law 422. Final paper, project, report, or exam. Prereq: Law 220 and Legal Studies major with C1C standing or departmental approval. Sem hrs: 3 fall.

Law 422. *Commander's Use of Military Law.* 3(1). This course is designed for students who have not had an in-depth study of law beyond Law 220. This course is more than just a continuation and expansion of Law 220, Law for Department of the Air Force Officers. The focus is on using real-world scenarios to help students think like a commander who has respect for the rule of law, knows how to evaluate basic legal advice about a problem, and appropriately uses it to make good decisions for the Air Force. Cadets will examine command authority over AF personnel, the extent of that authority to accomplish the mission and instill good order and discipline, the effective use of disciplinary tools, and common command/legal concerns facing leaders. This is a hands-on application class that allows students to practice problem-solving skills and to communicate solutions and rationale in an appropriate manner. Cadets cannot earn credit for both Law 421 and Law 422. Final paper, project, report, or exam. Prereq: Law 220 and C1C standing or departmental approval. Sem hrs: 3 spring.

Law 440. *Cyber Law.* 3(1). Cyber Law examines the effect of the Internet and technology on the law, and of the effects of law on the Internet and technology. The subject of Cyber Law offers a rich opportunity to examine the evolution of criminal law in cyberspace, specifically the problems associated with jurisdiction, the right of privacy, search and seizure, and evidence. The course will also examine how cyberspace impacts the law of war, including what constitutes the use of force in cyberspace, and how this all influences traditional notions of sovereignty. Although some basic technical information will be discussed during the semester, this course is designed for the non-technical student. The emerging legal issues discussed will also stimulate the interest of the technical student. As future commanders, cadets must be prepared to handle computer related legal issues, whether criminal, intellectual property, or use of force. Final paper, project, report, or exam. Prereq: Law 220. Sem hrs: 3 fall.

Law 456. *National Security Law.* 3(1). This course explores the nature and origins of the federal government's national security powers, U.S. law implementing international law, and the U.S. law of national security and counterterrorism. The field includes law of the use of the armed forces at home and abroad, intelligence operations abroad, counterterrorism, electronic surveillance and privacy, homeland security, crisis management and continuity of government, immigration, nonproliferation, treatment of detainees, congressional investigations and oversight, and using classified information in litigation. Final paper, project, report, or exam. Prereq: Law 220 or department approval. Sem hrs: 3 spring.

Law 463. *Law of War.* 3(1). This course provides a detailed introduction to the international laws governing armed conflicts often called international humanitarian law (IHL) or law of armed conflict (LOAC). Topics covered include the resort to force, rules on the conduct of hostilities, treatment and status of individuals, targeting, the application of law to varied domains (air, sea, land, space and cyber), war crimes, command responsibility and accountability. Students will study treaties such as the Geneva and Hague Conventions and will examine decisions of international courts, the U.S Supreme Court, and courts-martial to determine how the law of armed conflict is explained, interpreted, and applied to important historical and current conflicts. Final paper, project, report, or exam. Prereq: Law 220 or department approval. Sem hrs: 3 fall.

Law 466. *Advanced Law of War Topics.* 3(2x). This course goes beyond fundamental principles and primary sources of the Law of War explored in Law 463, focusing on unsettled questions and the foremost contemporary challenges. Topics may include the modern use of force, definitions of combatants, the interplay of the Law of War and human rights law, international criminal tribunals, rule of law efforts, and other current issues. Students will explore primary and secondary sources in a seminar setting, often utilizing simulation-based learning as a way of enhancing critical thinking and sharpening oral communication skills. This course is designed for those cadets selected to represent USAF Academy at various IHL and Law of War competitions. This course meets for the first 20 lessons of the semester. Repeatable. Final paper, project, report, or exam. Prereq: Law 463 and department approval. Sem hrs: 3 spring.

Law 480. *Topics in Constitutional Law and Appellate Advocacy.* 3(1). This course focuses on detailed analysis of two related constitutional law questions that are presented in a hypothetical

case problem. The selected constitutional law questions will reflect important public policy issues that are currently being litigated in the lower courts, but have not yet reached the Supreme Court. Students will research the relevant authorities cited in the case problem and write analytical case briefs, legal memoranda, and a persuasive appellate brief. Students will also argue both sides of one question in the case before a moot Supreme Court. This course is designed for those cadets selected to represent USAF Academy on the Moot Court Team. Repeatable. Final paper, project, report, or exam. Prereq: Department approval. Sem hrs: 3 fall.

Law 485. *Legal Studies Capstone.* 3(2). This course uses multiple law-related scenarios and real-world projects based upon contemporary military, national, and international issues. It affords students the opportunity to integrate knowledge and expertise acquired in other law and core courses and further hone their critical thinking and communication skills as they work collaboratively to identify and resolve complex legal issues. Final paper, project, report, or exam. Prereq: Law 421 and Legal Studies major with C1C standing or department approval. Sem hrs: 3 spring.

Law 495. *Special Topics.* 3(1). Selected topics in law. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Law 499. Independent Study. 3(0). Study and research in a legal topic or topics of choice for students who have demonstrated their ability for advanced study in regularly offered enrichment courses. Topics and meetings arranged with the instructor. Final paper, project, or report. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Law 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Law 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Law 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

LEADERSHIP (Ldrshp)

Offered by the Department of Behavioral Sciences and Leadership (DFBL) and the Department of Management (DFMA)

Ldrshp 100. *Foundations for Personal Leadership.* .75(1x). This 10-lesson course explores leadership development through both academic study and applied exercises. The academic study of leadership development will be combined with experiential exercises, case studies, and student projects designed to help students develop in their own leadership capacity. Specifically, the course examines individual leader development principles that will set students on a lifelong path of becoming a leader of character who treats others with respect and dignity. Final project/paper. Prereq: Basic Cadet Training. Sem hrs: .75 fall or spring.

This course, integrated with CE 100 and CL 100, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Ldrshp 200. *Foundations for Interpersonal Leadership.* .75(1x). This 10-lesson course explores leadership development through both academic study and applied exercises. The

academic study of leadership development will be combined with experiential exercises, case studies, and student projects designed to help students develop their capacity to lead one or more other people. Specifically, the course examines interpersonal leader development principles that will set students on a lifelong path of becoming an officer of character who leads others with respect and dignity. Final project/paper. Prereq: Ldrshp 100. Sem hrs: .75 fall or spring.

This course, integrated with CE 200 and CL 200, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Ldrshp 300. Foundations for Team Leadership. .75(1x). This 10-lesson course explores leadership development through both academic study and applied exercises. The academic study of leadership development will be combined with experiential exercises, case studies, and student projects designed to help students develop their capacity to lead an interdependent group toward accomplishment of a common goal. Specifically, the course examines team leadership development principles that will set students on a lifelong path of becoming an officer of character who leads teams with respect and dignity. Final project/paper. Prereq: Ldrshp 200. Sem hrs: .75 fall or spring.

This course, integrated with CE 300 and CL 300, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Ldrshp 400. Leadership Capstone. .75(1x). This 20-lesson class will serve as the capstone of the Lead 100-300 and officer development sequence. Ldrshp 400's primary objective is to apply and reflect upon foundational principles of organizational leadership to evaluate the strengths and weaknesses of oneself and of organizational systems. This course explores leader and organizational dynamics through both academic study and applied exercises. Academic study is combined with experimental exercises, case studies, and student projects designed to help students develop their capacity to guide an organization to success while understanding that it is embedded within a larger institution and environment. Specifically, the course examines organizational leader development principles that will set students on a lifelong path of becoming an officer of character who leads organizations with respect and dignity. Final project/paper. PreReq: Officership 300. Sem hrs: 0 fall and .75 spring

This course, integrated with CE 400 and CL 400, is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

LEARNING STRATEGIES

(Lrn Strt)

Offered by the Academic Success Center (DFVRL)

Lrn Strt 101. Learning Strategies for Academic and Career Success. 0(1). This course teaches learning strategies such as time-task management and prioritization, note-taking and reading skills, test preparation and test-taking skills, as well as the six most effective learning strategies. Cadets will elevate their pre-existing study skills and incorporate more sophisticated techniques that better match the demands and rigor of USAF Academy. Discussion about Mindset and Grit are included to incorporate affective/motivational techniques which will complement the cognitive/metacognitive strategies taught in the course. This is a semester-long course. Pass/fail. Prereq: None. Sem hrs: 0 fall.

Lrn Strt 102. *Learning Strategies for Academic and Career Success (Abridged)*. 0(1x). This course is an abbreviated version of Lrn Strt 101. It is offered at mid-term in the fall for those who are struggling academically during their first semester at USAF Academy. This course is also offered during the first-half and second-half of each spring semester. Cadets are most often placed into Lrn Strt 102 due to low grades, but cadets can also self-select into this course because they realize they need additional support academically if they are not achieving their full potential. This course also teaches learning strategies such as time-task management and prioritization, note-taking and reading skills, test preparation and test-taking skills, and the six most effective learning strategies, but at an accelerated pace. Cadets will elevate the skills they have previously used and replace them with more sophisticated techniques. Discussion about Mindset and Grit are included to incorporate affective/motivational techniques which will complement the cognitive/metacognitive strategies taught in the course. This is a half-semester course. Pass/fail. Sem hrs: 0 fall or spring.

MANAGEMENT

(Mgt)

Offered by the Department of Management (DFMA)

Mgt 303. *Management Perspectives*. 3(2). Managers are responsible for systems architecture and maintenance. These roles demand the development of life-long learners who can creatively solve organizational problems through the adaptive use of information. This course will help cadets understand their role as a systems architect, while informing their need to work diligently throughout their time in the major. Managerial competence is dependent on the acquisition of requisite variety, which can only be obtained by mastering each management area. Final exam or final project. Prereq: Mgt major or Department Head approval. Sem hrs: 3 fall.

Mgt 337. *Managerial Finance*. 3(1). A study of financial decisions and their effects on organizations. Emphasis is on developing the concept of risk/return tradeoff as well as inter-temporal monetary tradeoffs. Topics include time value of money (including stock and bond valuation), project capital budgeting and analysis, cost of capital, and capital structure (including dividend policy). A key construct is the impact of decisions on the value of the firm. Case studies and problems expose the student to current financial problems and their solutions. Final exam or final project. Prereq: Mgt 341 or AIC approval. Sem hrs: 3 spring.

Mgt 341. *Financial Accounting*. 3(1). Analysis of business transactions and recording of business data taught from the perspective of understanding the theoretical and practical issues in measurement of income, assets, liabilities and owner's equity. Annual reports used to perform financial statement analysis. Alternative accounting methodologies permitted under GAAP are explored. Final exam or final project. Coreq: Mgt 303 or AIC approval. Sem hrs: 3 fall.

Mgt 342. *Managerial Accounting*. 3(1). Focuses on the uses of accounting information by managers. Discusses full cost accounting and responsibility accounting, from the perspective of data collection and analysis, for short and long range decisions. Topics include cost behavior,

activity-based costing, contribution margin analysis, measurement of cost of goods manufactured, capital budgeting, and management control systems. Final exam. Prereq: Mgt 341 or AIC approval. Sem hrs: 3 spring.

Mgt 345. *Organizational Behavior and Human Resource Management.* 3(2). An introduction to individual and group theories of behavior and their integration into the organization as-a-whole. Foundational management and organizational behavior theories are applied to the understanding of how to make decisions based on accurate diagnoses of situations that involve people in organizational systems. Behavioral theories will be applied to human capital issues such as human resource planning, job design/analysis, recruitment and selection, performance appraisal, pay-for-performance, career development, ethical behavior and treatment, and legal issues in the work place. Topics will apply to both the public and private sectors. Students learn through a variety of experiential exercises and case studies. Final exam or final project. Coreq: Mgt 303 or AIC approval. Sem hrs: 3 fall.

Mgt 361. *Organization Development and Change.* 3(1). This course builds on concepts presented in Mgt 303 and Mgt 345, primarily examining the nexus of the individual and the organization while investigating the complexity of contemporary management challenges through the lens of change theory and practice. Management theories such as Action Research, Process Consultation, and Appreciative Approaches to Change, are explored and applied through case studies and experiential exercises, building learners' understanding of, and confidence in, facilitating change in groups and organizations. Final exam or final project. Prereq: Mgt 303 and Mgt 345. Sem hrs: 3 fall.

Mgt 372. *Introduction to Investments.* 3(1). This course introduces financial markets, investment vehicles (stocks, bonds, mutual funds, and derivatives), and retirement planning. Specific topics include time value of money, risk and return, valuation, portfolio mathematics, behavioral finance, and the basics of mutual funds. Additionally, officer-relevant personal finance discussions enrich the core material. Unlike Mgt 382, this course is introductory in nature and assumes no knowledge of accounting or financial markets, to include non-Management majors. A term project provides experience in comprehensive portfolio management—developing and analyzing investment opportunities for a young officer's portfolio. A cadet cannot receive credit for both Mgt 372 and Mgt 382. Final exam and/or final project. Prereq: None. Sem hrs: 3 fall or spring.

Mgt 375. *Marketing Analysis.* 3(1). This course emphasizes how marketing concepts can be used to analyze different markets to both determine customer needs, and to deliver customer value. Both product and service markets are analyzed with special emphasis on government and public sector concerns. This course covers market research, segmentation, distribution, supply chain, cost, and pricing considerations. In addition, this course is designed to provide cadets certain market analysis tools they will find useful in Mgt 400, Leading Innovation. Final exam or final project. Prereq: None. Sem hrs: 3 spring.

Mgt 382. *Investments.* 3(1). This course introduces financial markets, investment vehicles (stocks, bonds, mutual funds, and derivatives), and retirement planning. Specific topics include time value of money, risk and return, valuation, portfolio mathematics, behavioral finance, and the basics of mutual funds. Additionally, officer-relevant personal finance discussions enrich the core material. This course assumes a prior knowledge of the principles developed in Financial Accounting and Managerial Finance. A term project provides experience in comprehensive portfolio management—developing and analyzing investment opportunities for a young officer’s portfolio. Final exam and/or final project. A cadet cannot receive credit for both Mgt 372 and Mgt 382. Prereq: C or better in Mgt 337 or Sys Engr 336, or AIC approval. Sem hrs: 3 fall.

Mgt 391. *Business Data Analytics.* 3(1). This course examines how organizations use information technology and analytics to support decision making. Topics include business process analysis, information systems management, data modeling, data visualization and analytic decision making. Through this course students will describe the core elements of the corporate decision-making process, learn the principles and application of data modeling in a business setting, construct and evaluate data models for a data warehouse with data marts, learn about tools and approaches used in business analytics to support decision-making, and understand how ethics, privacy, security, and international and cultural differences affect the data and analytic environment. Final exam or final project. Prereq: None. Sem hrs: 3 spring.

Mgt 392. *Organizational Networks in Cyberspace.* 3(1). This course examines how organizations use information technology to develop and manage relationships with external institutions. Topics covered include electronic commerce, supply chain management, customer relationship management, e-government, and electronic networking in cyberspace. Emphasis is placed on legal, cultural, and international issues. Case studies offer a real-world emphasis. Organizational strategies are analyzed, using examples of both successful and unsuccessful online implementations. Students get hands-on web site development experience. Final exam or final project. Prereq: None. Sem hrs: 3 fall.

Mgt 400. *Leading Innovation.* 3(1). This course examines the essential elements of leading evolutionary or revolutionary change across various organizational contexts to develop students capable of both innovating and leading innovation. Students will explore innovation strategies that facilitate unit and process improvement. Topics include: developing and instilling a personal mindset of innovation, identifying opportunities, mobilizing necessary resources, creating processes, and building the capabilities and culture needed to support an agile innovative organization. The course emphasizes experiential learning and application of management theories through case studies, research, analysis papers, and team projects which can be further developed into future projects or real-world application. Final exam or final project. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Mgt 401. *Project Management.* 3(1). This course teaches how to properly plan, implement, and control organizational activities, personnel, and resources. Topics include project selection, roles and responsibilities of the project manager, project initiation (planning, budgeting, scheduling,

allocating resources, risk assessment), delivery and control (monitoring, evaluating, risk management, change control), and closure and handoff to customer. Additional topics address managing and allocating human resources and identifying possible structures for processes. Case studies and course assignments illustrate problems that engage the students in critical thinking. The class project will provide students with the opportunity to integrate project management techniques, project management software, and other tools in order to successfully plan and control a realistic project. Final project. Prereq: Mgt 303, Mgt 345, and C1C standing or AIC approval. Sem hrs: 3 spring.

Mgt 411. *Business Ethics*. 3(1). This course is a study of the moral dimensions of business practice and business leadership. Topics will include: work as vocation, the effects of corporate organizations on moral character, virtuous organizational leadership, corporate responsibility, stakeholder theory, government regulation, business and the environment, fairness in hiring and treatment of employees, the ethics of advertising, the ethics of international business, and moral challenges posed by the developing information age. Graded assignments include case studies and short papers incorporating both group and individual work. Final exam or final project. Prereq: None. Sem hrs: 3 fall.

Mgt 419. *Technological Innovation Management*. 3(1). This course examines how to recognize, analyze, and exploit opportunities in the competitive environments faced by business, nonprofit, and government organizations. Students will explore the resources, processes, and structures necessary to transfer technological innovations to appropriate markets. Application of innovation management theories is stressed through the use of case studies, analysis papers, field trips, and projects. By the end of the course, students will have completed a feasibility study of a new concept which can be further developed in capstone projects. For a limited number of cadets with majors in the Basic Sciences Division, this course serves as a core substitute for Mgt 400. This substitution occurs on a cadet-by-cadet basis and requires joint approval by the Department Head for each cadet's major and the DFMA Department Head. Final project. Prereq: C1C Standing. Sem hrs: 3 fall.

Mgt 420. *Management Capstone Practicum*. 3(2"). Cadets complete an original, applied systems research and/or development project that demonstrates their capacity to solve complex problems in an organizational setting. Each cadet chooses a project from among four options: 1) Management Field Studies: Teams or individuals complete advanced case studies or organizational consulting projects for clients developed through DFMA or arranged by the team independently with DFMA approval--cadets will work closely with clients and faculty to define and analyze difficult managerial and competitive problems and make recommendations for future action by the client or subject organization; 2) Venturing Projects: Teams or individuals will develop or select innovative projects and create new venture plans or feasibility studies; or 3) Research projects: Teams or individuals will propose and investigate significant managerial or technological issues in a research context. These projects require extensive interaction with faculty to develop research findings that can be presented and/or published. 4) Competitive Business Simulation and Integrative Case Studies: Cadets gain practical experience in addressing organizational and managerial issues in the context of a competitive simulation, integrative case studies, and advanced management readings. Final project. Prereq: C1C Standing; Mgt or Soc Sci major. Sem hrs: 3 fall or spring.

Mgt 440. *Management Lessons in Literature.* 3(1). Through a collection of classic and contemporary stories, novels, and plays, this course provides a unique perspective of organizational life. The course looks at what authors like Arthur Miller and Mark Twain can tell you about being a more effective manager. Great literature reflects familiar patterns of behavior in a variety of circumstances. But, unlike self-help, inspirational, and how-to manuals, they dispense no advice; they preach no morals; they prescribe no rules. In a world of turbulent change, the works of literature offer us vivid testimony as to what stays constant in human behavior. Final exam or term project. Prereq: Mgt 303 or AIC approval. Sem hrs: 3 spring.

Mgt 448. *Power and Influence in Organizations.* 3(1). Focus is on understanding how managers can effectively mobilize resources to be effective in their job. This course examines how power is acquired, retained, and used in organizations. In addition, it explores what effect power has on employees and the overall performance of the organization. Students learn through a variety of experiential exercises and case studies. Final exam or final project. Prereq: C1C standing; Mgt majors or DFMA Deputy for Academics approval. Sem hrs: 3 spring.

Mgt 472. *Strategic Management Capstone.* 3(2"). This course emphasizes the integration of organizational strategy formulation and implementation to include such topics as the strategic management process, environmental forecasting and analysis, strategic planning, top-level decision-making, the strategic use of technology, the management of innovation, and strategic control. Application of contemporary theory to critical issues in the public and private sectors is stressed through the use of seminars, case studies, field trips, and distinguished guest speakers. Final integrated case study. Prereq: Mgt 303 or AIC approval; C1C standing; Mgt or Gen Stu - Soc Sci major. Sem hrs: 3 fall.

Mgt 476. *Logistics and Transportation Management.* 3(1). This course examines logistics and transportation systems analysis and planning in an interdependent world economy. Topics include material handling, inventory control, global and military logistics, vehicle routing, and transportation modeling. Students will gain an understanding of logistics planning and evaluation, transportation modes, systems and networks, as well as the critical trade-offs that drive logistics and transportation decision-making in dynamic operating environments. Final exam or final project. Prereq or Coreq: Geo 440 or Math 378 or Mgt 391 or Ops Rsch 310 or department approval. Sem hrs: 3 fall.

Mgt 477. *Operations & Project Management.* 3(1). This course provides an introduction to a broad range of issues in managing production and service in business and military organizations. Students learn to apply a selection of analytical approaches that are used to efficiently manage projects and provide quality products and services on time and at minimal cost. Throughout the course, students apply critical thinking and operations management techniques in case studies and course assignments. Final exam or final project. Prereq: None. Sem hrs: 3 fall or spring.

Mgt 478. *Supply Chain Management.* 3(1). Focus is on understanding how managers can effectively create, modify, and manage supply chain strategies to be effective in business or a

military operation. This course examines purchasing, logistics, and limited operations management concepts and how to apply these to upstream and downstream supply chain strategies that can be employed to complement organizational strategy. The course will examine trust, power, culture, globalization, and other interorganizational issues. Students learn through a variety of experiential activities and case studies. Designed for all future Air and Space Force officers, especially those interested in the career fields of acquisitions, contracting, logistics readiness, engineering, and aircraft/munitions maintenance. Final exam or final project. Prereq: None. Sem hrs: 3 spring.

Mgt 495. *Special Topics.* 3(1). Selected topics in management. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Mgt 498. *International Management.* 3(1). As a result of the increase in communications and flow of information, there is a growing need to possess a greater understanding about global, cross-cultural management issues. This course examines management on an international level looking at cultural, legal, financial, and trade considerations for managing in the Global Century, while integrating the functional areas of management. Final exam or final project. Prereq: None. Sem hrs: 3 spring.

Mgt 499. *Independent Study.* 3(0). Tutorial investigation of a specific area of management. Final exam or final project. Prereq: Requires departmental approval of USAF Academy Form 0-498 prior to enrollment. Sem hrs: fall or spring.

- Mgt 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Mgt 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Mgt 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

MATHEMATICS

(Math)

Offered by the Department of Mathematical Sciences (DFMS)

Math 130. *Basic Math – Algebra and Trigonometry.* 3(1). This course is designed to help reinforce algebraic and trigonometric skills necessary for success in the technical core. Basic graphing, algebraic manipulation, and trigonometric calculations are covered. Elementary functions, function manipulation, and some function applications are also discussed. This course may be used as an Academy Option to fulfill graduation requirements. This course does not fulfill any major's requirements. Final exam. Prereq: Can only be enrolled in the course by recommendation of the Department of Mathematical Sciences. Sem hrs: 3 fall.

Math 141. *Calculus I.* 3 (1). An introduction to fundamental ideas in Calculus, mathematical modeling, and linear algebra. Topics include single and multivariate functions with parameters; modeling data; fundamental concepts in linear algebra such as vectors, dot products, projections, linear combinations; rates of change and slope of a function; differentiation; algebraic rules for

derivatives including product rule and chain rule; extrema; continuity and smoothness; dimensional analysis and units. Significant emphasis is placed on using computers to solve and investigate mathematical problems with special attention toward building data literacy. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Math 142. Calculus II. 3(1). A continuation of the themes and concepts developed in Math 141 with a significant emphasis on the use of Calculus to solve real-world problems and perform mathematical modeling. Topics include optimization in both single and multiple variable functions; Euler's method; antidifferentiation; algebraic rules for antiderivatives including substitution and integration by parts; definite integrals and their properties; the Fundamental Theorem of Calculus; applications and analysis of real-world problems; mathematical modeling with differential equations. Significant emphasis is placed on using computers to solve and investigate mathematical problems with special attention toward expanding students' data literacy. Final exam. Prereq: Math 141. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Math 152. Advanced Placed Calculus II. 3(1). Calculus II for advanced-placed fourth class cadets. Math 152 covers Math 142 content at an accelerated pace with additional topics designed to enhance preparation for Math 243 and a technical major. Final exam. Prereq: C4C standing and qualifying performance on DFMS placement exam. Sem hrs: 3 fall.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Math 243/253. Calculus III. 3(1). Multivariate calculus. Topics include solid analytical geometry to include lines, planes, and surfaces in 3-space; vector functions, partial differentiation, and directional derivatives; maxima and minima in multiple dimensions and the method of Lagrange Multipliers; multiple integration and line integrals culminating in Green's Theorem. Designed for cadets who indicate an interest in a technical major. Cadets cannot take and receive credit for both Math 243 and Math 253. During their first attempt at Math 243/253, cadets will have grade protection as described elsewhere in this Handbook. Final exam. Prereq: C or better in Math 142 (or Math 152). Placement into Math 253 is for fourth-class cadets via the mathematics placement exam. Waiver authority is DFMS Deputy Head for Academics. Sem hrs: 3 fall or spring. (Math 253 is offered fall only)

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Math 245. Differential Equations. 3(1). Modeling with and analysis of first order and second order linear ordinary differential equations, as well as modeling with and analysis of systems of ordinary differential equations. Solution techniques will involve analytical, numerical, and qualitative approaches. These approaches may include separation of variables, integrating factors, method of undetermined coefficients, eigenvector/eigenvalue solutions, transform techniques,

Euler and Runge-Kutta methods. The course will include applications that may draw from biological, mechanical, electrical, and other fields of study. Final exam. Prereq: Prior completion of Math 243 (or Math 253) is strongly recommended. C or better in Math 142 (or Math 152) or advanced-placement through DFMS exams. Waiver authority is the DFMS Deputy Head for Academics. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Math 300. *Introduction to Statistics.* 3(1). An introduction in probability and statistics for decision-makers. Topics include basic probability, statistical inference, prediction, data visualization, and data management. This course emphasizes critical thinking among decision-makers, preparing future officers to be critical consumers of data. Math 300 is designed primarily for majors in the Social Sciences and Humanities. Math majors and Operations Research majors will take Math 377. Cadets cannot earn credit for both Math 300 and Math 356, nor for both Math 300 and Math 377. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Critical Thinking outcome.

Math 320. *Foundations of Mathematics.* 3(1). This course emphasizes exploration, conjecture, precise mathematical language, and methods of proof. Students will develop the ability to read and communicate (both orally and written) in mathematical terms. Includes an introduction to the theory of sets, number theory, and functions. Topics from algebra, analysis, or discrete mathematics may be introduced. A cadet cannot receive credit for both Math 320 and Math 340. Final exam or final project. Prereq: Math 142 or Math 152 with a 'C' or better. Waiver authority is the Deputy Head for Academics. Sem hrs: 3 fall or spring.

Math 340. *Discrete Mathematics.* 3(1). Useful for cadets interested in applications of mathematics to computer science and electrical engineering. Propositions and logic; sets and operations on sets; functions, recursion, and induction; basic proof techniques; introduction to graph theory, counting methods and combinatorics. A cadet cannot receive credit for both Math 320 and Math 340. Final exam. Prereq: Comp Sci 110 and C3C standing or department approval. Sem hrs: 3 spring.

Math 342. *Numerical Analysis.* 3(2). An introduction to numerical algorithms, algorithm analysis, and error analysis. Course topics include: root finding, fixed point iteration, polynomial interpolation, numerical differentiation, numerical integration; additional topics vary and may include: linear algebra, curve fitting, numerical solutions to ODEs, and Monte Carlo methods. Topical coverage is balanced between theoretical, computational, and applied perspectives. Final exam or final project. Prereq: Math 245 and one of Comp Sci 206, 210, 211, or 212. Coreq: one of Math 360 or Math 344. Waiver authority is the Deputy Head for Academics. Sem hrs: 3 fall.

Math 344. *Applied Linear Algebra.* 3(1). An introduction to linear algebra focusing on Euclidean vector spaces and their bases. Using matrices to represent linear transformations, and to solve systems of equations, is a central theme. Emphasizes computational aspects and

applications (theoretical foundations are covered in Math 360). Applications may include curve fitting, Markov chains, ordinary differential equations (ODEs) and systems of ODEs. A cadet cannot receive credit for both Math 344 and Math 360. Final exam. Prereq: Math 142 or department approval. Sem hrs: 3 spring.

Math 346. *Engineering Math.* 3(1). Provides advanced mathematical concepts and skills necessary for technical disciplines. Topics include differential and integral vector calculus (surface integrals, flux, Divergence Theorem, Stokes' Theorem); systems of ordinary differential equations and their applications; Fourier series; orthogonal functions; partial differential equations (e.g., separation of variables, transform methods, and numerical techniques). Final exam or final project. Prereq: C or better in both Math 243 (or Math 253) and Math 245. Waiver authority: Deputy Head for Academics. Sem hrs: 3 fall or spring.

Math 356. *Probability and Statistics for Scientists and Engineers.* 3(1). An introduction to probability and statistics for decision-makers. Topics include basic probability, statistical inference, prediction, data visualization and data management. This course emphasizes critical thinking among decision-makers, preparing future officers to be critical consumers of data. Math 356 is primarily designed for cadets in engineering, science, or other technical disciplines. Math majors and Operations Research majors will take Math 377. Cadets cannot earn credit for both Math 300 and Math 356, nor for both Math 300 and Math 377. Final exam. Prereq: Math 142/152. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Critical Thinking outcome.

Math 359. *Design and Analysis of Experiments.* 3(1). An introduction to the philosophy of experimentation and the study of statistical designs. Topics include design and analysis of single-factor and multi-factor studies. A valuable course for all science and engineering majors. Final project. Prereq: Math 356 or Math 377. Sem hrs: 3 spring.

Math 360. *Linear Algebra.* 3(1). A first course in linear algebra focusing on Euclidean vector spaces and their bases. Using matrices to represent linear transformations, and to solve systems of equations, is a central theme. There is a significant emphasis on theoretical foundations. A cadet cannot receive credit for both Math 344 and Math 360. Final exam or final project. Prereq: Math 320. Waiver authority is the Deputy Head for Academics. Sem hrs: 3 fall or spring.

Math 366. *Real Analysis I.* 3(1). A theoretical study of functions of one variable focused on proving results related to concepts first introduced in differential and integral calculus. This course is an essential prerequisite for graduate work in mathematical analysis, differential equations, optimization, and numerical analysis. Final exam or final project. Prereq: Math 360 or department approval. Sem hrs: 3 fall or spring.

Math 377. *Advanced Probability and Statistics.* 3(1). This course introduces calculus-based probability for both continuous and discrete random variables, as well as univariate and multivariate distributions. It also introduces inferential statistics with confidence intervals,

hypothesis testing, and the corresponding sampling distribution. Modern software appropriate for data analysis will be used. This course is a core substitute for Math 300. Credit will not be given for Math 377 and either Math 300 or Math 356. Final exam and/or final project. Prereq: Math 142/152. Sem hrs: 3 fall.

This course is a contributor to the development and assessment of the Critical Thinking outcome.

Math 378. *Applied Statistical Modeling.* 3(1). This course introduces traditional and modern modeling methods that are relevant for data analysts. These regression and classification methods include topics such as K nearest neighbors, generalized linear models, discriminant analysis, neural networks, support vector machines, tree methods, and ensemble methods. The course will also introduce more recent advances such as free form text analysis, social network analysis, and web-based data collection. Final exam or final project. Prereq: Math 377. Sem hrs: 3 spring.

Math 420. *Mathematics Capstone I.* 1(1). The first semester of the mathematics capstone experience. Students will decide on a topic of independent research in, or related to, the mathematical sciences and begin work with a faculty advisor. Significant progress toward a thesis will be made during the semester. Final project. Prereq: C1C standing in the Mathematics major. Sem hrs: 1 fall.

Math 421. *Mathematics Capstone II.* 2(1). The second semester of the mathematics capstone experience. Students will complete work on their independent research project and produce a thesis to present their findings. Final project. Prereq: C1C standing in the Mathematics major. Sem hrs: 2 spring.

Math 443. *Numerical Analysis of Differential Equations.* 3(1). An intermediate numerical analysis course with an emphasis on solving differential equations. Specific topics include solving linear and nonlinear systems; solutions of initial value problems via Runge-Kutta, Taylor, and multistep methods; convergence and stability; and solutions of boundary value problems. Other topics include approximating eigenvalues and eigenvectors and numerically solving partial differential equations. The approach is a balance between the theoretical and applied perspectives with some computer programming required. Final exam or final report. Prereq: Math 346 or Math 469, and one of Math 342 or Physics 356, or department permission. Sem hrs: 3 spring of even numbered years.

Math 451. *Complex Variables.* 3(1). A valuable course for cadets intending to pursue graduate work in mathematics or its applications, particularly in areas involving partial differential equations. Analytic functions; integration; the Cauchy Integral Theorem and applications; power and Laurent series, residues and poles; conformal mapping with applications to potential theory and fluid flows. Final exam or final project. Prereq: Math 243/253 and Math 245 or department approval. Sem hrs: 3 spring.

Math 465. *Modern Algebra.* 3(1). A valuable course for cadets intending to pursue graduate work in mathematics or its applications. Focuses on the study of algebraic structures and functions

between these structures. Topics include: cyclic groups, permutation groups, normal subgroups and quotient groups; rings, ideals, polynomial rings and fields. Depending on instructor and student preferences, applications to coding theory, crystallography, or combinatorics are explored. Final exam or final project. Prereq: Math 320 or department approval. Sem hrs: 3 fall.

Math 467. *Real Analysis II.* 3(1). A theoretical study of functions of several variables to include topology of cartesian spaces, compact and connected sets, convergence of sequences of functions, continuous functions, fixed point theorems, contractions, Stone-Weierstrass approximation theorems, differentiation, partial differentiation, mapping theorems, and Implicit Function Theorem. Final exam or final project. Prereq: Math 366 or department approval. Sem hrs: 3 spring of even-numbered years.

Math 468. *Dynamical Systems.* 3(1). The study and application of linear and nonlinear differential equations to physical systems from both computational and analytical points of view. Topics vary. Typical choices include systems of differential equations, stability analysis, bifurcations, maps, and chaos. Final exam or final report. Prereq: Math 243/253 and Math 245 or department approval. Sem hrs: 3 fall of even-numbered years.

Math 469. *Partial Differential Equations.* 3(1). Solutions of boundary value problems with applications to heat flow, wave motion, and potential theory. Methods of solution include separation of variables and Eigen function expansion, including Fourier series. Topics typically include the method of characteristics, generalizations to higher dimensions, and the use of non-Cartesian coordinate systems. Additional topics may include numerical methods, nonlinear equations, and transform methods. Final exam or final report. Prereq: 243/253 and Math 245 or department head approval. Sem hrs: 3 spring.

Math 470. *Mathematical Physics.* 3(1). An introduction to various mathematical topics needed in graduate-level physics and applied mathematics courses, including special functions (Legendre polynomials, Bessel functions, etc.), calculus of variations, and series solutions of ordinary differential equations. Additional topics may include integral transform concepts (Fourier and Laplace transforms, Green's functions), linear algebra (function spaces, tensors), and complex functions (Laurent series, contour integration, and the Residue Theorem). Final exam or final report. Prereq: Math 346 or Math 469 or department head approval. Sem hrs: 3 fall of odd-numbered years.

Math 472. *Introduction to Number Theory.* 3(1). Properties of integers, the Euclidean algorithm, prime numbers, modular arithmetic, number theoretic functions, primitive roots, and quadratic reciprocity. Special topics such as public key cryptography, the Riemann Zeta function, and connections to abstract algebra will be covered at the instructor's discretion. Final exam or final project. Prereq: Math 320. Sem hrs: 3 spring of odd-numbered years.

Math 473. *Introduction to Point-Set Topology.* 3(1). Review of set theory; topology on the real line and on the real plane; metric spaces; abstract topological spaces with emphasis on bases; connectedness and compactness. Other topics such as quotient spaces and the separation axioms

may be included. A valuable course for all math majors in the graduate school option. Final exam or final project. Prereq: Math 320. Sem hrs: 3 fall of odd-numbered years.

Math 474. *Combinatorics and Graph Theory.* 3(1). Permutations, combinations, recurrence relations, inclusion-exclusion, connectedness in graphs, colorings, and planarity. Theory and proofs, as well as applications to areas such as logistics, transportation, scheduling, communication, biology, circuit design, and theoretical computer science. Final exam or final project. Prereq: One of Math 320 or Math 340; and one of Math 245 or Math 344; or department approval. Sem hrs: 3 spring.

Math 491. *Teaching Practicum.* 3(1). This course gives senior technical majors an opportunity to understand and experience the role of a mathematics instructor under the direction of an experienced faculty mentor. Participants will observe experienced instructors, research teaching pedagogy, maintain a reflection journal, write papers, assist students during class, assist students through E.I., prepare lesson plans, facilitate lessons, and engage in assessment activities. Course outcomes include effective communication, leadership in an academic environment, and developing strength of character through self-assessment. Final report. Prereq: C1C in good standing and department approval. Sem hrs: 3 spring.

Math 495. *Special Topics.* 3(1). Selected advanced topics in mathematics. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Math 499. *Independent Study and Research.* 3(0). Individual study and/or research under the direction of a faculty member. Oral midterm and final; final paper. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Math 499A. Independent Study and Research. 2(0). Sem hrs: 2 fall or spring.
- Math 499B. Independent Study and Research. 1.5(0). Sem hrs: 1.5 fall or spring.
- Math 499C. Independent Study and Research. 1(0). Sem hrs: 1 fall or spring.

MECHANICAL ENGINEERING

(Mech Engr)

Offered by the Department of Mechanical Engineering (DFME)

Mech Engr 220. *Fundamentals of Mechanics.* 3(1). An introduction to the fundamental principles of statics and mechanics of materials applied to aerospace systems. Topics include: force and moment equilibrium using free body diagrams and vector algebra; stress, strain, and deformation response of deformable bodies to axial, torsional, flexural, and combined loadings; material properties and selection criteria; and failure modes of materials and structures. Laboratory exercises. Final exam. Prereq: Math 141. Coreq: Physics 110. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Mech Engr 220S. *Fundamentals of Mechanics for Academy Scholars.* 3(1). An introduction to the fundamental principles of statics and mechanics of materials applied to aerospace systems with an introduction to the engineering design process and innovation. Topics include: force and moment equilibrium using free body diagrams and vector algebra; stress, strain, and deformation response of deformable bodies to axial, torsional, flexural, and combined loadings; material properties and selection criteria; failure modes of materials and structures; understanding design requirements, developing and selecting solution concepts, and prototyping and evaluating proposed solutions. Throughout the course, scholars students will explore innovators throughout history, inventive techniques they used and how their work impacted the culture of their time. Laboratory exercises. Final exam or final project. Prereq: Math 141. Coreq: Physics 110. Sem hrs: 3 spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Mech Engr 205. *Engineering Tools Seminar.* 1(1). An introductory seminar course designed to help Mech Engr majors transition into the degree-granting program. Content includes industrial design and fabrication and essential skills required for success in the Mech Engr program. Emphasis is on hands-on engineering tools with in-class practice using related hardware, software, and program-specific techniques and safe operation of critical lab equipment. No homework or outside preparation required. Prereq: None. Pass/fail. Sem hrs: 1 fall or spring.

Mech Engr 306. *Advanced Manufacturing Methods Seminar.* 1(1). This course provides an overview of novel and emerging aerospace industry manufacturing methods coupled with 3D modeling, 3D printing, CNC machining, reverse engineering, and digital twin design. These topics provide a survey of the latest "Air Force Standard" in manufacturing capabilities affecting all current and next generation weapons systems. No homework or outside preparation required. Prereq: ME 205. Pass/fail. Sem hrs: 1 spring.

Mech Engr 312. *Thermodynamics.* 3(1). Fundamental principles of classical equilibrium thermodynamics. Modeling of gas and fluid properties. Thermodynamic processes. Development and application of the first and second laws of thermodynamics to closed and open systems. Applications to power and refrigeration cycles. Final exam. Prereq: Mech Engr 220 and Math 243. Sem hrs: 3 fall.

Mech Engr 320. *Dynamics.* 3(1). Kinematic and kinetic analysis of particles and rigid bodies, as well as an introduction to mechanical vibrations of simple systems. Topics include kinematics in 2- and 3-dimensions using Cartesian, path, and polar coordinates; kinetics using force-mass-acceleration, work-energy, and impulse-momentum methods; introduction to single degree of freedom vibration. Methods emphasize vector solutions. Laboratory exercises. Final exam. Prereq: Mech Engr 220. Coreq: Math 245. Sem hrs: 3 fall or spring.

Mech Engr 325. *Engineering System Dynamics.* 3(1). Modeling, analysis, and design of multi-domain engineering systems including mechanical, electrical, hydraulic, thermal, and control

elements. Models are developed based on tracking power interactions between system components. Mathematical models are developed in state space form and are investigated both analytically and numerically. System response to initial conditions and forcing functions is examined. Tools are introduced to predict system stability, behavior, and response to parameter variation. Non-linear models and elementary control systems are introduced. Final exam or final project. Prereq: Mech Engr 320, ECE 315, and Math 245. Sem hrs: 3 spring.

Mech Engr 330. *Mechanics of Deformable Bodies.* 3(1). Axial loading. Statically indeterminate structures. Beam theory: shear and moment diagrams, stress, and deflection. Transformation of stress and strain. Mohr's circle. Introduction to failure theories. Introduction to material selection criteria. Euler buckling. Stress concentrations. Introduction to energy methods and Castigliano's theorems. Laboratory exercises. Final exam. Prereq: Mech Engr 220. Coreq: Math 245. Sem hrs: 3 fall or spring.

Mech Engr 332. *Aerospace Structures.* 3(1). Analysis and design of lightweight, thin-walled and semi-monocoque structures. Margin of safety. Material selection including strength, stiffness, and weight. Lab. Final exam or final project. Prereq: Mech Engr 330. Coreq: Aero Engr 315 and Mech Engr 320. Sem hrs: 3 fall or spring.

Mech Engr 340. *Materials Science for Engineers.* 3(1). Survey of engineering applications of non-ferrous and ferrous alloys, polymers, ceramics and composites. Basic crystallographic notation and molecular structure of common engineering materials. Principles of metallurgical thermodynamics and kinetics applied to phase transformations and strengthening mechanisms. Field trip. Final exam. Prereq: Mech Engr 220. Sem hrs: 3 spring.

Mech Engr 341. *Fluid Mechanics.* 3(1). Description of fluid matter. Derivation of the governing equations. Application to hydrostatics, boundary layers, pipe flow, introductory computational fluid dynamics, compressible flow, introduction to turbomachinery (with emphasis on pumps). Normal shocks and isentropic flow. Final exam. Prereq: Math 245 and Mech Engr 312 or department approval. Sem hrs: 3 spring.

Mech Engr 350. *Mechanical Behavior of Materials.* 3(1). Behavior of materials under simple axial, biaxial, and triaxial states of stress. Micromechanisms of elastic and inelastic deformation and strengthening mechanisms. Introduction to linear elastic fracture mechanics. Fatigue failure theories and fatigue crack growth analysis. Applications to design of aerospace vehicles and structures. Final exam. Prereq: Mech Engr 330. Sem hrs: 3 fall or spring.

Mech Engr 370. *Introduction to Machine Design.* 3(1). Analysis and design of machine components including shafts, hydrodynamic and rolling element bearings, spur gears, clutches, brakes, and springs. Design of joints using screws, bolts, and welds. Emphasis on stress analysis and design trade-offs. Final exam or final project. Prereq: Mech Engr 320, Mech Engr 330, and Mech Engr 350. Sem hrs: 3 spring.

Mech Engr 396. *Mechatronics*. 3(1). Cadets will learn the integration of mechanical and electrical design, applying the design process to develop an integrated electromechanical system autonomously controlled by a microprocessor. Electrical system development topics include digital logic, actuator control, sensor integration, and signal conditioning. Group design projects throughout the semester leading to the integrated final project. Open only to Engineering majors with Department of Mechanical Engineering approval. Final exam or final project. Coreq: ECE 315. Sem hrs: 3 fall.

Mech Engr 405. *Mechanical Engineering Design Seminar I*. 0(1). The course is designed to give Mechanical Engineering majors or those cadets considering majoring in Mechanical Engineering an opportunity to participate on one of the various capstone teams offered within the Mechanical Engineering department. This involvement will increase their knowledge of topics within the major as well as increase continuity in the capstone design teams. In addition, it will allow cadets to work on a real-world engineering design problem. Cadets will participate with a capstone team through the duration of the course. This course will meet concurrently with Mech Engr 491. Pass/withdraw. Prereq: C3C or C2C in good standing. Sem hrs: 0 fall.

Mech Engr 406. *Mechanical Engineering Design Seminar II*. 0(1). The course is designed to give Mechanical Engineering majors or those cadets considering majoring in Mechanical Engineering an opportunity to participate on one of the various capstone teams offered within the Mechanical Engineering department. This involvement will increase their knowledge of topics within the major as well as increase continuity in the capstone design teams. In addition, it will allow cadets to work on a real-world engineering design problem. Cadets will participate with a capstone team through the duration of the course. This course will meet concurrently with Mech Engr 492. Pass/withdraw. Prereq: C4C, C3C, or C2C in good standing. Sem hrs: 0 spring.

Mech Engr 421. *Vibrations*. 3(1). Free and forced vibrations of discrete systems. Effect of viscous and other types of damping considered. Matrix methods used to analyze multi-degree-of-freedom systems. Dynamic analysis of continuous systems. Final exam or final project. Prereq: Mech Engr 320 or Physics 355; completed or enrolled in Math 346 or Engr 346. Sem hrs: 3 spring of even-numbered years.

Mech Engr 431. *Introduction to Finite Element Analysis*. 3(1). Analysis and design of truss, frame, shell, and solid structures using the direct stiffness and energy formulation methods. Topics include: theoretical development of elementary finite elements and models, thermal and dynamic structural analysis, and computer-aided design and analysis projects using commercial, professional software. Final exam or final project. Prereq: Mech Engr 330 and Math 342, Math 344, Math 346, or Engr 346. Sem hrs: 3 fall.

Mech Engr 440. *Physical Metallurgy*. 3(2). Physical metallurgy related to properties of engineering metals. Study of crystal structure and imperfections, diffusion, thermodynamics, phases and phase transformations, and material processing and how each alters material properties. Discussion of specific metals/alloy systems and design philosophies for new alloys.

Thermomechanical strengthening design project and semester-long knife design and construction project. Final project. Prereq: Mech Engr 340. Sem hrs: 3 fall.

Mech Engr 441. *Heat Transfer.* 3(1). Study of thermal radiation, steady and transient conduction, convection (laminar and turbulent, internal and external flow, boundary layers, and empirical correlations). Analytical and numerical solution techniques applied to selected problems. Applications address fins, heat exchangers, and interactive computing. Final exam. Prereq: Mech Engr 312. Coreq: Mech Engr 341 and Math 342, Math 346, or Engr 346. Sem hrs: 3 spring.

Mech Engr 445. *Failure Analysis and Prevention.* 3(1). Failure analysis and prevention is a technical discipline that integrates mechanical engineering, materials engineering, and structural analysis into component analysis and design. Laboratory techniques including scanning electron microscopy, metallography, non-destructive inspection, and mechanical testing will be used to determine the causes of failures of mechanical components. Re-designs may include changes in geometry, materials selection, or operation to preclude failure. Final exam or final project. Prereq: Mech Engr 350 and Mech Engr 340 (recommended). Sem hrs: 3 spring of even-numbered years.

Mech Engr 450. *Aerospace Composite Materials.* 3(1). Introduction to select advanced aerospace materials. Topics covered include: mechanical behavior, design and analysis, processing, testing, inspection and repair of resin-matrix composite materials, and processing and application of metal-matrix and ceramic-matrix composites. Topics emphasized through hands-on project in design, fabrication, and testing of a composite structure. Final exam or final project. Field trip. Prereq: Mech Engr 330 and Math 245. Sem hrs: 3 spring.

Mech Engr 460. *Experimental Mechanics.* 3(2). Introduction to experimental measurements and their role in the mechanical design process. Includes theory and application of static and dynamic instrumentation to include: strain, vibration, temperature, and pressure transducers. Hands-on laboratory experience constitutes one-half of the course. Laboratory sessions involve analysis, design, test plans, calibration, and testing. Final exam or final report. Lab. Prereq: ECE 315, Mech Engr 320, Mech Engr 330, Math 300 or Math 356. Sem hrs: 3 fall.

Mech Engr 468. *Sustainable Energy.* 3(1). Current and potential future energy systems are covered including resources, extraction, conversion, and application with sustainability as a major consideration. Different renewable technologies will be considered as possible replacements for more conventional energy technologies. Final project or final exam. Prereq: Mech Engr 312. Coreq: Mech Engr 341, or department approval. Sem hrs: 3 fall of odd-numbered years.

Mech Engr 490. *Automotive Systems Analysis for the Engineer.* 3(1). An analysis of the modern automobile as an engineering system. Engineering concepts applied to the design, maintenance, and integration of automotive subsystems. Analysis of power plants, clutches, transmissions, drive trains, suspension systems, steering and braking dynamics, and overall vehicle performance including economy. Final report or final exam. Field trip. Coreq: Mech Engr 320 or department approval. Sem hrs: 3 fall of even-numbered years.

Mech Engr 491. *Capstone Design Project I.* 3(2). Capstone engineering design experience for the Mechanical Engineering Major. Emphasis placed on the design process, complete analysis, and technical communication in the creative development of a mechanical system. The system is designed, fabricated, and tested against performance specifications determined by faculty members. Final report. Prereq (required for all): C1C standing and team advisor approval. Prereq (required for Mech Engr Majors): Mech Engr 320, Mech Engr 330, Mech Engr 312, and Mech Engr 341. Coreq (required for Mech Engr majors): Mech Engr 460. Non-Mech Engr majors are welcome on a case-by-case basis. Waiver authority is the DFME Deputy for Curriculum. Sys Engr majors do not require waivers but must have capstone design team advisor approval. Sem hrs: 3 fall.

Mech Engr 492. *Capstone Design Project II.* 3(2). Capstone engineering design experience for the Mechanical Engineering Major. Emphasis placed on the design process, complete analysis, and technical communication in the creative development of a mechanical system. The system is designed, fabricated, and tested against performance specifications determined by faculty members. Final report. Prereq (required for all): C1C standing and team advisor approval. Prereq (required for Mech Engr Majors): Mech Engr 320, Mech Engr 330, Mech Engr 312, Mech Engr 341, and Mech Engr 460. Non-Mech Engr majors are welcome on a case-by-case basis. Waiver authority is the DFME Deputy for Curriculum. Sys Engr majors do not require waivers but must have capstone design team advisor approval. Sem hrs: 3 spring.

Mech Engr 495. *Special Topics.* 3(1). Selected topics in mechanical engineering. Prereq: Department approval. Sem hrs: 3 fall or spring

Mech Engr 499. *Independent Study.* 3(0). Individual study, research, or design on a topic established with the approval of the Department Head. If the cadet performs exceptionally well (as determined by the Research Mentor and Department Head), Mech Engr 499 credit can be awarded for a successful Cadet Summer Research Program also meeting the Mech Engr Option II requirement of the Mechanical Engineering program. Prereq: Departmental approval of USAF Academy Form 0-498 prior to enrollment. Final report. Sem hrs: 3 fall or spring.

- Mech Engr 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Mech Engr 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Mech Engr 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

METEOROLOGY

(Meteor)

Offered by the Department of Physics and Meteorology (DFPM)

Meteor 320. *Introduction to Meteorology and Aviation Weather.* 3(1). A survey course in the fundamentals of meteorology. Emphasis will be placed on flight weather and its impact on aviation. Topics include atmospheric structure, clouds, air masses and weather systems, surface and upper-air weather observations, weather forecasting, severe weather, hazards to aviation, and

an introduction to weather satellites and radar. Final project. Prereq: Physics 110. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Meteor 330: *Physical Meteorology I.* 3(1). Radiative transfer and dry thermodynamic processes applied to the atmosphere and remote sensing. Radiative transfer topics include global energy balance, latitudinal and seasonal effects on climate, properties of radiation in different regions of the electromagnetic spectrum, reflection and refraction, atmospheric transmission, emission and absorption, scattering and absorption by particles, atmospheric optical phenomena, and broadband fluxes and heating rates. Thermodynamic topics include atmospheric composition and structure, thermodynamic systems and variables, physical properties of air, atmospheric pressure, the first law of thermodynamics, air parcels, and dry adiabatic processes. Final exam. Prereq: Math 243 (or Math 253) and Meteor 320. Sem hrs: 3 fall.

Meteor 331. *Physical Meteorology II.* 3(1). Moist thermodynamic processes and cloud microphysics. Moist thermodynamic topics include the second law of thermodynamics, moisture variables, phase changes of water, moist adiabatic processes, thermodynamic diagrams, atmospheric stability, and stability parameters. Cloud microphysics topics include cloud condensation nuclei, water vapor condensation, growth of cloud droplets in warm clouds, collision-coalescence theory, microphysics of cold clouds, ice multiplication processes, cloud and precipitation types, thunderstorm electrification, and cloud and precipitation chemistry. Final exam. Prereq: Meteor 330. Sem hrs: 3 spring.

Meteor 351. *Weather Data, Analysis, and Structure of Mid-latitude Weather Systems.* 3(1). An introduction to conventional weather data, subjective and objective analysis techniques, and the three-dimensional structure of mid-latitude weather systems. Topics include a review of vector operations, especially the gradient operator, the kinematics of fluid flow, surface and upper air measurements of atmospheric variables, data reporting formats, synoptic analysis and interpretation, isentropic charts and cross sections, the vertical structure of upper level troughs and ridges, the structure and evolution of extratropical cyclones including fronts, and polar and subtropical jet streams. Final exam. Prereq: Math 243 (or Math 253) and Meteor 320. Coreq: Meteor 330. Sem hrs: 3 fall.

Meteor 352. *Climatology.* 3(1). An introduction to climatology utilizing the fundamentals of meteorology and climate literacy, including components of the Earth system, climate and weather, climate data, cycling of material, features of global circulation, regional and local climates, classifying and describing climates, local climate, climate modeling, and key products and services. Final project. Sem hrs: 3 Fall.

Meteor 370. *Meteorological Applications of Remote Sensing.* 3(1). An in-depth examination of how meteorologists exploit passive and active remote sensing platforms to measure the physical characteristics of a broad range of meteorological phenomena. Topics include the physical basis of the remote sensing products and their application to meteorology with an emphasis on

interpreting information derived from satellite measurements in the visible, infrared, and microwave portions of the electromagnetic spectrum, and from single- and dual-polarization radar measurements. Final exam or final project. Prereq: Meteor 330. Sem hrs: 3 spring.

Meteor 430. *Atmospheric Dynamics I.* 3(1). An introduction to atmospheric dynamics. Topics include continuity, thermodynamic energy, scale analysis, the equations of motion, hydrostatic balance, generalized vertical coordinate systems, balanced and unbalanced flows, divergence, circulation, vorticity, and potential vorticity. Final exam. Prereq: Meteor 330. Sem hrs: 3 spring.

Meteor 431. *Atmospheric Dynamics II.* 3(1). Advanced applications of atmospheric dynamics. Topics include advanced quasi-geostrophic theory and applications, ageostrophy, baroclinic and barotropic instability, cyclogenesis, atmospheric wave theory and behavior, and numerical weather prediction (NWP). Special emphasis is placed on numerical weather modeling to include finite differencing, data assimilation, ensemble techniques, pre- and post-processing, downscaling and parameterizations, and operational use of NWP models. Final exam. Prereq: Meteor 430. Sem hrs: 3 fall.

Meteor 432. *Boundary Layer Structure and Processes.* 1.5(1X). An advanced course in planetary boundary layer meteorology. Topics include boundary layer structure and evolution, turbulence and turbulence kinetic energy, flux gradient theory, energy and momentum exchange, boundary layer measurements, and contaminants. Meteor 432 meets for the second half (lessons 21 – 40) of the semester. Final exam. Prereq: Meteor 430. Sem hrs: 1.5 fall.

Meteor 450. *Tropical Meteorology.* 1.5(1X). An examination of the unique nature of atmospheric flows and disturbances in the tropics. Topics include tropical contributions to the general circulation, circulations such as the inter-tropical convergence zone (ITCZ) and the monsoons, tropical waves, the importance of atmosphere-ocean as evidenced by El Nino and the Southern Oscillation (ENSO), and the development, intensification, impact and forecasting of tropical cyclones. Meteor 450 meets for the first half (lessons 1 – 20) of the semester. Final exam or final project. Prereq: Meteor 430. Sem hrs: 1.5 fall.

Meteor 451. *Development and Evolution of Extratropical Weather Systems.* 3(1). Study of mid-latitude and polar weather systems, including synoptic-scale vertical motion, ageostrophic flow, and variables influencing the evolution of heights, temperatures, vorticity, and pressure. Conceptual models and three-dimensional analysis and oral communication of these analyses is emphasized. Final exam or final project. Prereq: Meteor 430. Sem hrs: 3 fall.

Meteor 452. *Mesoscale Meteorology.* 3(1). Study of the structure, development, and evolution of mesoscale weather systems. Topics include orographic mesoscale phenomena, the structure and types of convective weather from single-cell thunderstorms to mesoscale convective systems, conditions conducive to the development and subsequent evolution of organized convection, and the nature, climatology, and prediction of severe local storms. Final exam. Prereq: Meteor 451. Sem hrs: 3 spring.

Meteor 490. *Weather Forecasting and Impacts on Society.* 3(2). Capstone course in meteorology. Using real-world scenarios, this course assesses the cadet's ability to use critical thinking skills to integrate and synthesize a wide range of meteorological information to produce forecasts and assess societal impacts. Types and methods of forecasting and communication of meteorological benefits and limitations will be emphasized. Final project. Prereq: Meteor 431. Sem hrs: 3 spring.

Meteor 499. *Independent Study.* 3(0). Individual research under direction of a faculty member. Research paper or final project. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Meteor 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Meteor 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Meteor 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

MILITARY & STRATEGIC STUDIES

(MSS)

Offered by the Department of Military & Strategic Studies (DFMI))

MSS 251. *Air and Space Power in Joint Operations Strategy.* 4.5(2). MSS 251 prepares cadets to plan for and solve complex problems in pursuit of national security interests through the integration and application of multi-domain joint warfighting concepts with a particular focus on air, space, and cyber power across the range of military operations. This course serves as the educational cornerstone for cadet exposure to the context, theory, and application of military strategy and operational art. Cadets will engage in strategic and operational decision wargaming to better understand and apply the military instrument of power to promote and advance U.S. national interests and objectives. Final project and/or final paper. Prereq: History 100. Sem hrs: 4.5 fall or spring.

This course is a contributor to the development and assessment of the following outcomes: 1) National Security of the American Republic, and 2) Warrior Ethos as Airmen and Guardians.

MSS 251S. *Air and Space Power in Joint Operations Strategy.* 4.5(2). This course provides cadets the professional military education cornerstone for development as Airmen. Students will study "great works" and cutting edge scholarship in the realm of military strategy with the goal of synthesizing the enduring qualities of military strategy. Students will use strategic thinking and operational planning concepts to evaluate and apply air, space, cyber, and joint capabilities to contemporary strategic problems and operational simulations. Final project. Prereq: History 100. Sem hrs: 4.5 fall or spring.

This course is a contributor to the development and assessment of the following outcomes: 1) National Security of the American Republic, and 2) Warrior Ethos as Airmen and Guardians.

MSS 298. *Research Methods.* 3(1). This course focuses on both quantitative and qualitative research methods at the undergraduate level. Focused around policy analysis such as cost benefit

and cost effectiveness, cadets will learn the principles of comparative analysis, experimental design, case study analysis, and problem framing. Research Methods gives the cadet a solid understanding of the methodology necessary to conduct scholarly research, and will help cadets succeed in both STEM and non-STEM courses. Final exam and/or project. Prereq: None. Sem hrs: 3 fall or spring.

MSS 302. *Future Conflict and Disruptive Technologies.* 3(1). This course examines the role of emerging and disruptive technologies in the planning and waging of future conflict. The specific types of disruptive technologies discussed in the course will change over time, but current examples include hypersonic weapons, bio-technological weapons, autonomous weapon systems, Vertical Take-off and Landing (VTOL) systems, drones/Remotely Piloted Aircraft (RPA), quantum computing, and Artificial Intelligence, among others. This course emphasizes how such technologies are developed, integrated, and utilized (ideally without proliferation), to ensure the continuing effectiveness of the United States military. Students will engage with forward-thinking scholarship on emerging and disruptive technologies and, as appropriate, use the Multi-Domain Laboratory to work through concepts and simulations as they prepare themselves to understand the impacts of technological challenges that threaten to change the character of war. Final project. Prereq: MSS 251. Sem hrs: 3 fall or spring.

MSS 343. *Foundations of Joint Air, Space, and Cyber Strategy.* 3(1). Seminar course that provides the foundation for strategic thought by analyzing the context, theory, and doctrine associated with air, space, and cyber power. The course examines classic strategic concepts; war, politics, and the state; and technology, doctrine, and strategy. Lessons address irregular war and the evolution of air, space, and cyber as both revolutionary war-fighting domains and emerging strategic realms. The course focuses on the US Air Force as a pioneering organization and seeks to build Air Force identity through comprehending the evolving ideas of air, space, and cyber strategy. The course also surveys strategic doctrinal challenges for the US Space Force. Final exam and/or project. Prereq: None. Sem hrs: 3 fall.

MSS 353. *Strategies of Military Innovation.* 3(1). This seminar introduces and provides context for understanding the strategic application and military integration of the concept of innovation. To prepare cadets to understand and prepare for emergent threats, the course will examine innovation frameworks, models, and processes, along with concepts of networks and collaboration to leverage systems and concepts. Cadets will be able to analyze and more effectively manage innovation development and develop alternatives for the successful integration of innovation concepts to solve complex problems. Cadets will examine future problem sets in all domains and seek solutions from a broad range of perspectives. Final project. Prereq: None. Sem hrs: 3 fall.

MSS 363. *Intelligence, Surveillance, and Reconnaissance Analysis.* 3(1). This course introduces and applies types of intelligence, surveillance, and reconnaissance (ISR) analysis across the spectrum of conflict and around the globe. Analytic methods include kinetic and non-kinetic; individual and group; as well as technological and social approaches to understanding the contemporary threat environment. Students analyze complex operational environments to shape decisions. Final project or final exam. Prereq: None. Sem hrs: 3 spring.

MSS 369. *Spectrum of Conflict.* 3(1). Addresses the application of military power across the spectrum of conflict and in international context. Cadets study subjects such as hybrid warfare, counterinsurgency, peacekeeping, humanitarian assistance, foreign internal defense, information operations, and other uses of the military below the level of conventional war. Cadets will be able to tailor their research to both specific types of military intervention along the spectrum of conflict and to specific locations according to their academic interests and USAF Academy degree path. Final project. Prereq: None. Sem hrs: 3 fall.

MSS 371. *Joint Targeting and Strategy.* 3(1). This course provides a foundation in methodologies, theories, and operational challenges of military targeting to fulfill national security objectives. Strategies address kinetic and non-kinetic methods including direct and indirect targeting using airpower. Analytic approaches link national-level strategy to decisions about weaponeering, desired effects, and assessments. Cadets evaluate academic and doctrinal concepts relevant to mission and campaign-level operations, and adaptively apply them in scenarios. Our learning focus is to practice intellectual initiative, flexible planning, and strategic thinking. Final project. Prereq: None. Sem hrs: 3 spring.

MSS 372. *Wargame Design for Military & Strategic Studies.* 3(1). Cadets learn and apply the fundamentals of design for education and analytical wargames. Using hands-on wargaming, students explore design concepts for a variety of military & strategic studies topics. To facilitate their design, cadets will conduct in-depth research on military theory, a potential future conflict, or an emerging technology. Cadets will design and create an educational or analytical wargame for use in an academic course or a defense of defense-related organization. Final project. Prereq: None. Sem hrs: 3 fall.

MSS 377. *Airpower for Combined Effects.* 3(1). Cadets relate air campaign planning and airpower strategy and operational concepts in robust scenarios. Content includes weapons platforms, sensors and munitions, as well as roles, missions, and types of manned and unmanned aerial warfare in contemporary operating environments. Cadets adaptively plan and adjust air operations to combine effects in multiple simulations. Final paper. Prereq: MSS 251 and department approval. Sem hrs: 3 spring.

MSS 381. *Air Warfare Operations and Planning.* 3(1). Develops air-minded warrior ethos. Teaches the creation, conduct, and evaluation of contemporary air war at the tactical level. Teaches how airmen contribute to the military mission through robust airpower mission roles in a dynamic joint air warfare environment. Hones airpower leadership skills, mental stamina, and self-discipline/self-control through planning, briefing, executing, and debriefing comprehensive and highly demanding tactical airpower employment combat mission scenarios. Final project. US Cadets only. Prereq: MSS 251. Sem hrs: 3 fall or spring.

MSS 421. *International Power Projection.* 3(1). This seminar introduces cadets to how the U.S. government achieves international power projection and influence. Cadets analyze the complexity of the international security environment and how the United States pursues national security objectives through the application and projection of power in various forms. Cadets examine the context and theories of power projection, types of power, and the strategies informing the

application of military power projection toward national security aims. Cadets will also analyze the logistics enterprise that enables and sustains military power projection and discuss the ways in which the US operationalizes the National Security and National Defense Strategies through its military posture. Final project or paper. Prereq: MSS 251. Sem hrs: 3 fall.

MSS 422. *Strategy of Special Operations.* This seminar introduces the strategy of special operations forces (SOF) doctrine, concepts, capabilities, and limitations. Students will analyze the effectiveness of special operations in achieving strategic effects through case studies and cultural context that emphasize SOF-unique missions including direct action, counter-terrorism, and unconventional warfare. Cadets leverage the lessons of this class to develop a strategy using SOF capabilities to address a specific contemporary or potential regional conflict according to the academic and degree requirements of the individual cadet. Examples might include Foreign Internal Defense operations in North Africa or counter-terrorism operations in Europe. Prereq: MSS 251. Sem hrs: 3 fall.

MSS 423. *Nuclear Operations and Warfighting Strategy.* 3 (1). Seminar examines how the military instrument of national power integrates all domains to deter or counter the use of nuclear weapons and other weapons of mass destruction through integrated deterrence, including both offensive and defensive operations, to achieve desired effects. The seminar focuses on U.S. Strategic Command force structure, nuclear and conventional operations in warfighting and counterproliferation strategies. Cadets leverage the lessons of this course to develop operational plans to counter nuclear proliferation or the potential use of weapons of mass destruction by regional and/or great nuclear powers. Final project and/or paper. Prereq: MSS251. Sem hrs: 3 fall.

MSS 444. *Space and Cyber Strategy for National Security.* This course provides cadets the necessary knowledge and frameworks to understand the context, theory, and application of space and cyber capabilities as elements of national power. Cadets will explore national policy, doctrine, and strategy for the space and cyber domains for the US, foreign actors, commercial and civil actors, establishing a foundation to evaluate and apply space and cyber capabilities to contemporary strategic problems and operational simulations. Students will be able to form creative solutions to complex problems with emphasis on operational and strategic planning and teamwork. Final exam and/or final project. Prereq: MSS 251. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the National Security of the American Republic outcome.

MSS 490. *Strategy in Asia and the Pacific.* 3(1). This is a synthesis-level class designed to be taken the spring semester of a cadet's first-class year. Cadets will be required to employ the knowledge and skills that they have developed in their USAF Academy major and core courses in order to examine regional security issues and develop an interdisciplinary theater campaign strategy for contemporary or potential conflict in the region. Cadets will gain regional understanding and practice solving current strategic challenges. Final project or exam. Prereq: MSS 251. Sem hrs: 3 spring.

MSS 491. *Strategy in the Americas.* 3(1). This is a synthesis-level class designed to be taken the spring semester of a cadet's first-class year. Cadets will be required to employ the knowledge and skills that they have developed in their USAF Academy major and core courses in order to examine regional security issues and develop an interdisciplinary theater campaign strategy for contemporary or potential conflict in the region. Cadets will gain regional understanding and practice solving current strategic challenges. Final project or exam. Prereq: MSS 251. Sem hrs: 3 spring.

MSS 493. *Strategy in Eurasia.* 3(1). This is a synthesis-level class designed to be taken the spring semester of a cadet's first-class year. Cadets will be required to employ the knowledge and skills that they have developed in their USAF Academy major and core courses in order to examine regional security issues and develop an interdisciplinary theater campaign strategy for contemporary or potential conflict in the region. Cadets will gain regional understanding and practice solving current strategic challenges. Final project or exam. Prereq: MSS 251. Sem hrs: 3 spring.

MSS 494. *Strategy in the Middle East and Africa.* 3(1). This is a synthesis-level class designed to be taken the spring semester of a cadet's first-class year. Cadets will be required to employ the knowledge and skills that they have developed in their USAF Academy major and core courses in order to examine regional security issues and develop an interdisciplinary theater campaign strategy for contemporary or potential conflict in the region. Cadets will gain regional understanding and practice solving current strategic challenges. Final project or exam. Prereq: MSS 251. Sem hrs: 3 spring.

MSS 495. *Special Topics.* 3(1). Selected topics related to military doctrine, operations and strategy. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring

MSS 498. *Capstone Course in Joint Strategy.* 3(1). This course culminates the Military & Strategic Studies curriculum, integrating previous coursework to contribute knowledge to the context, theory, and application of military & strategic power. Cadets can accomplish the capstone in a seminar version or independently. Those in the seminar version will collectively develop research topics while cadets in the independent version will select their own topic and be individually paired with a subject matter expert. Cadets in both versions create a final project, presenting the results to applicable audiences. The independent capstone requires approval based upon the cadet's research topic and faculty advisor recommendation. Final project. Prereq: MSS 298. Sem hrs: 3 spring.

MSS 499. *Independent Study.* 3(0). Individual study and/or research under the direction of a DFMI instructor. No final. Prereq: Department approval. Sem hrs: 3 fall or spring.

- MSS 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- MSS 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- MSS 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

MILITARY TRAINING

(Mil Tng)

Offered by the Training Support Division (USAF Academy/CWT)

Mil Tng 100. *Basic Cadet Training (BCT)*. 0(0). Student Course. BCT is a 5 1/2-week transition period from civilian to military life. Indoctrination of the overall USAF Academy program: UCMJ, Introduction to Living Honorably in the Profession of Arms (ILHPA), manual of arms, drill, customs and courtesies, introduction to basic Air Force weapons, a field encampment, and other general military subjects. This course is a graduation requirement. Pass/fail. No final. Coreq: Phy Ed 100. Sem hrs: 0 summer.

This program is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Mil Tng 101. *Operation Air Force-Preflight (3 9)*. 0(0). TDY program conducted at Air Force installations worldwide. Cadets will experience the roles, responsibilities, and expectations of second lieutenants. Each cadet will receive exposure to officer and enlisted AFSCs, the associated duties accomplished, the various AF wing organizations, and experience the officer perspective in both support and operational squadrons. Not Graded. Sem hrs: 0 summer.

Mil Tng 201. *Operation Air Force Program (OpsAF)*. 0(0). Student Course. This three week program is conducted at Air Force installations worldwide. Cadets will learn the roles, responsibilities, and expectations of second lieutenants. Each cadet will understand the Air Force organization and gain a broad officer perspective in both support and operational squadrons. This course, is a graduation requirement. AETC Ops and Civil Engineering-Field Engineering Research Lab (CE-FERL) are substitute courses that fulfill the graduation requirement. Pass/fail. Sem hrs: 0 summer.

Mil Tng 205. *Wing Summer Support*. 0(0). Student Course. Cadets assigned to prepare facilities and resources for summer programs. Not Graded. No final. Sem hrs: 0 summer.

Mil Tng 220. *Combat Survival Training (CST) (Student Course)*. CST is a USAF Academy graduation requirement. Enrolled third-class cadets receive Code of Conduct training with an emphasis on expeditionary skills, Survival, Evasion, military operations in an austere environment, and personnel recovery tactics, techniques, and procedures (TTPs) enabling them as potential isolated personnel to “Return with Honor.” The program curriculum utilizes academic and laboratory learning, culminating in application-based field exercises to reinforce newly acquired skills supporting CSAF’s intent for USAF Academy graduates to be “Full Spectrum Readiness” trained. Upon completion of Mil Tng 220, member will receive credit for Long Term Survival and Evasion training (S-V98-A) and Emergency Parachuting Water Survival Training (S-V85-A). Pass/fail. Sem hrs: 0 summer.

Mil Tng 233/234/235. *Admin Squadron*. 0(0). Student Course. Cadets in a temporary hold for either the Physical Education Review Committee (Mil Tng 234), the Academic Review Committee (Mil Tng 235), or for some other purpose (Mil Tng 233). Not Graded. Sem hrs: 0 summer.

Mil Tng 240. *Special Warfare Orientation Course (SWOC) (Student Course).* 0(0). The two-week SWOC is designed to offer cadets to first garner interest and second to prepare for selection. Specific topics within these two main areas include:

A. Garner interest: AFSPECWAR History, application process, small unit tactics, land navigation, helicopter sortie, local AFSPECWAR unit visit, Tactical Combat Casualty Care, Troop Leading Procedures, Mission Planning, and simulated missions of Global Access (survey/establish/control airfields), Precision Strike (direct airstrikes), and Personnel Recovery (save lives and manage incident sites). The program culminates with 6 Full Mission Profiles (FMP) where cadets combine all learned skills.

B. Prepare for selection: Physical entry tests, Human Performance (vision and nutrition), surface and subsurface water skills clinics, physical fitness, Outdoor Leadership Course leadership reaction events, interviews, peer and permanent party feedback, risk management, decision making, durable mindset resiliency, and numerous leadership opportunities. They will also comprehend the importance of grit when experiencing mental/physical hardships. The culminating mission requires cadets to lead within small teams, plan a land route, negotiate mental/physical challenges, and attempt to reach a designated goal in an outdoor setting.

Cadets will leverage course content to better understand how they can improve their interpersonal leadership performance in a small team setting. Not Graded. Sem hrs: 0 summer.

Mil Tng 270. *Student Course. Expeditionary Skills Training.* 0(0). Cadets are trained and demonstrate M16 and M9 proficiency, dismounted patrol, military operations in urban terrain, chemical-biological-radiation-nuclear preparedness and response, mission planning, land navigation, Tactical Combat Casualty Care, basic survival, and evasion. These standalone training lessons will also include field hygiene, communications, combat rules of engagement, and combat first-aid. The program curriculum utilizes academic and laboratory learning culminating in application-based forward operating base and isolated personnel exercises to reinforce newly acquired skills. This course is a USAF Academy graduation requirement. Not Graded. Sem hrs: 0 summer.

Mil Tng 300. *Operation Air Force Program (International Students).* 0(0). Student Course. This three week program is conducted by the international student's home country. Not Graded. Sem hrs: 0 summer.

Mil Tng 302. *Navy Programs.* 0(0). Student Course. First-class cadets volunteer for SEAL Selection or SOAS training courses. This program is a prerequisite to cross commissioning into the Navy SEALs. Programs are three weeks in length. Not Graded. Sem hrs: 0 summer.

Mil Tng 304. *Army Programs.* 0(0). Student Course. First- and second-class cadets volunteer for Army training courses. Training is conducted at an army location and only if sponsored and initiated by USAF Academy and funds are available. Programs are two to three weeks in length. Not Graded. Sem hrs: 0 summer.

Mil Tng 305. *Marine Leatherneck.* 0(0). Student Course. First- and second-class cadets volunteer for Marine training. This program is a prerequisite to cross commissioning to the Marine Corps. Not Graded. Sem hrs: 0 summer.

Mil Tng 309. *Prep School BMT Cadre.* 0(0). Military Leadership. First- and second-class cadets serve as cadre for USAF Academy Preparatory School basic training. Not Graded. Sem hrs: 0 summer.

Mil Tng 315. *Cadet Wing Operations Center (CWOC).* 0(0). Military Leadership. Staff is responsible for manning the center 24 hours a day. Duties include maintaining wing locator information, emergency procedures notification, and information dissemination. Not Graded. Sem hrs: 0 summer.

Mil Tng 320. *Combat Survival Training (CST) (Cadre).* Leadership positions as instructors, officers, or NCOs in the cadet chain of command for Mil Tng 220 Combat Survival Training (CST) students. This course provides cadets the opportunity to learn and practice team leadership, coaching and facilitation in survival scenarios as they serve as cadre in the CST program. Not Graded, MPA Awarded by Pass/Fail. Sem hrs: 0 summer.

Mil Tng 332. *Summer Seminar.* 0(0). Career Broadening. Summer Seminar's purpose is to attract and inspire diverse, highly-qualified candidates to pursue USAF Academy appointments by actively engaging them in substantive and representative USAF Academy experiences. Cadets serve as leaders and counselors for 1125 high school students from all 50 states and around the world. During the three, 5-day camp sessions students are housed in Vandenberg Hall and fed at Mitchell Hall. Students experience cadet life through military briefings and demonstrations, academic workshops, character workshops, physical training sessions, intramurals, and a "Doolie for a Day" exercise. This program is first period only. Not Graded. Sem hrs: 0 summer.

Mil Tng 340. *Special Warfare Orientation Course (SWOC) (Cadre).* 0(0). Leadership positions as instructors, officers, or NCOs in the cadet chain of command for the Mil Tng 240 SWOC students. This course provides an opportunity to learn and practice team leadership, coaching, planning, risk management, logistics, and facilitation as they serve as cadre in the SWOC program. Cadre will receive an MPA to assess performance. Not Graded. Sem hrs: 0 summer.

Mil Tng 341. *Cadet Summer Language Immersion Program (CSLIP) In Lieu of Break.* 0(0). Student Course. DF Coordinated Program. This is an intensive foreign language and cultural study program at an accredited foreign university or language institute. Those selected for this program will spend the entire time in a foreign country where the target language is spoken. The program takes place during first summer period. Participation in CSLIP provides cadets with significant across-the-board improvement in language skills and cultural understanding, as well as the ability to function with confidence in international/foreign environments. Not Graded. Sem hrs: 0 summer.

Mil Tng 351. *Civil Engineering Field Engineering and Readiness Lab (FERL) Leadership.* 0(0). Military Leadership. C1C Civ Engr cadets selected by the Department of Civil and Environmental Engineering serve as Squadron Commander, Chief of Operations, Flight Commanders, and Logistics Officers for Civ Engr 351. Cadets lead second-class students through hands-on engineering/construction activities, a variety of team building activities, and field trips. Flight Commanders deploy with students to active duty AF installations on Operation Civil Engineering Air Force (OpsCEAF). Logistics Officers and leadership cadre prepare site and activities at the Field Engineering and Readiness Laboratory (FERL) for Civ Engr 351. Not Graded. Sem hrs: 0 summer.

Mil Tng 352. *SAME/USAF Academy Engineering and Construction Camp Cadre (CE-SAME).* 0(0). Career Broadening. C1C Civ Engr cadets selected by the Department of Civil and Environmental Engineering serve as Flight Commanders for high school students during the second summer period at the Field Engineering and Readiness Laboratory (FERL) complex in Jack's Valley. Cadets lead the students through a variety of team building activities/competitions, hands-on engineering/construction activities, and field trips. Cadets prepare site and activities prior to camp while leading and mentoring their students during the camp. Not Graded. Sem hrs: 0 summer.

Mil Tng 369. *Cadet Outdoor Leadership Experience (COLE).* 0(0). Student Course. Leadership positions as Ranger staff members with Philmont Scout Ranch in Cimarron, N M. Cadets lead groups of 8 - 12 youth and adults in demanding high adventure backcountry treks, instructing and developing outdoor and behavioral leadership skills. Each academic year, up to 30 rising 2-degrees are competitively selected to attend COLE during one of three summer training periods. Three of these cadets will be competitively selected to serve in COLE leadership positions the following year, with the remaining purposefully developed to serve in EST leadership/training positions their rising 1-degree summer. Prereq: None. Not Graded. Sem hrs: 0 summer.

Mil Tng 370. *Expeditionary Skills Training: (Cadre).* 0(0). Military Leadership. First- and second-class cadets will perform leadership positions as instructors, officers or NCOs in the cadet chain of command for the Mil Tng 270 EST students. The course provides cadets the opportunity to exercise leadership and management skills in dynamic settings that include simulated deployed operations and geographically forward operating base exercise locations. Cadets manage Mil Tng 270, Expeditionary Skills Training. Not Graded. Sem hrs: 0 summer.

Mil Tng 400/402. *Basic Cadet Training Cadre.* 0(0). Military Leadership. Leadership positions as instructors, officers or NCOs in the cadet chain of command during Basic Cadet Training. Some areas include: Combat Arms Training, Obstacle Course, Assault Course, Confidence Course, Self-Aid/Buddy Care, and Leadership Reaction Course. Mil Tng 400 refers to 1st BCT during 2nd summer period. Mil Tng 402 refers to 2nd BCT during 3rd summer period. Not Graded. Sem hrs: 0 summer.

Mil Tng 403. *Basic Cadet Training Group Staff.* 0(0). Military Leadership. Cadet officer and NCO group leadership positions maintaining command, control, and accountability for Basic Cadet Training. Not Graded. Sem hrs: 0 summer.

Mil Tng 405. *Basics and Principles for Developing the Innovation Mindset.* 0(1). This non-credit course explores different techniques for generating and developing ideas, transforming these ideas into viable business concepts, process improvement, executing and managing the business concepts to translate into business value. This course is designed to provide both a deep grounding in the field of innovation for entrepreneurs and entrepreneurs whose goal is to play a leading role in innovation-driven organizations. The course combines lectures, case analyses, and visiting experts. This is a semester course and the required cadet contact time is 53 minutes of seminar/in-class and ~92 hours of videos through self-directed learning (SDL) via online modules via the learning management system (LMS) OpusWorks. Not Graded. Sem hrs: 0 fall 2023, spring 2024, and fall 2024.

Mil Tng 407. *Operations Group Staff.* 0(0). Military Leadership. Cadet Officer and NCO leadership positions maintaining command, control, accountability, and providing billeting for all programs and cadets not assigned BCT or EST. Pass/fail. Not Graded. Sem hrs: 0 summer.

Mil Tng 408. *Sports Camp.* 0(0). Career Broadening. Cadets accepted by the Athletic Department program manager to work sports camps during the first summer period. Not Graded. No final. Sem hrs: 0 summer.

Mil Tng 411. *AETC Leadership Ops.* 0(0). Military Leadership. Leadership positions with a Basic Military Training Squadron at Lackland AFB, TX, as assistants to Military Training Instructors and as basic airmen training instructors and counselors. AETC Leadership Ops meets the requirements for Operation Air Force. Cadets cannot be scheduled for Operation Air Force after completing AETC Leadership Ops. Not Graded. Sem hrs: 0 summer.

Mil Tng 412. *Falconry.* 0(0). Career Broadening. Train recently hatched falcons for upcoming football season performances, train falcons on hand, public relations work, and assist in renovations/repairs of mews and equipment. Only cadet falconers are eligible. Not Graded. Sem hrs: 0 summer.

Mil Tng 413. *Operations Group Cadre.* 0(0). Military Leadership. Cadets who are assigned as Cadre to assist the Operations Group Staff maintaining command, control, and accountability. Assists with providing billeting for all programs and cadets not assigned BCT or EST during summer. Not Graded. Sem hrs: 0 summer.

Mil Tng 434. *Summer RECONDO Cadre.* 0(0). Military Leadership. First- and second-class cadets serve as cadre for USAF Academy/AD Summer RECONDO under the oversight of the USAF Academy PERC. Not Graded. Sem hrs: 0 summer.

Mil Tng 435. *Cadet Wing Leadership.* 0(0). Military Leadership. Selected cadets will perform in Cadet Wing Command functions managing all aspects of the Cadet Wing to include: Wing Commander, Deputy Commander, Superintendent, Director of Operations, and Leadership Staff. Not Graded. Sem hrs: 0 summer.

Mil Tng 441. *Cadet Summer Language Immersion Program (CSLIP).* 0(0). Student Course. DF Coordinated Program. This is an intensive foreign language and cultural study program at an accredited foreign university or language institute. Those selected for this program will spend the entire time in a foreign country where the target language is spoken. The program takes place during first summer period. Participation in CSLIP provides cadets with significant across-the-board improvement in language skills and cultural understanding, as well as the ability to function with confidence in international/foreign environments. Not Graded. Sem hrs: 0 summer.

Mil Tng 442. *Cultural Immersion Program (CIP).* 0(0). Student Course. Provides unique cultural and language learning opportunities for USAF Academy faculty, staff, and cadets. DFLCP solicits proposals from faculty and staff to study specific international issues, cultures, and histories in a variety of foreign countries around the world. DFLCP will determine which proposals are approved for funding. Not Graded. Sem hrs: 0 summer.

Mil Tng 444. *Summer Break.* 0(0). Summer break. Cadets who require more than three weeks of summer break during the summer will need to request a turnback through the Superintendent. No Military Training credit. Sem hrs: 0 summer.

Mil Tng 445. *Critical Language Scholarship Program (CLS).* 0(0). Student Course. DF Coordinated Program. The State Department's CLS seeks to enhance critical/strategic language capability in the United States government. Undergraduate students are selected to participate in fully-funded summer language opportunities, including instruction in languages taught at USAF Academy as well as those not offered in the USAF Academy curriculum. CLS participants receive academic credit through Bryn Mawr College or other US nationally accredited colleges that partner with the State Department. For languages taught at USAF Academy, DFLC may recommend participating cadets receive equivalent USAF Academy credit after assessing the curriculum. For languages not taught at USAF Academy, DFLC may recommend applicable foreign language validation credit. CLS details are available at <http://clscholarship.org>. Not Graded. Sem hrs: 0 summer.

Mil Tng 446. *Special Break.* 0(0). First-, second-, and third-class cadets requiring summer break at a certain time during the summer. Examples include: third-class football players and cadets requiring summer break for weddings or other special occasions. All requests for special summer break will be submitted to CWTS by the third week of January for consideration. Cadets who require more than three weeks of summer break during the summer will need to request a turnback through the Superintendent. No Military Training credit. Sem hrs: 0 summer.

Mil Tng 447. *Medical Summer Break.* 0(0). First-, second-, and third-class cadets requiring summer break at a certain time for scheduled medical operations or when sent home on

recuperative summer break. Cadets who require more than three weeks of summer break during the summer will need to request a turnback through the Superintendent. No Military Training credit. Sem hrs: 0 summer.

Mil Tng 451. *Honor Cadre.* 0(0). Career Broadening. First-class cadets who teach honor lessons to basic cadets and process honor cases during the summer. Not Graded. Sem hrs: 0 summer.

Mil Tng 452. *Media Cadre.* 0(0). Career Broadening. First- and second-class cadets selected for cadet-in-charge (CIC) duty for media. Not Graded. Sem hrs: 0 summer.

Mil Tng 460. *National Character and Leadership Symposium (NCLS) Summer Cadre.* 0(0). This program will allow up to six first-class cadets who have been selected for NCLS Wing Staff positions to practice leadership competencies, team-building, and organizational management by recruiting other cadet volunteers, creating cross-functional teams that include USAF Academy/CM, PA, A6, and CCLD professionals, and planning/executing NCLS-related events that occur throughout the academic year, in accordance with USAF Academy PLAN 10-46. Participating cadets will serve as NCLS Summer Cadre for a single summer period, and participation in the NCLS Summer Cadre program does not preclude the cadet from participating in another summer cadre opportunity as applicable. Not Graded. Sem hrs: 0 summer.

Mil Tng 48X. *Cadet Summer Research Program (CSRP).* 0(0). Student Course. This course is a DF coordinated summer research program for firsties. This course consists of 33-36 days conducting a research project usually in the cadet's major area of study. Operation Air Force credit may be provided if the cadet spends at least 2 weeks at a location engaged in activities typical of varied DoD operations and functions to include interaction with Air Force officers. Cadets are selected by their academic advisor and applicable academic department and may receive independent study credit with department approval. Summer Research programs are coordinated with CWT to ensure appropriate scheduling, training credit, and support. 3 course options are listed below. Not Graded. Sem Hrs: 0 summer.

Mil Tng 481. *Cadet Summer Research Program (CSRP) with Partial Summer Break.* 0(0). Student Course. This option begins the day after graduation (1st summer period) and ends partway into the second period of summer. This option is in lieu of a full second period summer break. NOTE: This option can begin second period and end partway through the third period with appropriate CW and DF coordination. Mil Tng 481 can be scheduled for 21 days and support a full summer break period with academic departmental approval. Not Graded. Sem hrs: 0 summer.

Mil Tng 486. *Summer Research Leadership with Summer Break.* 0(0). Student Course. Under special circumstances USAF Academy/CC may authorize cadets to participate in national level research projects for 41-43 days at a research location. This option occurs during two summer periods. Not Graded. Sem hrs: 0 summer.

Mil Tng 488. *Summer Research In Lieu Of Summer Break and Over Graduation Activities.* 0(0). Student Course. This option begins after finals and runs first summer period only. Not Graded. Sem hrs: 0 summer.

Mil Tng 492. *Military & Strategic Studies Application Laboratories.* 0(0). Student Course. DF Coordinated Program. Cadet Air and Space Instructors use a number of educational laboratories such as available aircraft, Air Warfare Laboratory simulators, aviation flight training devices, and the Space Education Laboratory. Cadets interact with visiting dignitaries such as congressional delegations, high school and university counselors, and General Officers. In addition, cadets host the air and space application portions of Summer Seminar, conduct integrated field studies, teen aviation camp, space camp, and ROTC summer visitations. Prereq: Department of Military Instruction approval. Not Graded. Sem hrs: 0 summer.

Mil Tng 499. *Internship.* 0(0). Student Course. DF Coordinated Program. 1^o and 2^o cadets work special research/internships at various TDY locations or on USAF Academy. These are individual programs structured for each cadet enrolled. The program may be scheduled for any one of the three summer periods. Internships may be longer than three weeks. Examples of such programs are the Georgetown and Washington Internship programs, which are directly tied to the allocated CSRP numbers. Not Graded. Sem hrs: 0 summer.

SmrAcad 700. *Summer Academic Placeholder.* 0(0). Student Course. DF Coordinated Program. SmrAcad 700 is the generic placeholder to reserve a specific summer period for future enrollment in a specific summer academic course. Sem hrs: 0 summer.

OPERATIONS RESEARCH **(Ops Rsch)**

Offered by the Department of Computer and Cyber Sciences (DFCS), Department of Economics and Geosciences (DFEG), Department of Management (DFMA), and Department of Mathematical Sciences (DFMS)

Ops Rsch 310. *Systems Analysis.* 3(1)*. This course exposes students to quantitative modeling methods that have broad application. The course focuses on computer implementation of models and the application of these models to practical decision-making scenarios. The course demonstrates the application of modeling techniques to problems in a wide range of disciplines. The course covers OR tools such as optimization, queuing, simulation, and decision analysis. Administered by the Department of Management. Instruction provided by inter-departmental Operations Research faculty. Final exam. Prereq: Comp Sci 110, Math 142/152. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Ops Rsch 311. *Deterministic Models.* 3(1). Topics include linear programming (with sensitivity analysis and applications) and non-linear programming. Both the theory and the computer implementation of these techniques are addressed. Administered by the Department of Mathematical Sciences. Final exam. Prereq: Math 344 or Math 360, and either Ops Rsch 310 or department approval. Coreq: Math 243/253. Sem hrs: 3 fall.

Ops Rsch 312. *Probabilistic Models.* 3(1). Selected probabilistic models (such as random walks, Markov Chains, queues, and reliability models) are analyzed as stochastic processes. Administered by the Department of Mathematical Sciences. Final exam. Prereq: Math 356, Math 377, or department approval. Sem hrs: 3 spring.

Ops Rsch 331. *Optimization Theory with Microeconomic Principles.* 3(1). Calculus-based study of optimization theory for constrained and unconstrained problems focusing on first and second order conditions, comparative statics, envelope theorem, and duality. Optimization tools will be used to develop traditional microeconomic theory: consumer behavior, product and factor pricing, allocation and employment of resources, and the implications of various market structures. The course also includes an introduction to game theory. Cadets cannot receive credit for Ops Rsch 331 in addition to Econ 333 or Econ 423. Administered by the Department of Economics and Geosciences. Final exam. Prereq: Econ 201, Math 243/253, and Ops Rsch 310. Sem hrs: 3 fall.

Ops Rsch 405. *Operations Research Seminar I.* 0(1). A course for Operations Research majors that provides for presentation of cadet and faculty research; guest lecturers; field trips; seminars on career and graduate school opportunities for scientific analysts in the Air and Space Forces; goal setting exercises; and applications of Operations Research. The class meets once each week. Open only to 1^o Operations Research majors or other students enrolled in Ops Rsch 421. Administered by the Department of Mathematical Sciences. Pass/fail. Prereq: C1C standing. Sem hrs: 0 fall.

Ops Rsch 406. *Operations Research Seminar II.* 0(1). A course for Operations Research majors that provides for presentation of cadet and faculty research; guest lecturers; field trips; seminars on career and graduate school opportunities for scientific analysts in the Air and Space Forces; goal setting exercises; and applications of Operations Research. The class meets once each week. Open only to 1^o Operations Research majors or other students enrolled in Ops Rsch 422. Administered by the Department of Management. Pass/fail. Prereq: C1C standing. Sem hrs: 0 spring.

Ops Rsch 417. *Quick-Turn Analysis.* 3(1). The pace of decisions in modern warfare requires analytic results within very limited time constraints and using only commonly available tool sets. This course focuses on rapid data analysis by writing software to integrate standard office productivity software and geographical information systems to provide visibility and illumination to decision making. Specific skills and abilities taught in this course include data manipulation and analysis, database design and usage, visualization techniques, and high impact – short duration presentation skills. Administered by the Department of Computer and Cyber Sciences. Final Project. Prereq: Comp Sci 210, Comp Sci 211, or Comp Sci 212. Sem hrs: 3 fall.

Ops Rsch 421. *Capstone in Operations Research I.* 3(2). The study of methodologies associated with business and operations management. A project-based course intended to provide the proper foundation necessary to conduct effective analyses supporting a variety of scenarios. Students will evaluate various project scenarios, develop plans for and conduct analyses, and create effective

written and oral presentations. Develop capstone project proposal and milestones supporting Ops Rsch 422. Administered by the Department of Management. Final project. Prereq: Ops Rsch 310; C1C standing in the Ops Rsch or Sys Engr majors, or course director approval. Sem hrs: 3 fall.

Ops Rsch 422. *Capstone in Operations Research II.* 3(2). Project development and implementation for real-world clients using advanced operations research techniques with emphasis on problem recognition, model formulation, and Air and Space Force applications. Administered by the Department of Management. Final project. Prereq: Ops Rsch 421, C1C standing in the Ops Rsch or Sys Engr majors, or course director approval. Sem hrs: 3 spring.

Ops Rsch 476. *Sports Analytics.* 3(1). The use of analytic tools and techniques in sports has been steadily increasing over time. Both amateur and professional teams and individuals in almost every sport imaginable use analytics to try to gain a competitive edge. Sports analytics gives students the opportunity to apply descriptive, predictive and prescriptive analytics tools and techniques to tackle a variety of sports-related problems. This application-based course will afford students the opportunity to interpret situations, determine the best modeling approach to address a situation, conduct in-depth analysis to find solutions, and present findings to senior-level decision makers. Final project. Prereq: Math 377 (or Math 356 with a B or higher) and Ops Rsch 310, or Course Director approval. Sem hrs: 3 fall.

Ops Rsch 495. *Special Topics.* 3(1). Selected topics in Operations Research. Final exam or final report. Offered by DFCS, DFEG, DFMA or DFMS. Prereq: Department approval. Sem hrs: 3 fall or spring.

Ops Rsch 499. *Independent Study.* 3(0). Individual study and/or research in Operations Research, under the supervision of a faculty member. Final exam or final report. Offered by DFCS, DFEG, DFMA, or DFMS. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Ops Rsch 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Ops Rsch 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Ops Rsch 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

PHILOSOPHY

(Philos)

Offered by the Department of Philosophy (DFPY)

Philos 200. *Introduction to Philosophy.* 3(1). An introduction to basic deductive and inductive logic through a study of important philosophical texts from antiquity to the modern era. Cadets will gain a sense of philosophy's history and scope while learning what makes a good argument. Final exam or final project. Prereq: None. Sem hrs: 3 fall or spring.

Philos 210. *Ethics.* 3(1)*. A critical study of several major moral theories and their application to contemporary moral problems with special emphasis on the moral problems of the profession

of arms. Highlighted are the officer's responsibilities to reason and act ethically; develop critical thinking skills; know civic, cultural, and international contexts in which the U.S. military operates; and learn influential normative theories about ethics and the foundations of character. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Ethics and Respect for Human Dignity outcome.

Philos 210S. *Scholars Ethics*. 3(1). This course is the Martinson Honors Program version of Philos 210, Ethics. A critical study of several major moral theories and their application to contemporary moral problems with special emphasis on the moral problems of the profession of arms. Highlighted are the officer's responsibilities to reason and act ethically; develop critical thinking skills; know civic, cultural, and international contexts in which the U.S. military operates; and learn influential normative theories about ethics and the foundations of character. Final exam. Prereq: Scholar status. Sem hrs: 3 fall.

This course is a contributor to the development and assessment of the Ethics and Respect for Human Dignity outcome.

Philos 311. *War, Morality, and the Military Profession*. 3(1). An in-depth examination of the moral issues raised by the profession of arms. Presumes an understanding of moral theory, as a minimum: relativism, egoism, utilitarianism and deontology. May be taken as a sequel to Philos 210, or substitutes for Philos 210 (with department approval) if the student has independently studied ethical theory. Final exam or final project. Prereq: Philos 210. Sem hrs: 3 fall or spring.

Philos 320. *Ethics and Technology*. 3(1). A study of ethical theories and their application to issues in science, technology, engineering, and mathematics (STEM), e.g.: safety and liability in engineering, professional responsibility to clients and employers, professional code of ethics, ethics of research including collection and uses of data, ethical implications of human enhancements, cyber ethics, ethical uses of space, issues in environmental ethics, and the ethics of pedagogy in STEM disciplines. Although the course will focus on ethics, cadets may elect to explore related issues in other sub-disciplines of philosophy, e.g., the epistemology of artificial intelligence and aided perception, and the metaphysics of functions. Cadets may choose project and paper topics related to their majors. Final exam or final project. Prereq: Philos 210, Philos 200, or instructor approval. Sem hrs: 3 fall.

Philos 330. *Introduction to the Philosophy of Science*. 3(1). An analysis of the basic assumptions and principles of the sciences. Types of topics considered include the scientific method, scientific laws, theory construction, scientific explanation, probability, the relationship between the social sciences and the physical sciences, and the relationship between the sciences and the humanities, especially in the formation of values. Final exam or final project. Prereq: Completed or enrolled in Philos 210 or department approval. Sem hrs: 3 spring of even-numbered years.

Philos 345. *Philosophy of Love and Sex.* 3(1). This course examines the meaning of love and the nature of different kinds of love, such as affection, friendship, erotic love, and charity. This course also explores proposed connections between love and sex and the relevance of such connections to questions of sexual ethics. Final exam or final project. Prereq: None. Sem hrs: 3 spring.

Philos 350. *Philosophy and Christian Thought.* 3(1). A philosophical investigation of various, important doctrines and topics in Christian thought, such as God, creation and providence, human nature and sin, Trinity, incarnation, atonement, ethics, and eschatology (study of "last things"). Major thinkers from the history of Christianity who may be studied in the course include Origen, Athanasius, Augustine, Anselm, Aquinas, Luther, Calvin, Edwards, Newman, Kierkegaard, Tillich, Barth, Rahner, and others. Final exam or final project. Prereq: None. Sem hrs: 3 fall.

Philos 355. *Theories of Justice.* 3(1). What is justice? The aim of this course is to consider the most prominent and persistent answers that philosophers have given to this question. Readings will be drawn from a mix of historical and contemporary authors. Authors might include: Aristotle, Thomas Aquinas, John Locke, John Stuart Mill, John Rawls, Robert Nozick, Michael Sandel, Alasdair MacIntyre, Carol Gilligan, Charles Mills, Carole Pateman, and Thomas Sowell. Cadets should expect a seminar focused on primary sources, together with a variety of formal and informal writing assignments. Final paper. Prereq: None. Sem hrs: 3 fall, odd-numbered years.

Philos 365. *C.S. Lewis and Philosophy.* 3(1). C.S. Lewis was not a professor of philosophy, but he was arguably one of the most influential public philosophers of the 20th century. As a writer for the Los Angeles Times observed, "Lewis, perhaps more than any other twentieth-century writer, forced those who listened to him and read his works to come to terms with their own philosophical presuppositions." In this course we will evaluate and discuss the philosophical arguments and themes in some of Lewis's most influential books and essays. Along the way we will consider how he engaged with the views of leading philosophers of his day, such as Elizabeth Anscombe, as well as great philosophers from the history of philosophy including Plato, Aristotle, Kant, and Hume. Final exam or final project. Prereq: Completed or enrolled in Philos 210, or with instructor approval. Sem hrs: 3 fall of even-numbered years.

Philos 370. *Introduction to Symbolic Logic.* 3(1). An advanced course in logic that examines propositional and predicate languages, model theory, quantifiers, proofs, identity theory and properties of logical systems. Final exam or final project. Prereq: Completed or enrolled in Comp Sci 110. Sem hrs: 3 spring.

Philos 382. *American Philosophy.* 3(1). An examination of the philosophic background of Puritanism, the Revolutionary period, transcendentalism and pragmatism with special reference to the thought of major American philosophers such as Pierce, James, Royce, Santayana, Dewey. Final exam or final project. Prereq: Completed or enrolled in Philos 210. Sem hrs: 3 fall of even-numbered years.

Philos 391. *Ancient Western Philosophy.* 3(1). A survey of selected philosophers and schools of thought from the 6th century BCE to the 3rd century CE. Major philosophers of this era include the Pre-Socratics, Plato, Antisthenes, Aristotle, Epicurus, Epictetus, Plotinus, and others. Major schools of thought include the Academics, Cynics, Peripatetics, Epicureans, and Stoics. Final exam or final project. Prereq: Completed or enrolled in Philos 210, or with instructor prior approval. Sem hrs: 3 fall, even-numbered years.

Philos 392. *Western Medieval Philosophy.* 3(1). A survey of selected philosophers and schools of thought from the 4th through the 16th centuries. Major philosophers of the era include Augustine, Boethius, Al Farabi, Avicenna, Anselm, Averroës, Maimonides, Aquinas, Duns, Scotus, William of Ockham, and others. The period is characterized by attempts to reconcile classical philosophy with the revealed religions of Judaism, Christianity, and Islam. Final exam or final project. Prereq: Completed or enrolled in Philos 210, or with instructor prior approval. Sem hrs: 3 spring, odd-numbered years.

Philos 393. *Modern Western Philosophy.* 3(1). A survey of selected philosophers and schools of thought from the 17th through the 19th centuries. Major philosophers of this era include Descartes, Hobbes, Spinoza, Locke, Leibniz, Hume, Kant, Hegel, Mill, Kierkegaard, Marx, Nietzsche, and others. Major schools of thought include Rationalism, Empiricism, Skepticism, and German Idealism. Final exam or final project. Prereq: Completed or enrolled in Philos 210, or with instructor prior approval. Sem hrs: 3 fall, odd-numbered years.

Philos 394. *Contemporary Topics in Philosophy.* 3(1). An in-depth study of central themes and issues in philosophy examined through the work of contemporary philosophers (defined as those working from the 20th century through today.) Topics may require a historical survey to provide context for examining contemporary developments. Final exam or final project. Prereq: Completed or enrolled in Philos 210, or with instructor prior approval. Sem hrs: 3 spring, even-numbered years.

Philos 395. *Philosophy of Law.* 3(1). This course will serve as an introduction to legal philosophy and its relations to moral reasoning. Emphasis on the nature of law, its authority, its relations to morals, the controversies over judicial decision-making, the justification of states interfering with the liberty of its individual citizens, the various different or competing senses of "justice," the question of responsibility and the justification of legal punishment. Final exam or final project. Prereq: Philos 210. Sem hrs: 3 spring.

Philos 401. *Comparative Religion.* 3(1). A philosophical survey of selected world religions, possibly including "extinct" religions now known only through texts and other artifacts. Faith traditions to be surveyed in every offering of this course include Hinduism, Buddhism, Islam, Judaism, and Christianity. See course syllabus for additional traditions to be examined in a given semester. Final exam or final project. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Ethics and Respect for Human Dignity outcome.

Philos 402. *Philosophy of Religion.* 3(1). Topics to be considered include concepts of the divine, grounds for belief in a deity, theories of salvation, the problem of evil, the roles of revelation and reason in religion, problems of religious language, and the role of religion in moral theory. Final exam or final project. Prereq: None (but students may find Philos 401 a helpful foundation). Sem hrs: 3 spring.

Philos 410. *Medical Ethics.* 3(1). Ethics applied to biomedical issues using a seminar approach. Ethical problems considered will include informed consent, refusal of treatment, suicide, killing and letting die, paternalism, allocation of health care, patient confidentiality, codes of medical ethics and specific case analyses. Final exam or final project. Prereq: Completed or enrolled in Philos 210. Sem hrs: 3 fall.

Philos 420. *Religion Studies Capstone.* 3(1). The culminating, integrative and interactive learning experience for the Religion Studies minor. Will involve cross-traditional study of major themes in religion. Topics may include theories in the study of religion, religion and politics, comparative religious ethics, religion in art and literature, religion in war and peace, and advanced studies in philosophy of religion. All cadets earning the Religion Studies minor should take this course in their final spring semester. Final paper or final project. Coreq: C1C status and earning the Religion Studies minor, or instructor approval. Sem hrs: 3 spring.

Philos 423. *Knowledge and Reality.* 3(1). This course serves as an advanced survey of central questions in metaphysics, epistemology, and philosophy of language. Questions covered may include: What is knowledge? What, if anything, can we know? Do we have free will? What is causation? What is a mind, a self, a person? And how are these things related to material things like bodies and brains? What is the nature of time and space? Is time-travel possible? What is truth? What is meaning? Final exam or final project. Prereq: Completed or enrolled in Philos 210, or with instructor approval (assuming the instructor exists). Sem hrs: 3 fall.

Philos 430. *Philosophy of Art & Aesthetics.* 3(1). Aesthetic philosophy investigates the nature of beauty, asking questions such as: How do we determine what qualifies as art in any form? Based on what principles or criteria do we deem something beautiful or ugly? Is beauty a natural property or a conventional projection? What defines the difference between music and non-musical sound? Is good taste in matters of art innate or something one can develop? Thinkers including Plato, Aristotle, Horace, Shaftesbury, Hume, Burke, Kant, Schopenhauer, Heidegger, Benjamin, Foucault, Collingwood, Danto, and many others have written influentially on these and other questions. Philosophy majors may earn 6 semester hours toward the major by combining this course with any Creative Art course. Final project. Prereq: None. Sem hrs: 3 spring of odd-numbered years.

Offered this fall, next offered in the spring of 2025 and biennially thereafter.

Philos 495. *Special Topics.* 3(1). Selected topics in philosophy. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Philos 499. *Independent Study.* 3(0). Philosophical research guided by an instructor. Topics and meetings arranged with the instructor. No final. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Philos 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Philos 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Philos 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

PHYSICAL EDUCATION

(Phy Ed)

Offered by the Department of Physical Education under the Director of Athletics (AD).

Phy Ed 100. *Basic Physical Training.* 0(0). Preparation for strenuous physical education and athletics by development of physical strength, endurance, agility, and coordination through conditioning exercises, sports competition, and taking the Physical Fitness and Aerobics Test. Special training in conditioning as needed. Pass/fail. Sem hrs: 0 summer.

Phy Ed 110. *Boxing.* Boxing is taught to all cadets in order to develop an understanding of the physiological and psychological aspects of personal confrontation and provide the foundation for future combatives training and proficiency. Boxing is a proven developer of personal self-efficacy and physical conditioning, and also develops and intensifies the military leadership attributes of quick reaction, coordination, accurate timing, judgment, aggressiveness, and determination. Boxing quickly acclimates the mind and body to adapt to stress and overcome fear which are abilities essential for military leadership. It further teaches the ability to keep calm and poised under pressure, thus developing emotional control. Cadets will also be taught specific mental skills that can be used in their military career and personal lives. These skills will include visualization, positive self-talk, and proper body language. The course includes 8 lessons of boxing skills, with safety, rules, and scoring emphasized prior to the graded review lessons. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 111. *Swimming.* Introduces cadets to a variety of aquatic skills necessary for safety, fitness, and recreation. This course will provide sufficient instruction so every cadet is able to maintain and improve his or her physical fitness in an aquatic environment. Students are graded on stroke skills, a timed 250 yard or meter swim, underwater swim, egress scenario, treading water, drown proofing, and a mile swim. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 112. *Physical Development.* Introduces cadets to foundational principles of strength and conditioning, including applied knowledge of needs-analysis, exercise selection, teaching progressions, recovery, and restoration modalities. Cadets will participate in proven strength and conditioning programs to enhance their Mission Essential Fitness. Each cadet will learn, practice,

and be assessed on their technical proficiency of the PFT exercises (Push-up, Pull-Up, Sit-up, Long Jump), and four structural lifts (Back Squat, Deadlift, Shoulder Press and Dumbbell Row). Prereq: None. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 113. *Fundamentals of Physical Development.* A 16 lesson (20 contact hours) individual developmental physical education course in which cadets will learn and apply the skills necessary to establish and maintain proficient levels of fitness as a cadet and officer. Participants will engage in a rigorous physical conditioning program comprised of alternating sessions of muscular resistance training, aerobic and anaerobic conditioning, functional fitness, core strengthening and stabilization, and flexibility training. In addition, cadets will be exposed to proper diet and nutrition concepts and resources, as well as tools and methods for mental strengthening to foster resiliency. Cadets with a diagnostic PFT following BCT of 226 or lower for A-B Go or diagnostic or primary PFT of 250 for later Goes will be automatically enrolled. Prereq: Selection by Athletic Department. Sem hrs: 0.5(2xx) summer, fall, or spring.

Phy Ed 119. *Basic Swimming.* This course is designed for cadets with little aquatics experience or those needing additional time to develop swimming endurance. Because these cadets typically need more time to acclimate to the aquatic environment, the course is 16 lessons. Entry into the course is determined by an aquatic ability assessment consisting of a 250-yard timed swim and input from aquatics instructors. The first 8 lessons focus on technique, while the final 8 lessons focus on swimming endurance. Cadets are instructed on proper swimming technique and development of the skills necessary for basic water safety and personal fitness. Cadets are introduced to water survival skills in preparation for the 200-level water survival course. Replaces Phy Ed 111. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 152. *Intercollegiate Sports.* .05(2xx) fall or spring.

Phy Ed 211. *Basic Water Survival.* This course continues the development of the basic swimmer and teaches cadets basic aquatic survival skills that last a lifetime. These survival methods serve officers well throughout their careers. The class provides sufficient aerobic and anaerobic activities that challenge the cadets to maintain an above average level of fitness while having fun through aquatics. Cadets learn to save their own lives and assist others in a water emergency, survive in the water for long periods of time, and build confidence to swim long distances. Moreover, cadets experience situations that develop self-confidence, emotional control, persistence and courage. A variety of skills challenge cadets to move beyond their current skill and comfort levels. Cadets are evaluated in each one of the skills taught throughout the course. Replaces Phy Ed 222. Final exam. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 215. *Combatives I.* Introduces cadets to hand-to-hand combat skills and scenarios and provides a context for the application of combatives techniques. Reinforces fundamental fight concepts that are universally applicable and develops a combatives operating system that is reliant on situational awareness, Strategic Social Interactions, understanding the physiological impacts of the stress response, ethical decision-making under stress, use of force considerations, and maintaining or regaining composure while managing potential or actual interpersonal violence. Cadets learn offensive and defensive techniques from standing and ground-fighting positions that include select strikes, takedowns, dominant body positions, and submissions. Skills are practiced and assessed through drilling, live resistance training, and live competition. Academic and practical graded reviews. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 219. *Fundamentals of Personal Water Safety.* The course continues to develop swimming skills for the basic swimmer. The course will teach cadets basic aquatic survival skills that last a lifetime. These survival methods serve officers well throughout their careers and personal lives. The course provides sufficient aerobic and anaerobic activities that challenge the cadets to maintain an average level of fitness while having fun through aquatics. Cadets learn to save their own life and assist others in a water emergency, survive in the water for extended periods of time, and build confidence, emotional control, persistence and courage. A variety of skills challenge cadets to move beyond their current aquatic skill and comfort level. Cadets are evaluated in each one of the skills taught throughout the course. Replaces Phy Ed 211 or Phy Ed 222. Prereq: Phy Ed 119, Phy Ed 211 or Phy Ed 222 Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 222. *Water Survival.* An introduction to basic personal water survival skills and lifesaving techniques. The primary objective of the course is to learn personal water survival skills that are needed in a water emergency. A secondary objective is to learn basic lifesaving skills needed to assist someone else involved in a water emergency. Work to increase cardiovascular and muscular endurance is also part of the course. Prereq: Phy Ed 111 or 119. Final exam. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 252. *Intercollegiate Sports.* Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 315. *Combatives II.* Builds upon baseline proficiencies established in Phy Ed 215, with emphasis on dominant body positions and submissions in ground-fighting combatives. Cadets learn additional submissions and transitions, and gain a deeper understanding of related offensive and defensive principles. Cadets are exposed to considerations for fighting with tools and team fighting concepts. Cadets also learn about operational combatives through class discussion, studying the history of USAF Combatives, and After Action Reports. Skills are practiced and

assessed through drilling, live resistance training, and live competition. Academic and practical graded reviews. Prereq: Phy Ed 215. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 340. *Racquetball.* Introduces cadets to the fundamentals of the sport of racquetball. Cadets will learn skills, strategies, and rules of a fun and exciting sport often played during base intramural competition, as well as to remain physically fit throughout their lives. Written and practical graded reviews. Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 341. *Tennis.* Introduces cadets to the fundamentals of the sport of tennis. Cadets will develop necessary skills while also gaining an understanding of rules, strategies, and etiquette of the sport. Additionally, their physical fitness will be maintained and improved through drills and match play. Written and practical graded reviews. Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 342. *Golf.* Introduces cadets to the sport of golf focusing on fundamental golf mechanics taught through repetitive drill techniques. Emphasis is placed on skill improvement and understanding a respect for the game, its traditions, rules, and etiquette. Basic golf swing technique demonstration and practice of putting, short irons, long irons, proper setup, and grip make up the foundation of the course. Emphasizes the need for practice, discipline, and mental concentration. Written and practical graded reviews. Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 343. *Indoor Rock Climbing.* Introduces cadets to the fundamentals of indoor rock climbing. The course is designed to develop strength, agility, balance, coordination, problem solving, fear management, and mental focus. Mandatory components, such as situational awareness, risk management and proper decision making, are emphasized and taught in topics such as use and care of climbing equipment, hand and footwork efficiency, knots, top roping, bouldering, belaying, rated climbs, judgment, and safety. Cadets will be provided all equipment and gear necessary to complete the course. Offered to upperclassmen as an individual or open elective. Prereq: Phy Ed 112 and physical standards as established by the course director. Written and practical graded reviews. Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 344. *Yoga.* Cadets learn basic yoga skills that improve physical and mental health and resilience and can be practiced anywhere with little or no equipment. Cadets learn breath awareness and control along with physical postures and movements that improve mobility and range of motion, balance, strength, stamina, and body awareness. Cadets also practice self-awareness and reflection, self-discipline, mindful attentiveness, clear communication, developing congruence between intent and action, and purposeful relaxation. The combined mental and physical skills learned can be integrated as part of an ongoing wellness regimen for continued improvement of overall mental and physical health, self-confidence, mind-body connection, mental focus and clarity, and stress management. Academic and practical graded reviews. Prereq: Phy Ed 112 or Phy Ed 152/252/352/452. Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 345. *Advanced Physical Development.* Phy Ed 345 introduces cadets to an advanced fitness regimen to optimize their physical strength, stamina, speed, resiliency, and recovery. Based upon the principles learned in Phy Ed 112, Physical Development students will learn basic pushing and pulling movements using principles of biomechanics to safely increase load, speed, and thus intensity. Advanced Physical Development course incorporates multi-planar and multi-joint movements, which have been widely adopted by the military/Battlefield Airmen communities to prepare warfighters for the demands of operational environments. The skills introduced can be performed with an intensity level tailored to enhance individual fitness requirements and development. Cadets are evaluated through Quizzes, Needs Analysis, Workout Program Design and practical graded reviews. Prereq: Phy Ed 112 or at least one of the following: Phy Ed 152/252/352/452. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 346. *Pickleball.* This course is designed to provide a learning environment that enhances physical and mental wellbeing, while promoting skill development in a popular lifetime sport. Cadets will receive foundational tools for engaging in physical activity, understanding the sport, and building capacity to utilize transferrable skills in other activities throughout their lives. In Pickleball, cadets will be introduced to the rules, etiquette, and strategies of the sport and through engagement will develop skills such as agility, balance, and hand-eye coordination. Additionally, cadets will be encouraged to communicate and develop camaraderie through their involvement in singles and doubles match play. Students are graded on skills, knowledge, and match play. Written and performance exams. Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 347. *Self-Protection.* This course exposes cadets to Combatives concepts and techniques in everyday environments. Within a Combatives framework, topics including the psychology of violence, physiological reactions under duress, danger recognition, and risk mitigation. The information introduced in this course covers options for avoiding, evading and escaping various threats. This course provides cadets an opportunity to learn and apply techniques in a scenario based environment. Prereq: None. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 348. *Marksmanship.* Exposes cadets to basic marksmanship education and training with emphasis on techniques that they can employ any time they are around or handling firearms. Within a competency environment, topics include firearm safety; weapon terminology; marksmanship fundamentals; the act of firing a shot; shot plans; competition plans; managing mind and body in stressful situations; the ability to perform under duress; and care, cleaning, and management of weapons. The information introduced in this course covers options for continued marksmanship training and foundations for completing the Air Force Qualification Courses. This course provides cadets an opportunity to learn and gain confidence with a rifle and pistol, so when deployed they are safe and can masterfully handle the weapon issues. Prereq: None. Sem hrs: 0.5 (2xx) fall or spring.

This course is a contributor to the development and assessment of the Warrior Ethos as Airmen and Guardians outcome.

Phy Ed 352. *Intercollegiate Sports.* Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Phy Ed Aca 440. *Exercise Physiology.* 3(2). Exercise physiology is the study of body functions before, during, and after an exercise session. This class also looks at the short-term and long-term changes that result from exercise training. Includes both academic classes and laboratory experiences where the students learn about their body composition, strength, anaerobic power, and aerobic capacity. Prereq: Course Director approval. Sem hrs: 3 fall.

Phy Ed 452. *Intercollegiate Sports.* Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Phy Ed Aca 460. *Philosophies and Principles of Coaching.* 3(1). An integrated course – applying organizational management, psychology, sociology, ethics, and philosophy to the art and science of coaching. Independent research. Final paper. Prereq: C1C/C2C standing with Course Director approval. Sem hrs: 3 fall or spring.

Phy Ed 477. *Independent Exercise.* Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 479. *Cadet Instructor.* Sem hrs: 0.5(2xx) fall or spring.

Phy Ed 484. *Volleyball.* Introduces cadets to the fundamental skills, rules, and strategies of the lifetime team sport of volleyball. The course emphasizes the importance of teamwork through competitive play. Cadets will receive historical context of the sport, instruction on rules and strategy, as well as opportunities to develop basic, intermediate, and advanced technical skills. Students are evaluated via skills testing in underhand/overhand passing, serving, setting, and attacking. Also, each cadet's ability, attitude, effort, and teamwork are evaluated in match play. Written and practical graded reviews. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Phy Ed 486. *Basketball.* Introduces cadets to the fundamentals skills, rules, and strategies of the team sport of basketball. This course is designed to broaden each cadet's understanding, knowledge, and appreciation for the game. Cadets will also engage in competition designed to enhance skill development and teamwork. Areas covered include passing, ball handling, shooting, individual offense, individual defense, rebounding, screens, team offense, team defense, and transition. Students are graded based on an evaluation of their play, demonstration of their understanding of the game, and their performance on skills-based drills. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Phy Ed 487. Soccer. Introduces cadets to the fundamental skills, rules, and strategies of the lifetime team sport of soccer. This course provides sufficient aerobic and anaerobic activity so that each cadet's physical fitness will be maintained or improved, while enjoying competitive participation. Students are evaluated on rules of the game, skills including juggling, dribbling, passing, and shooting, and their ability, attitude, and effort during competitive play. Written and practical graded reviews. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Phy Ed 488. Softball. Introduces cadets to the fundamental skills, rules, and strategies of the lifetime team sport of softball. Students will learn the mechanics for throwing, hitting, fielding, and base-running, and will be evaluated on their progression throughout the class. In this course, cadets also learn the relationship between individual performance and overall team success through teambuilding and leadership opportunities. Written and practical graded reviews. Sem hrs: 0.5(2xx) fall or spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Phy Ed 499. Independent Exercise Study. Independent study focused on physical exercise. Sem hrs: 0.5(0) fall or spring.

Phy Ed Aca 499. Independent Study. 3(0). Individual research and study in the physical education field under the direction of a faculty member. Emphasizes the use of laboratory facilities. No final. Research report. Prereq: Course Director approval and Department Head approval. Sem hrs: 3 fall or spring.

- Phy Ed Aca 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Phy Ed Aca 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Phy Ed Aca 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

Phy Ed 8xx. Intercollegiate Phy Ed Time. These excusal codes help schedulers block out the time in cadets' schedules for participation in Phy Ed class to support NCAA competition. For more information see COURSES WITH UNUSUAL SCHEDULES section.

Phy Ed 9xx. Intercollegiate Practice Time. These excusal codes help schedulers block out the time in cadets' schedules for participation in the appropriate athletic activities. For more information see COURSES WITH UNUSUAL SCHEDULES section.

Phy Ed 816. Intercollegiate Phy Ed Time. Intercollegiate athletes are enrolled in this course to block out time for Phy Ed class on M afternoons. Scheduling is based on deconflicting Phy Ed class with varsity team NCAA season.

Phy Ed 826. Intercollegiate Phy Ed Time. Intercollegiate athletes are enrolled in this course to block out time for Phy Ed class on T afternoons. Scheduling is based on deconflicting Phy Ed class with varsity team NCAA season.

Phy Ed 916. Intercollegiate Practice Time. Intercollegiate athletes are enrolled in this course to block out time for intercollegiate practice on M afternoons.

Phy Ed 926. Intercollegiate Practice Time. Intercollegiate athletes are enrolled in this course to block out time for intercollegiate practice on T afternoons.

PHYSICS

(Physics)

Offered by the Department of Physics and Meteorology (DFPM)

Physics 110. General Physics I with Laboratory. 4(2)*. Introductory calculus-based physics course with emphasis on contemporary applications (Part I). Topics include kinematics, Newtonian mechanics (statics and dynamics), work, conservation of energy, conservation of momentum, rotational motion, Universal Law of Gravitation, orbital mechanics, simple harmonic motion, and wave motion. Possible additional topics include astronomy, thermodynamics, and relativity. Course emphasizes the use of vectors and calculus in problem solving. Course includes in-class laboratories and computer applications to highlight key concepts. Final exam. Coreq: Math 142. Sem hrs: 4 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Physics 215. General Physics II with Laboratory. 4(2)*. Introductory calculus-based physics course with emphasis on contemporary applications (Part II). Topics include electrostatics, simple DC circuits, magnetic fields, electromagnetic induction, electromagnetic waves, and physical optics. Possible additional topics include simple AC circuits and applications, geometric optics, and selected topics in modern physics. Course emphasizes the use of vectors and calculus in problem solving. Course includes in-class laboratories and computer applications to highlight key concepts. Highly desirable for course to be taken in the semester immediately following the successful completion of Physics 110. Final exam. Prereq: Physics 110 and Math 142. Sem hrs: 4 fall or spring.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Physics 242. Quantum Information. 3(1). Introductory physics course aimed to provide the mathematical skills and physical intuition necessary for the emerging fields of quantum computing and quantum sensing. Topics include quantum state vectors, Bloch sphere, measurements and linear operators, uncertainty principle, density matrices, entanglement, Bell Inequalities, time evolution, quantum sensing protocols, decoherence and dephasing, and open quantum systems. Possible additional topics include simple quantum computing and communication algorithms and

selected topics in physical manifestations of qubits for quantum sensors. Course emphasizes the use of linear algebra and Dirac notation in problem solving using primarily spin systems as opposed to a traditional, calculus-based wave mechanics approach to quantum mechanics. Course is designed to build a solid foundation for students seeking research opportunities in quantum sensing and quantum computing research projects. Final exam. Prereq: Physics 110 and Math 142. Sem hrs: 3 fall.

Physics 264. *Modern Physics.* 3(1). Introduction to the special theory of relativity and quantum theory, with application to problems involving simple forms of potential energy, scattering, and tunneling. Possible application topics include atomic and molecular physics, solid-state physics, nuclear reactions and decay, and elementary particles. Final exam. Prereq: Physics 215 or department approval. Coreq: Math 243 (or Math 253). Sem hrs: 3 spring.

Physics 291. *Introduction to Optics and Lasers.* 3(1). This is a survey course in the fundamentals and applications of optics. The topics covered include geometrical optics, physical optics, optical instruments, contemporary topics such as imaging and holography, and an introduction to lasers. The course may include opportunities to gain hands-on experience working with optics in a laboratory setting. Final exam. Prereq: Physics 215. Coreq: Math 245 or department approval. Sem hrs: 3 spring.

Physics 310. *Principles of Nuclear Science.* 3(1). This course introduces the student to the physics principles of nuclear science needed for reactors and weapons. This includes the physics of radioactive decay, fission, fusion, nuclear cross-sections, nuclear fuel production, isotope separation, the protection of personnel and materiel assets from nuclear radiation, and the safe disposal of radioactive waste. Some Secret Restricted Data (S/RD) material is included. U.S. citizens only. SECRET (RESTRICTED DATA) clearance required. Final exam. Prereq: C or better in Physics 215 or department approval. Sem hrs: 3 fall.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Physics 341. *Laboratory Techniques.* 4(2). An introductory laboratory course developing skills in experimental techniques and data analysis. Course includes instruction in the use of various types of electronic instrumentation and devices to analyze and design electrical circuits. Experiments will investigate the laws and principles of modern physics taught in Physics 264. Coreq: Physics 264 or department approval. Sem hrs: 4 fall or spring.

Physics 354. *Nuclear Weapons Engineering.* 3(1). This course focuses on the operation of fission and fusion weapons and the science behind nuclear proliferation. The elements and technology involved in building a nuclear weapons capability, including acquiring the appropriate material, assembling a weapon, fusing and firing, testing, storage, operations, maintenance, surety, and delivery are examined. Some Secret Restricted Data (S//RD) material is included. U.S. citizens only. SECRET (RESTRICTED DATA) clearance required. Final exam. Prereq: C or better in Physics 310. Sem hrs: 3 spring.

Physics 355. *Classical Mechanics.* 3(1). An examination of the underlying classical laws governing the general motion of bodies. Topics covered include vector calculus, Newtonian dynamics, Lagrangian and Hamiltonian dynamics, the law of gravity and central-force motion, two-particle collisions, and scattering. Possible topics include linear and coupled oscillations, non-inertial reference frames, chaos, transformation properties of orthogonal coordinate systems and rigid-body motion. Extensive application of calculus, ordinary differential equations, and linear algebra will be made in the solution of problems. Final exam. Prereq: Physics 215; completed or enrolled in Math 346 or department approval. Sem hrs: 3 fall.

Physics 356. *Computational Physics.* 3(1). An introduction to solving complex physical problems using numerical techniques. Methods include regression analysis, numerical differentiation, solutions to ordinary and partial differential equations, Fourier analysis, and machine learning. Applications may include kinematics, damped/driven oscillators, nonlinear dynamics, chaos, coupled oscillators, waves, thermal diffusion, and electromagnetic potentials. Final exam or final project. Prereq: Physics 355. Sem hrs: 3 spring.

Physics 361. *Electromagnetic Theory I.* 3(1). Develops Maxwell's equations and basic principles of electromagnetism. Includes electrostatic fields in both vacuum and in dielectrics, the Laplace and Poisson equations, magnetostatic fields, and magnetic materials. Final exam. Prereq: Physics 215. Coreq: Math 346 or department approval. Sem hrs: 3 fall.

Physics 362. *Electromagnetic Theory II.* 3(1). Further development of Maxwell's equations to include induced electric and magnetic fields. Applications include electromagnetic waves, reflection, refraction, guided waves, electric and magnetic dipoles and quadrupoles, and antennas. Basics of relativistic electrodynamics are introduced. Final exam. Prereq: Physics 361. Sem hrs: 3 spring.

Physics 370. *Upper Atmospheric and Geo-Space Physics.* 3(1). A survey course on the composition and physics of the upper atmosphere and the near-earth environment. Topics include solar-terrestrial interactions; observations, phenomena and military operations in the near-earth environment; structure, dynamics and transport in the upper atmosphere; and energy transfer, remote-sensing, and military operations in the upper atmosphere. Final exam. Prereq: Physics 215 or department approval. Sem hrs: 3 fall of odd-numbered years.

Physics 371. *Astronomy.* 3(1). A calculus-based study of the fundamental concepts of astronomy. Emphasis is placed on understanding the basic physical concepts that explain stellar structure, stellar evolution, galactic structure, the solar system and the origin of the universe. Includes up to three night classes at the USAF Academy Observatory. Final exam. Prereq: Physics 215 or department approval. Sem hrs: 3 fall.

This course is a contributor to the development and assessment of the Scientific Reasoning and the Principles of Science outcome.

Physics 375. *Physics of Space Domain Awareness.* 3(1). A survey course in the application of physics principles and their constraints to space domain awareness (SDA). SDA of space objects

can be thought of in terms of where it is and how did it get there, what it is and has it changed, and do we need to worry about it? The answers to these questions are crucial in deriving actionable knowledge for national defense. Topics include space surveillance using radar and electro-optical sensors; orbit determination and prediction; high-resolution imagery; non-resolvable space object identification; and military operations in space and mission impacts. Final exam or final project. Prereq: Physics 215 or department approval. Sem hrs: 3 fall of even-numbered years.

Physics 405. *Physics Seminar*. 0(1). A professional development course emphasizing skills useful for physics research. This course gives cadets enrolled in Physics 490 an opportunity to present results of their research, receive training in specific research skills, and have discussions with experienced faculty researchers regarding such topics as professional ethics and contemporary issues. Pass/fail. Prereq: C1C standing, Physics major or department approval. Coreq: Physics 490. Sem hrs: 0 fall or spring.

Physics 421. *Thermal and Statistical Physics*. 3(1). Classical thermodynamics with an emphasis on thermodynamic laws and applications to cycles. Kinetic theory, statistical thermodynamics, and quantum statistics. Applications of statistics to quantum systems. Final exam. Prereq: Math 300, Math 356, or Math 377. Coreq: Physics 465, Chem 336, or department approval. Sem hrs: 3 fall.

Physics 450. *Nuclear Weapon Effects*. 3(1). This course emphasizes the unique effects of nuclear weapon detonations: blast, thermal, EMP, radiation, biological, and fallout effects. Each effect is treated by examining its generation, transmission, and mechanisms of interaction with the environment and infrastructure. Survivability/vulnerability issues which apply to various weapon systems will be emphasized. Some Secret Restricted Data (S//RD) material is included. U.S. citizens only. SECRET (RESTRICTED DATA) clearance required. Final Exam. Prereq: C or better in Physics 354. Sem hrs: 3 fall.

Physics 451. *Plasma Physics*. 3(1). A comprehensive introduction to the plasma state of matter. Topics include single particle motion, adiabatic invariants, fluid description of a plasma, waves in plasmas, kinetic theory, diffusion and resistivity, and stability. Emphasis will be placed on applying plasma physics principles to solar-planetary interactions and space vehicle operations. Final exam. Prereq: Physics 370 recommended but not required. Coreq: Physics 362 and Math 346 or department approval. Not offered every year; check with DFPM before scheduling. Sem hrs: 3 spring.

Physics 465. *Quantum Mechanics*. 3(1). Basic principles of quantum mechanics, including Schrodinger's equation and interpretation of the wave function; the uncertainty principle; postulates and general formalism; operators, Eigen functions, and eigenvalues; and Dirac notation. Applications include potential barriers and wells; the harmonic oscillator; orbital and spin angular momentum and addition of angular momenta; and the hydrogen atom. Final exam. Prereq: Physics 264 and Math 346, or department approval. Sem hrs: 3 fall.

Physics 468. *Atomic and Nuclear Physics.* 3(1). Treatment of the fundamental physical concepts governing all of microscopic physics which includes elementary particle, nuclear, atomic and molecular physics. The topics covered include the standard model of elementary particles and interactions symmetries and conservation laws, gauge theories, properties of the nucleus, nuclear models, nuclear interactions and decays, scattering theory, atomic systems, atomic and molecular spectroscopy techniques. Final exam. Prereq: Physics 465 or department approval. Sem hrs: 3 spring.

Physics 473. *Solid State Physics.* 3(1). Introduction to the physics of the solid state nature of matter. Crystal structure, crystal binding, lattice vibration, free electron theory, and band theory. Basic introduction to quantum theory and quantum statistics of solids. Theories are used to explain metals, semi-conductors and insulators. Survey topics include magnetism, superconductivity, optical phenomena in solids, crystal imperfections, and the physics of solid state devices. Final exam. Prereq: Physics 215. Coreq: Physics 465 and Math 245 or department approval. Not offered every year; check with DFPM before scheduling. Sem hrs: 3 fall or spring.

Physics 482. *Laser Physics and Modern Optics.* 3(1). A detailed study of the operation of the laser: types of lasers, lasing media, pumping mechanisms, resonators and cavities, laser modes and Gaussian properties. Covers modern optics: introductory electro-optics, nonlinear optics, statistical optics, and quantum mechanical analogs of optical systems. Final exam. Coreq: Physics 362, ECE 444, or department approval. Sem hrs: 3 spring of odd-numbered years.

Physics 486. *Astrophysics.* 3(1). Application of physics to astrophysical problems and topics of current interest in astrophysics. Typical topics include stellar structure and evolution, supernovae, white dwarfs, neutron stars, black holes, galactic structure, active galaxies, quasars, cosmology and general relativity. Specific topics depend on instructor and student preferences. Final exam. Prereq: Physics 264 and Physics 371, or department approval. Coreq: Physics 362 or department approval. Sem hrs: 3 spring of even-numbered years.

Physics 490. *Capstone Physics Research.* 4(2). A research experience course in which cadets work in small teams to conduct original research in one area of physics, which may include lasers/optics, space physics, astronomy, nuclear physics, or other physics subdiscipline. During the semester, each team will work on a single project and experience the full range of the research process, including planning and implementing a research project, analyzing data, and reporting results in technical written reports and oral presentations. Some cadets will publish their work in professional journals. Prereq: C1C standing and department approval. Coreq: Physics 405. Sem hrs: 4 fall or spring.

Physics 495. *Special Topics.* 3(1). Selected topics in physics. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Physics 499. *Independent Study.* 3(0). Individual research under the direction of a faculty member. Final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

- Physics 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.

- Physics 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Physics 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

POLITICAL SCIENCE

(Pol Sci)

Offered by the Department of Political Science (DFPS)

Pol Sci 211. *Politics, American Government, and National Security.* 3(1). This course introduces students to the study of politics and government and examines the basic theoretical, structural, and procedural choices faced by any political system. The course will emphasize the following areas of study: foundations and traditions of American democracy; the structure, decision-making processes, and policy outcomes of the American political system; the specific development of national security strategy and policy; and civil-military relations in the American Republic. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the National Security of the American Republic in a Complex Global Environment outcome.

Pol Sci 211S. *Politics, American Government, and National Security.* 3(1). This course is the Martinson Honors Program version of Pol Sci 211. This course introduces students to the study of politics and government and examines the basic theoretical, structural, and procedural choices faced by any political system. The course will emphasize the following areas of study: foundations and traditions of American democracy; the structure, decision-making processes, and policy outcomes of the American political system; the specific development of national security strategy and policy; and civil-military relations in the American Republic. Critical thinking on these matters is encouraged through use of primary texts and seminar-style class discussion. Final exam or final paper. Prereq: Academy Scholar status. Sem hrs: 3 spring.

This course is a contributor to the development and assessment of the National Security of the American Republic outcome.

Pol Sci 300. *Quantitative Methods and Research Design.* 3(1). The course introduces students to the quantitative methods used in political science, placing emphasis on research design, causal inference, and analysis of social science data using statistical methods. The research approaches presented in this class are essential to the political science discipline and the systematic examination of research questions in social sciences. Final exam, research paper, or final project. Prereq: Math 300, Math 356, or Math 377. Sem hrs: 3 spring.

Pol Sci 301. *Political Theory.* 3(1). Provides an overview of political thought from the ancient Greeks to the present. Philosophers studied include Plato, Aristotle, Augustine, Aquinas, Machiavelli, Hobbes, Locke, Montesquieu, Rousseau, Marx, and Nietzsche. The course's examination of the debates about human nature, the best regime, justice, equality, freedom, community, natural rights, and between religion and comparative and national security politics provide an essential foundation for the political science major and are invaluable for any airman-scholar. Final exam or research paper. Prereq: None. Sem hrs: 3 fall.

Pol Sci 302. *American Foreign and National Security Policy.* 3(1). Explores the evolution of American foreign and national security policy within a rapidly changing global environment; sets American national security policy in a broader context of American foreign policy interests and instruments of state power. Prepares for advanced electives in international relations through an examination of how the U.S. pursues its objectives when the structure of the international environment and the nature of state power are in flux. Prepares for advanced electives in comparative politics by examining how the U.S. attempts to shape the political and economic institutions of other states using a broad array of foreign policy tools. Prepares for advanced electives in American politics by examining the domestic political, institutional, and constitutional sources of U.S. foreign and national security policy. Complements professionally oriented courses on contemporary global and security issues by providing the context for how the U.S. defines and pursues grand strategy in the modern world. Final exam or research paper. Prereq: Pol Sci 211 or Soc Sci 212. Sem hrs: 3 spring.

This course is a contributor to the development and assessment of the National Security of the American Republic in a Complex Global Environment outcome.

Pol Sci 390. *International Relations Theory.* 3(1). Introduces the basic concepts of international relations. Major theoretical approaches to the analysis of international politics (realism, liberalism, and globalism) will be used to explore the nature of the international system and various aspects of state behavior in their historical and contemporary settings. Among the subjects examined within this framework: the formulation of foreign policy, mechanisms of conflict and cooperation, the origins of war, issues of international interdependence, international political economy and questions of international ethics. Final exam or research paper. Prereq: Soc Sci 212 or Soc Sci 311. None. Sem hrs: 3 spring.

Pol Sci 392. *American Political System and Theory.* 3(1). Explores the origin and development of American political ideas and institutions. This course examines the notion of American exceptionalism and the design and operation of the American system. Topics include: American constitutional design and its consequences; the expression of preferences; the analysis of institutional behavior; and the policy process. Final exam or research paper. Prereq: Soc Sci 212 or Soc Sci 311. None. Sem hrs: 3 spring.

Pol Sci 394. *Comparative Politics.* 3(1). Provides an introduction to the discipline of political science and qualitative methods of research design through the lens of comparative politics. Substantively, the course considers the intra-state dynamics of citizens, identities, economies, policies, and, especially, political regimes. With respect to political regimes, the course covers democratic and authoritarian institutions, political regime transitions, and contemporary challenges to global democracy. Cadets engage with and produce original qualitative research on these substantive topics in the course. Final exam or research paper. Prereq: None. Sem hrs: 3 fall.

Pol Sci 421. *International Security: Political Violence and Terrorism.* 3(1). Applies theories of international security to the roots and forms of political violence in a globalized era. Examines the sub-national and transnational sources of conflict as well as the impact of globalization on the

character of collective violence. Investigates the emergence, motivations and strategies of violent non-state actors with emphasis on ethno-political groups, militant religious movements, transnational criminal organizations, warlords and insurgencies. Focuses on the use of terrorism to achieve political objectives. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Pol Sci 423. *Genocide and Mass Atrocity*. 3(1). The course will trace the causes, spread, and consequences of genocides and mass atrocities. The course examines: (i) why people acting on behalf of states and other groups commit genocides and mass atrocities; (ii) the role of national and societal support; (iii) the international community's reaction, including the relationship between war and atrocity; and (iv) the subsequent search for justice. Final exam or final paper. Prereq: None. Sem hrs: 3 fall.

Pol Sci 425. *Diversity and Security*. 3(1). The purpose of this course is to help students gain a better understanding of the complex interplay of gender, race, ethnicity, religion, economic status, and other elements of diversity with issues of international security. It seeks to expand and problematize the standard canon (which receives the bulk of focus in the core international security course) and leverage other perspectives to explain the complexity of security, analyze causes of and solutions to conflict and insecurity, and offer policy leverage for enduring change. Final exam, research paper, or project. Prereq: Soc Sci 212 or Soc Sci 311. Sem hrs: 3 spring of odd years.

Pol Sci 427. *The United States' Great Power Rivals: Russian and Chinese Foreign Policy*. 3(1). Explores Russian and Chinese foreign policy in the context of each country's domestic political priorities, conception of interests, and international relations theory. Examines China's and Russia's enduring foreign policy challenges and the evolution of policy based on changes in the international environment. Concludes with the Russian and Chinese challenges to the United States. Final paper. Prereq: None. Sem hrs: 3 fall

Pol Sci 445. *Global Governance and International Institutions*. 3(1). Examines the role and relationship of international institutions, to include transnational organizations, regimes, and networks, by which states and non-state actors address a broad spectrum of challenges for global governance. Pertinent global issues related to security, trade, and international justice include conflict resolution; peacekeeping and peacemaking; nuclear non-proliferation; international finance; world trade; development aid; refugee problems; climate change; and human rights. Final exam or final paper. Prereq: None. Sem hrs: 3 fall.

Pol Sci 451. *American Political Thought*. 3(1). A survey of basic themes in American political thought beginning with the 17th century European origins of American political thought and extending to modern attempts to strike a balance between individual rights and social needs. The focus is on the difficulties of translating principles into practice. Final exam or research paper. Prereq: None. Sem hrs: 3 fall of odd-numbered years.

Pol Sci 460. *Civil-Military Relations*. 3(1). Studies civil-military relations theory in comparative perspective. Examines relationship among civilian authorities, the military establishment, and society, with implications for governance and security policy. Conducts in-depth study of

American civil-military relations as a foundation for comparison with states from multiple regions and at different levels of political development. Hones individual skill in applying civil-military relations theory to future conflict and international peace. Final exam or research paper. Prereq: None. Sem hrs: 3 fall.

Pol Sci 462. *Politics and Intelligence.* 3(1). Explores the character of secrecy in the American democratic system. This course investigates the role of intelligence in the development and implementation of US national security policy. Focuses on the key players in the intelligence community, the capabilities of intelligence systems, the tradecraft of spying, and the core intelligence functions of collection, analysis, covert action and counterintelligence. Includes examination of the roles and contributions of military intelligence and current issues in the intelligence field. Final exam or research paper. Prereq: None. Sem hrs: 3 fall.

Pol Sci 464. *Regime Change: Coups, Revolutions and Democratization.* 3(1). Regime change is the high drama of comparative politics: from the “shot heard round the world” in 1776, to Boris Yeltsin standing atop a Soviet tank in 1991, to the Arab Spring of 2011. This course examines how countries transition from one type of regime to another, to include military coups and social revolutions. It will pay particular attention to the global phenomenon of democratization—the movement from authoritarianism to democracy—which has been the major political event of our generation. Final paper. Prereq: None. Sem hrs: 3 fall.

Pol Sci 465. *US National Space Policy.* 3(1). Examines the evolution, major influences on, and consequences of US national space policy. Focuses on the relationships among politics, policy-making processes, law, and technology as related to civil, military, commercial, and intelligence space sectors. Addresses rights and responsibilities of states in the use of outer space. Topics include NASA space strategies; military space missions; commercial space trends; intelligence function; international agreements; sovereignty over air, space, and celestial bodies; and government liability. Final exam, final paper, or final project. Prereq: None. Sem hrs: 3 fall.

Pol Sci 466. *Cyber Security Policy and Politics.* 3(1). Examines the policies, politics, and ethics of cyber security. Covers the national security implications of cyber—including how low cost of entry, limited chance of attribution, and the ubiquity of the domain create unique defense challenges. Discusses the domestic politics of cyber security—including how American values, culture, organizations, and laws will determine roles and responsibilities for government and the private sector. Concludes with a section on the international politics of cyber security—the applicability of deterrence, sovereignty, collective security, institutions, and treaties in cyberspace. Final paper or project. Prereq: Pol Sci 211 and Comp Sci 110. Sem hrs: 3 spring.

Pol Sci 469. *Politics of Russia, Eastern Europe, and Eurasia.* 3(1). Examines historic, cultural, economic, social, and geographic traits that distinguish Russia and its neighbors and shape their domestic political processes and interstate relations. Critically compares the politics, governments, and orientations of post-Soviet states. Surveys contemporary regional issues such as ethnic conflict, nationalism, and political-economic reforms, with a particular emphasis on security concerns. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Pol Sci 471. *Politics of Europe.* 3(1). Examines historic, cultural, economic, social and geographic traits that distinguish this region and shape its domestic political processes and interstate relations. Critically compares the politics, governments and orientations of European states and important regional powers. Surveys contemporary issues such as democratization, globalization and regional integration, with a particular emphasis on security concerns. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Pol Sci 473. *Politics of Asia.* 3(1). Examines historic, cultural, economic, social and geographic traits that distinguish this region and shape its domestic political processes and interstate relations. Surveys the governments of selected countries. Examines in particular the influence of Japan and China on regional and global affairs. Includes a survey of contemporary multilateral issues salient in the region, with particular focus on regional security concerns. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Pol Sci 475. *Politics of Latin America.* 3(1). Examines historic, cultural, economic, social, and geographic traits that distinguish this region and shape its domestic political processes and interstate relations. Selected Latin American political systems are explored in detail. Issues such as political stability, civil-military relations and democratization are treated as well, along with politico-economic concerns such as developmental strategies, debt relief and trade relations. Special treatment is given to U.S.-Latin American relations. Includes a survey of contemporary multilateral issues salient in the region, with particular focus on regional security concerns. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Pol Sci 477. *Politics of the Middle East.* 3(1). Examines historic, cultural, economic, social, religious, and geographic traits that distinguish the region extending from North Africa through Central Asia and shape its domestic political processes and interstate relations. Surveys the governments of selected countries, considering factors such as legitimacy and political development. Includes a survey of contemporary multilateral issues with particular focus on regional security concerns. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Pol Sci 479. *Politics of Sub-Saharan Africa.* 3(1). Examines historic, cultural, economic, social, religious, and geographic traits that distinguish the states of sub-Saharan Africa and their domestic political processes and interstate relations. Critically compares the politics, governments, and orientations of selected African states. Final exam or research paper. Prereq: None. Sem hrs: 3 spring of odd years.

Pol Sci 481. *American Elections and Political Parties.* 3(1). Examines the nature of the electoral process and the roles that candidates, political parties, public opinion, and interest groups play in the process. Focuses on the role of candidates' election organizations, political parties, professional campaign managers, public opinion pollsters, professional fund raisers, and media consultants in congressional and presidential campaigns. Special attention is given to the current presidential or congressional elections. Final exam or research paper. Prereq: None. Sem hrs: 3 fall of even-numbered years.

Pol Sci 482. *The U.S. Supreme Court.* 3(1). The Supreme Court is extremely influential in American politics, sometimes even acting as a policy-making body, deciding the fate of such contentious matters as abortion, capital punishment, public expressions of religious belief, and even a presidential election. We will study the Court's rulings in these areas and many others, focusing on the Court's written opinions, the thoughts of those who designed our government, and competing views about the Court's proper role in our system of separated powers. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Pol Sci 483. *The US Congress.* 3(1). Studies Congress as a political institution, with an emphasis on the unique natures of the House and Senate, congressional norms and procedures, and the roles of committees and political parties. Topics include elections, member-constituent relations, national policy roles, leadership, the committee system, legislative procedures, legislative oversight of the executive branch, and the effects of public opinion and interest groups on law making. Final exam or research paper. Prereq: None. Sem hrs: 3 fall of odd-numbered years.

Pol Sci 484. *The American Presidency.* 3(1). Provides an in-depth study of the Presidency with emphasis on the post-World War II period. Examines the presidential selection process and the office and powers of the President as well as presidential administrative structures, styles, roles and personalities. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Pol Sci 491. *Capstone Seminar in Political Science: National Security and Political Analysis.* 3(2). This course is the culmination of the political science curriculum. Readings and discussions will encourage a critical and synthetic application of the discipline's subfields (American Politics, Comparative Politics, and International Relations) in thinking strategically about a rapidly changing world and America's role in it. Cadets will undertake an elected research project with a faculty mentor. This blend of experiences seeks to produce officer-scholars with the intellectual foundations to develop as adaptive and strategic thinkers and national security leaders able to navigate the political-military dimensions of their profession. Final paper. Prereq: C1C Standing. Sem hrs: 3 fall.

Pol Sci 495. *Special Topics in Political Science.* 3(1). Selected topics in political science. Final exam or final report. Prereq: Department approval. Sem hrs: 3 fall or spring.

Pol Sci 496. *Causes of War and Conflict Resolution.* 3(1). This course examines the causes, conduct, and consequences of international conflict, interventions, crises, and wars. It also examines the theory and practice of conflict resolution. It uses wars from around the world, drawn from different historical periods, focusing on both theoretical and normative issues. Special attention will be paid to wars involving the United States, including ongoing interventions. Final exam, final paper, or final project. Prereq: None. Sem hrs: 3 spring.

Pol Sci 498. *Political Science Thesis.* 3(1). Cadets enrolled in this course will prepare a 50-75 page senior thesis under the guidance of the course director and other faculty members with particular expertise on the topic of research. This course combines the tutorial aspect of an

independent study (Pol Sci 499) with seminar on applied research methods. Cadets will meet individually or in seminar in accordance with a schedule determined by the course director. Formulation of thesis and research normally will begin in Pol Sci 300 and other political science courses. When the thesis has been completed, a formal defense will be given to a faculty committee in April or May. In preparation for the formal defense, each thesis will be presented to fellow cadets in the seminar for critique and evaluation. Research paper. Prereq: C1C standing and department approval. Sem hrs: 3 fall or spring.

Pol Sci 499. *Independent Study in Political Science.* 3(0). Individual study or research of a carefully selected topic conducted on a tutorial basis. Research paper or a directed reading. Prereq: Soc Sci 212 and department approval. Sem hrs: 3 fall or spring.

- Pol Sci 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Pol Sci 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Pol Sci 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

READING STRATEGIES

(Read Strt)

Offered by the Academic Success Center (DFVRL)

Comm Strt 101. *Introduction to Communication.* 1(1x). Course introduces students to evidence-based communicative practices for enacting skillful and ethical responses to academic, professional, and intercultural communicative situations. It supports this purpose through a variety of critical reading tasks, including reading academic and professional texts, as well as reading for pleasure. Special emphasis is placed on use of core academic texts. Course includes three oral presentations and reflective writing to foster critical thinking and clear communication. Course will meet twenty lessons. When registering for this course, please specify preference for taking course during first-half (i.e., Comm Strt 101) or second-half of semester (i.e., Comm Strt 101X). Prereq: None. Sem hrs: 1 fall or spring.

Read Strt 104. *Reading Enhancement for International Cadets.* 0(1x). Course is designed to enhance reading efficiency for international cadets for a wide variety of reading tasks, to include reading for academic courses, professional development, critical thinking, and reading for pleasure. Overall course goals include increasing reading rate, comprehension, and recall abilities. Special emphasis is placed on use of core academic course texts. Vocabulary development will include Greek and Latin roots, prefixes and suffixes, words in context, collocations, and idiomatic expressions. Cross-cultural skills as they relate to reading will also be addressed. Course will meet twenty lessons. When registering for this course, please specify preference for taking course during first-half (e.g., Reading Strategies 104) or second-half of semester (e.g., Reading Strategies 104X). Although enrollees do not receive credit towards graduation, the course is intended to facilitate progress towards graduation. Pass/fail. Prereq: None. Sem hrs: 0 fall or spring.

Read Strt 201. *Reading Enhancement.* 0(1x). Course is designed to enhance reading efficiency for a wide variety of reading tasks, to include reading for academic courses, professional development, critical thinking, and reading for pleasure. Overall course goals include increasing reading rate, comprehension, and recall abilities. Course will meet twenty lessons. When registering for this course, please specify preference for taking course during first-half (e.g., Read Strt 201) or second-half of semester (e.g., Read Strt201X). Although enrollees do not receive credit towards graduation, the course is intended to facilitate progress towards graduation. If you received credit for Reading Strategies 103/103X, Reading Enhancement for First-Year Cadets, you may not enroll in Reading Strategies 201/201X. Pass/fail. Prereq: None. Sem hrs: 0 fall or spring.

Read Strt 204. *Reading Enhancement for Semester-Exchange International Cadets.* 0(1x). Course is designed to enhance reading efficiency for semester-exchange international cadets for a variety of reading tasks, to include reading for academic courses, professional development, critical thinking, and reading for pleasure. Course readings will be drawn from the American canon, peer-reviewed journals, current events, and other primary sources to address the goals of cultural and language immersion with an emphasis on the profession of arms. Overall course goals include increasing reading rate, comprehension, and recall abilities. Vocabulary development will include Greek and Latin roots, prefixes and suffixes, words in context, collocations, and idiomatic expressions. Course will meet twenty lessons. When registering for this course, please specify preference for taking course during first-half (e.g., Read Strt 204) or second-half of semester (e.g., Read Strt 204X). Pass/fail. Prereq: None. Sem hrs: 0 fall.

SOCIAL SCIENCE

(Soc Sci)

Offered by various departments within the Social Sciences Division

Soc Sci 212. *International Security.* 3(1). Introduces major theoretical approaches to the study of international relations. Applies these approaches to the topics of security, political economy, and justice as they relate to various state and nonstate actors. This course is for Pol Sci and ForArStu majors. It should be taken as early as possible in the major and is a core substitute for Soc Sci 311. Final exam. Prereq: None. Sem hrs: 3 spring.

This course is a contributor to the development and assessment of the National Security of the American Republic in a Complex Global Environment outcome.

Soc Sci 311. *International Security Studies.* 3(1). This course addresses the causes of war and the sources of lasting peace in international politics focusing on the application of the instruments of power to accomplish national objectives. This multidisciplinary course challenges students to confront the essential "Clausewitzian" problem; to best integrate politics and war to make force a rational instrument of policy. The course analyzes the dynamics of great power challenges, assesses US defense priorities, and uses informed strategic analysis integrating political, legal, economic, and military judgment to best exercise military power. This course is organized thematically by illustrative examples drawn from conflicts throughout the world and from

contemporary US foreign and national security policy. Final exam. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the National Security of the American Republic in a Complex Global Environment outcome.

Soc Sci 311S. *International Security Studies*. 3(1). This course is the Martinson Honors Program version of Soc Sci 311. It addresses the causes of war and sources of lasting peace in international politics focusing on the application of the instruments of power to accomplish national objectives. This multidisciplinary course challenges students to confront the essential "Clausewitzian" problem; to best integrate politics and war to make force a rational instrument of policy. Final exam or final project. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the National Security of the American Republic in a Complex Global Environment outcome.

Soc Sci 400. *Social Sciences Seminar*. 3(2). Interdisciplinary course. An interactive seminar focused on relevant social sciences topics. Final paper, report or exam. Administered by the Social Science Division Chair. Sem hrs: 3 fall.

Soc Sci 401. *Social Sciences Divisional Core Substitute*. 3(0). This course can only be awarded for coursework accomplished during a semester of study abroad (CSSAP), international exchange (CSEAP), or service academy exchange (SAEP). With applicable Department Head or Division Chair approval, this course can fulfill the core requirement for Mgt 400 or Soc Sci 311. Sem hrs: 3 fall or spring.

Soc Sci 420. *Law and Economics*. 3(1). An interdisciplinary course which provides an economic analysis of the theory and practice of the development of a legal system. The course employs basic economic principles in an effort to understand the nature of legal rules, their effect on society, and to examine how these rules might be reformed. This framework is applied to tort, criminal, contract, and property law. Students will gain an understanding of the modern economic analysis of law, an ability to read and understand case law, and an ability to understand and analyze the development of laws and legal outcomes using economic theory. Final exam, paper, project, or report. Prereq: Econ 201; Law 220 recommended. Administered by DFLA and DFEG. Sem hrs: 3 spring odd-numbered years.

Soc Sci 444. *International Political Economy*. 3(1). This course will explore the theory and practice of how economic motives affect political decisions and how most political decisions have economic repercussions, both domestically and internationally. Specific topics will include the development of the international monetary system, international trade policy, the effects of multinational corporations, foreign direct investment, development of the Global South, and contemporary issues. The course is team taught by faculty in Political Science and Economics and may be used to fill requirements in either major. Final exam or research paper. Prereq: None. Sem hrs: 3 spring.

Soc Sci 467. *Nuclear Weapons Policy and Strategy.* 3(1). This course examines the evolution of US nuclear policy and strategy and its implementation as an instrument of deterrence and potential in warfighting. First, the course focuses on the role of nuclear weapons as a deterrent against attacks on the US, our allies, and our global interests and the inherent policy and strategic dilemmas associated with those ends. Second, the course discusses issues related to U.S. implementation of nuclear policy and strategy through force structure, weapons stockpile surety, and force employment concepts. This course is team taught by members of the Department of Political Science (DFPS) and the Department of Military and Strategic Studies (DFMI), and will include expert guest speakers on nuclear history, policy, strategy, or other related specialties. Final Project. Prereq: Physics 310, Pol Sci 211 and MSS 251 or DFPS or DFMI department head approval. Sem hrs: 3 spring.

Soc Sci 483. *Principles of Negotiation.* 3(1). Effective leaders negotiate intentionally to optimize benefits to themselves and their organizations. This course will provide a framework to help students intentionally negotiate in a variety of contexts. Specifically, the course will teach students how to prepare for and strategically communicate during negotiations. It will also teach students how to build and maintain positive relationships while focusing on crafting creative solutions to problems or conflict. Finally, students will learn how to methodically analyze past performance for future improvement. The course will measure and assess performance through using practical simulation exercises, analytical review of performance, in-class discussions, and other assessments. Final paper, project, report, or exam. Prereq: None. Offered by the Department of Law. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Soc Sci 483S. *Principles of Negotiation (Scholars).* 3(1). Effective leaders negotiate intentionally to optimize benefits to themselves and their organizations. This course will provide a framework to help students intentionally negotiate in a variety of contexts. Specifically, the course will teach students how to prepare for and strategically communicate during negotiations. It will also teach students how to build and maintain positive relationships while focusing on crafting creative solutions to problems or conflict. Finally students will learn how to methodically analyze past performance for future improvement. The course will measure and assess performance through using practical simulation exercises, analytical review of performance, in-class discussions, and other assessments. This is a Martinson Honors Program course, and therefore is open to students enrolled in the Martinson Honors Program or non-scholar students recommended by the DFLA Department Head, with approval of the Martinson Honors Program Director. If not in the Martinson Honors Program, only students with a 3.5 cumulative GPA or those who have otherwise demonstrated high probability of success with the material in the course will be considered. Final paper or project. Prereq: None. Offered by the Department of Law. Sem hrs: 3 spring.

This course is a contributor to the development and assessment of the Leadership, Teamwork, and Organizational Management outcome.

Soc Sci 499. *Independent Study.* 3(0). Individual research, practicum, or tutorial study in the social sciences under the direction of a faculty member. Final paper or report. Prereq: Soc Sci Division Chair approval. Sem hrs: 3 fall or spring.

- i. Soc Sci 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- ii. Soc Sci 499 B. Independent Study. 1.5 (0). Sem hrs: 1.5 fall or spring.
- iii. Soc Sci 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

SPACE

(Space Power Application, Capabilities, and Employment)

Space 251. *Basic Space Operations 1.* 0(2). Space operations training which supports USAF Academy Outcomes and helps motivate cadets towards a career in the United States Air Force. Offered both semesters during the academic day (periods 1-2 or 3-4) by block (fall: A and C; spring: E and G). Completion of course will allow cadets to enroll in Space 252, which will certify cadets as space operators for the FalconSAT program and will award basic space operations wings. AFT/PFT take precedence. Pass/Fail. Prereq: None. Sem hrs: 0 fall or spring.

Space 252. *Basic Space Operations 2.* 0(2). This course builds on operations concepts from Space 251, focusing more specifically on satellite payloads and subsystems. Offered both semesters during the academic day (periods 1-2 or 3-4) by block (fall: B and D; spring: F and H). Completion of course will certify cadets as space operators for the FalconSAT program and will award basic space operations wings. AFT/PFT take precedence. Pass/Fail. Prereq: None. Sem hrs: 0 fall or spring.

Space 253. *Azimuth (Student Course).* 0(2). Elective. This 3-week program is designed to motivate, inform, and evaluate rising 3rd class cadets considering a career in the USSF. Azimuth will provide a well-rounded exposure and view of the space domain and careers in the USSF. The framework for this summer program is modeled after the Marines Corps' Leatherneck program executed at the USNA and NASA's two year Astronaut Candidate Training program. The course is offered primarily to 3rd class cadets at USAF Academy who have expressed a desire or interest to join the USSF and to AFROTC cadets who have been selected to commission into the USSF. Enrollment is orchestrated by the Office of Student Academic Affairs (DFVR) and Cadet Wing Training (CWT) summer scheduling, and is based primarily on interest indicated by each cadet via a 4-degree fall semester Operational Career Interest survey, 3-degree summer planning requests, and/or inputs provided by cadets to their cadet leadership, to their senior leadership, and in coordination with the Space Delta 13 Det 1 at USAF Academy. Not Graded. Prereq: None. Sem hrs: 0 summer.

Space 350. *Advanced Space Operations Upgrade.* 3(2). This course prepares cadets to become space operations instructors and future leaders of the satellite operations program. Cadets are trained on advanced space operations techniques to include nominal and off nominal space operations planning, test operations, ground simulation, and data analysis. Cadets who complete the program will be instructors for Space 251, Space 252, and future upgrade classes. The course

is offered in the fall and spring semesters of the third-class year (periods 6-7) and is a prerequisite to Space 472 and Space 473. Final project is a certification satellite operations pass. Completion of course will certify cadets as space trainers and will award senior space operations wings. Pass/Fail. Prereq: Space 252. Sem hrs: 3 fall or spring.

Space 353. *Azimuth (Cadre Course).* 0(2). Elective. Leadership positions as instructors, officers, or NCOs in the cadet chain-of-command for the Space 253 Azimuth students. This course provides cadets the opportunity to learn and practice team leadership, coaching and facilitation as they serve as cadre in the Azimuth program. A specific number of cadre (4), require Space 350 to build trainers for FalconSAT program and instruct the Space 251 portion of the program. Not graded. Sem hrs: 0 summer.

Space 472. *Basic Space Operations Instructor.* 0(2). Select cadets serve as instructors in Space 251 and Space 252 (periods 1-2 and 3-4) by block (fall: A, B, C, D; spring: E, F, G, H). Cadets will also serve as instructors to the summer space training program. AFT/PFT take precedence. Pass/Fail. Prereq: Space 350. Sem hrs: 0 summer, fall, or spring.

Space 473. *Advanced Space Operations Instructor.* 0(2). Select cadets serve as instructors in Space 350 (periods 6-7). Prereq: Space 350. Sem hrs: 0 fall or spring.

SYSTEMS ENGINEERING

(Sys Engr)

Sys Engr 301. *Project Engineering.* 3(1). This course teaches how to design systems through the Agile development process, how to develop adequate and forward-leaning system architecture, how to make design decisions throughout development, and how to evaluate risk based on those design decisions. Topics include scrum management, backlog prioritization, planning, budgeting, scheduling, allocating resources, value modeling, and risk assessment/management of the project. Case studies illustrate problems and how to solve them. Course assignments are designed to help students learn and apply project engineering techniques taught in the course. Final project. PreReq: None. Sem hrs: 3 fall

Sys Engr 310. *Introduction to Systems Engineering.* 3(1). This course presents an introduction to the systems engineering process and the development lifecycle as a foundation for solving complex problems to fulfill end user needs. The course focuses on the systems engineering lifecycle process that includes design, concurrent engineering, software engineering, and the concepts of reliability, maintainability, availability and model-based systems engineering. Skills and tools are presented that are foundational in the development of interdisciplinary systems engineers. In parallel with the course material, a semester-long system development project facilitates application of systems engineering principles. Final project. Prereq: None. Sem hrs: 3 fall or spring.

This course is a contributor to the development and assessment of the Application of Engineering Problem-Solving Methods outcome.

Sys Engr 311. *Model Based Systems Engineering.* 3(1). This course develops digital modeling tools using established systems engineering methods and techniques employed within systems engineering development and lifecycle processes. Topics may include: analytic techniques supporting Analysis of Alternatives (AoA), decision models, risk analysis, trade-off analysis methods, system architectures, verification and validation processes, test and evaluation methods, software engineering, and other related topics. The course links various methods and techniques to a general systems engineering lifecycle model, exploring the utility of each method to applicable lifecycle phases and developmental activities. Final project. Prereq: Ops Rsch 310 Coreq: Math 300, Math 356, or Math 377. Sem hrs: 3 fall.

Sys Engr 320. *Optimization Theory with Design Applications.* 3(1). This course provides an introduction to quantitative modeling methods that have application to optimal design. The course focuses on computer implementation of models and the application of these models to practical decision-making scenarios. The course is divided into four parts: Math Foundations, Optimization Fundamentals, Numerical Methods for Optimization & Decision Making, and a Final Project. Administered by the Systems Engineering Program. Final report. Prereq: Math 142/152 (C or better), and Comp Sci 211. The Course Director may waive Comp Sci 211 with evidence of prior MatLab skills. Sem hrs: 3 spring.

Sys Engr 336. *Engineering Economics and Financial Management.* 3(1). A study of financial decisions and their effects on organizations. This course prepares students to consider the economic dimension in the evaluation of engineering alternatives--a consideration vital to the Systems Engineering Lifecycle, engineering management, systems acquisition and many other application areas. Emphasis is on developing the concept of risk/return tradeoff as well as inter-cost temporal monetary tradeoffs. After an introduction to accounting concepts, topics will include cost analysis, breakeven analysis, time value of money, project analysis/capital budgeting (including annual equivalence), interest rates, economic service life, and the weighted average cost of capital. Case studies and problems expose the student to current financial problems and their solutions. This course presumes no prior knowledge of accounting. Credit will not be given for both Sys Engr 336 and Mgt 337. Administered by the Department of Management. Final exam or final project. Prereq: None. Sem hrs: 3 spring.

Sys Engr 356. *UAS Flight Test Techniques.* 3(2x). In this capstone course, cadets in the Remotely Piloted Aircraft (RPA) track will learn AFMC-approved methods in Group 1, small UAS (sUAS) flight test. The course will expose cadets to test plan development, execution and data collection, dissimilar aircraft control, test report writing, and evaluation. Lessons and projects emphasize fundamentals of flight testing, critical thinking, multiple sUAS autopilot and interface systems, risk management, innovation, and joint operational concepts as cadets design, execute and report findings within a complex environment. Graduates who achieve Flight Test Operator status IAW AFI 11-502 standards are expected to serve as sUAS test pilots to support DF research at least 1 semester each year. Administered by the Department of Management. Final project. Prereq: sUAS-I qualification and sUAS OIC approval. Sem hrs: 3 spring (E & F blocks).

Sys Engr 402. *Professional Systems Engineering Development.* 0.5(1). Review of Systems Engineering principles; acquisition life cycle stages; technical, project, agreement, organizational, and tailoring processes; and specialty engineering activities in preparation for the internationally-recognized Certified/Associate Systems Engineering Professional (CSEP) certification exam administered at the end of the course by the International Council on Systems Engineering (INCOSE). This course meets in conjunction with Sys Engr 406. Targeted towards Systems Engineers and who will support or work in a Department of Defense acquisition environment. An annual INCOSE membership fee must be paid by the student to take the exam and maintain or improve the certification; therefore, taking the exam is not required. Note: When available, full or partial reimbursement of exam fees is provided. Prereq: C1C standing. Pass/fail. Sem hrs: 0.5 spring.

Sys Engr 405. *Systems Engineering Colloquium I.* 0(1). The course is designed to give Systems Engineering majors an exposure to the wide applicability of their common knowledge and to share knowledge across the various capstone design projects. The course is also designed to help transition Systems Engineering majors to duties as an AF officer and systems engineering professional. Students will make one graded presentation about their specific capstone experience. Invited speakers will discuss current issues in large complex systems and typical engineering and management problems which cadets may encounter during their capstone design and after graduation. Prereq: C1C Standing. Pass/fail. Sem hrs: 0 fall.

Sys Engr 406. *Systems Engineering Colloquium II.* 0(1). The course is designed to give Systems Engineering majors an exposure to the wide applicability of their common knowledge and to share knowledge across the various capstone design projects. The course is also designed to help transition Systems Engineering majors to duties as an AF officer and systems engineering professional. Students will make one graded presentation about their specific capstone experience. Invited speakers will discuss current issues in large complex systems and typical engineering and management problems which cadets may encounter during their capstone design and after graduation. Prereq: C1C Standing. Pass/fail. Sem hrs: 0 spring.

Sys Engr 460. *Unmanned Aerial Vehicle-Remotely Piloted Aircraft (UAV-RPA) Systems.* 3(2). An introduction to unmanned aerial vehicle-remotely piloted aircraft (UAV-RPA) systems and the systems engineering processes used to build them. Topics include air vehicles and capabilities, ground control stations, payloads, personnel training, and support systems. Students will work on an interdisciplinary team to build, fly, and test one or more UAV-RPA systems. Final project. Prereq: Course Director approval. Sem hrs: 3 spring.

Sys Engr 470. *Human Systems Integration.* 3(1). This course examines how Human Systems Integration (HSI) plays a critical role in the design, production, and implementation of military systems. Although certain systems are designed for uses that may be unique to a particular armed forces organization, the principles and applications discussed are (as far as possible) generic, and can therefore be applied to almost any weapons system design program. The course examines HSI as a Systems Engineering (SE) discipline and why HSI must be a core component of Systems Engineering. Students review the major HSI-related areas of concern (domains) that should be

assessed when designing, producing, and implementing a system. Administered by the Department of Behavioral Sciences & Leadership. Final project or final exam. Prereq: Sys Engr 310, Beh Sci 373, or department permission. Sem hrs: 3 spring.

Sys Engr 491. *Systems Engineering Capstone Design I.* 3-4(1-2). The capstone design experience for Systems Engineering majors. The emphasis placed on execution of the systems engineering process over the entire development lifecycle of a complex system. Students will be placed in systems engineering roles on existing capstone design projects in various departments. Students will apply the systems engineering tools acquired in their previous systems engineering coursework. Final project. Prereq: C1C in good standing in Sys Engr major, Sys Engr 301, and Sys Engr 310. Sem hrs: 3-4 fall.

Sys Engr 492. *Systems Engineering Capstone Design II.* 3-4(1-2). Continuation of Sys Engr 491. Final project. Prereq: Sys Engr 491. Sem hrs: 3-4 spring.

Sys Engr 495. *Special Topics.* 3(1). Selected topics in systems engineering. Final exam or final report. Prereq: Sys Engr Program Director approval. Sem hrs: 3 fall or spring.

Sys Engr 499. *Independent Study.* 3(0). Individual study, research, or design supervised by a faculty member. Topic established with the permission of the Department Head. Prereq: Department approval of USAF Academy Form O-498 prior to enrollment. Final report. Sem hrs: 3 fall or spring.

- Sys Engr 499A. Independent Study. 2(0). Sem hrs: 2 fall or spring.
- Sys Engr 499B. Independent Study. 1.5(0). Sem hrs: 1.5 fall or spring.
- Sys Engr 499C. Independent Study. 1(0). Sem hrs: 1 fall or spring.

APPENDIX 3: DEFINITION OF TERMS

ACADEMIC COURSE: A graded course yielding college credit, usually under the supervision of the Dean of the Faculty; however, the Commandant of Cadets (CW) and the Athletic Department (AD) also supervise a few academic courses. The 306 Flying Training Group administers Airmanship courses. The Director of Athletics oversees Phy Ed academic courses.

ACADEMIC DAY: There are 80 academic days in a semester, divided equally as "M" or "T" days. Each day consists of seven 53-minute class periods. Academic Call to Quarters (ACQ), as listed in the current Cadet Wing Schedule of Calls, is also considered part of the academic day.

ACADEMIC DIVISION OPTION: Any graded course taught for credit under the supervision of the Dean of the Faculty or the Director of Athletics. Courses must carry at least three semester hours of credit and be graded. Qualifying courses generally include offerings from the Basic Sciences, Engineering, Social Sciences, and Humanities divisions.

ACADEMY OPTION: Any course taught for credit under the supervision of the Dean of the Faculty, Commandant of Cadets, the Director of Athletics, or the 306 FTG. Courses must carry at least three semester hours of credit. Academy Options may include EAP 109, Armnshp 461, Armnshp 491, or any non-core course worth at least 3.0 semester hours.

ADVANCED COURSE: An academic course of similar content to another course, but covers material in significantly greater depth (e.g., Math 356 is an advanced substitute for Math 300).

ALTERNATE COURSE: Any course taken in place of another course to fill the core or major's requirements for that course.

CELO: Air Force Commissioning Education Learning Outcome (CELO), as identified in AFI 36-2014 (*Commissioning Education Program*).

CONCURRENT: See Co-requisite.

CORE COURSE: A course all cadets must take for graduation. Advanced courses, honors courses, or validation/transfer credit may fill core requirements (see Section 2-6 for details).

CORE PREPARATION COURSE: Cadets may be directed into one or more core preparation courses. These courses meet graduation requirements and can count towards USAF Academy residency requirements.

- a. EAP 109. EAP 109 is a three-semester hour course, scheduled for international cadets. Whenever possible, ESL cadets will take EAP 109 their first semester, English 111 their second semester, and English 211 their third semester.
- b. Math 130. Math 130 is a three-semester hour pre-calculus math course. Cadets may be placed into Math 130 based on results of math placement testing. These cadets will take Math 130 their first semester, Math 141 their second semester, and Math 142 their third semester.

CORE SUBSTITUTE: If an academic department requires cadets in its major to take a tailored version of a core course, or a core course earlier than one year removed from its designation (e.g., 400-level core courses expected to be taken in the 1^o year), that version of the course will be identified as a core substitute and be given a different (appropriate) number. Example: Soc Sci 311 is a core course for all 2^o cadets. Pol Sci and For Ar Stu majors will normally take that course as 3^o cadets enrolled in the core substitute course labeled Soc Sci 212. These different versions of a core course require different course descriptions in the Curriculum Handbook because the two versions have different known prior learning experiences and prerequisites and therefore different developmental expectations and approaches to the course. A major requiring cadets to take a core course no more than one year away from its core year has the option to create a new core substitute for their majors. Additionally, specialized versions of core courses are required for some majors (e.g., core substitute Math 356 for core Math 300) or available with department approval for interested cadets (e.g., core substitute English 212 for core English 211).

CO-REQUISITE: Course may be taken earlier or at the same time with, but no later than, another.

COURSE: A body of instruction in the USAF Academy curriculum. Courses may be academic or non-academic, graded or non-graded, core or major, advanced, audited, repeat, continuing, substitute or overload.

DELAYED COURSE: A core course taken in a later semester than found in the normal sequence for the particular class. Authorization to delay a core course must be approved by the appropriate department head. Delayed courses must be taken in the semester approved by the department head (see Section 2-6, Core Sequences).

DISCIPLINARY MAJOR: A major with a specific area of concentration which requires at least 42 semester hours beyond the core. Refer to Section 2-8 for requirements of offered majors.

ELECTIVE COURSE: Any course a cadet elects to take beyond the mandatory core curriculum.

FINAL EXAMINATION: An evaluation covering an entire course. It requires two or more hours to complete and counts for at least 25% of the course grade. See the course description portion of this handbook to find out which courses require a final examination. Unless waived by the Vice Dean, courses listing a final examination must have an in-class examination during the final examination periods. NOTE: Cadets who resign at the end of semester will receive course credit only if all finals/final projects are completed.

FINAL PROJECT: A project covering an entire course and counting for a significant percentage of the course grade. See the course description portion of this handbook to find out which courses require a final project. Unless waived by the Vice Dean, final projects must be turned in no later than the last day of regularly scheduled classes. Final projects will not be scheduled for turn-in during the final examination period. NOTE: Cadets who resign at the end of semester will receive course credit only if all finals/final projects are completed.

GRADED COURSE: A course for which a grade of A, A-, B+, B, B-, C+, C, C- or D is awarded upon successful completion. Grades of F (failing), W (withdrawn), WP (withdrawn passing), WF (withdrawn failing), and I (incomplete) may also be awarded at the end of a graded course.

GRADED REVIEW (GR): An evaluation covering material taught during several periods of instruction. It carries weight equal to two or more quizzes. The extent of the material and the approximate weight assigned to each GR are announced before the examination. If cadets are scheduled for more than two GRs on the same day, they may complete the additional GR(s) during free periods on the opposite day of the same lesson number with appropriate department head approval. A common graded review is a GR administered to an entire course of cadets at one time, during the common use period from 0700-0753. See USAF Academy Instruction 36-3524, *Cadet Graded Reviews and Course Evaluations*.

GRADUATION (ON TIME): Graduating in eight (8) semesters with the cadet's incoming class. This graduation ceremony occurs in May/June of each year. Cadets must graduate on time, even if it means dropping their major from disciplinary to a divisional major or the Bachelor of Science Program. Only the Academy Board may make a cadet a late graduate (see Late Graduation for further explanation).

LATE GRADUATION: Graduating after the May/June ceremony held for the cadet's incoming class. Late graduation occurs at the end of the summer term and in December. Only the Academy Board may make a cadet a late graduate.

MAJOR'S COURSE: A course taken to satisfy the requirements for an academic major.

NON-GRADED COURSE: A course with no final grade assigned. Successful course completion is indicated by enrollment in the course. If a cadet does not successfully complete the course, the cadet is withdrawn from the course.

NORMAL COURSE LOAD: The number of semester hours of academic courses and/or non-academic courses which a cadet may take without regard to grade point average.

OVERLOAD: Overloads are courses taken in excess of the normal course load. Cadets fulfilling overload requirements may take an overload after their first year at USAF Academy.

PASS-FAIL COURSE: A course for which a grade of P (passing) is awarded upon successful completion. Grades of F (failing), W (withdrawn), WP (withdrawn passing), WF (withdrawn failing), and I (incomplete) may also be awarded at the termination of a non-graded course.

PREREQUISITE: A course which serves as a foundation for another course and is therefore required to be taken in an earlier semester.

QUALITY POINTS: Quality points are numerical values, based on a 4.0 grading scale, that directly correspond to the letter grade a cadet receives for a course (excluding special grades) and

that standardize performance values for courses of varying semester hour credits, all of which are used in the calculation of a cadet's Grade Performance Average (GPA). Course Quality Points are quality points multiplied by the semester hour value of the course.

QUIZ: An evaluation which covers material taught in a small unit of instruction. Normally, it requires less than half of one class period to complete. Quizzes may be one of two types: (1) departmental quizzes, designed by a committee or the course director and administered to all cadets meeting the course on the same day, or (2) instructor quizzes, designed by the individual instructor and administered at the instructor's discretion during any class meeting not scheduled for a departmental quiz or graded review.

REPEATABLE COURSE: Some courses, either by design or in execution, change in such a significant way from offering to offering that repeatable credit is justifiable. Such a course is designated "Repeatable." Departments may request the "Repeatable" designation for a course thru a Course of Instruction (COI) Change Proposal. The "Repeatable" designation does not apply to those courses which are already repeatable by design, such as 499s (Independent Study courses) or 495s (Special Topics courses).

SPECIAL TOPICS COURSE: Each academic discipline may offer an academic course with the content varying semester to semester, based on cadet or department desires and needs. Such a course is designated "-----495. Special Topics." In late spring, the editor of the *Course of Instruction (COI) Supplement* publishes a complete listing and description of all special topics courses for the upcoming fall semester. Spring offerings are published in late fall.

SUMMER ACADEMIC COURSES: Cadets may volunteer or be directed by an Academic Review Committee to take an academic course in lieu of summer break. Registration for summer academics is in February and March of each year.

TRANSFER CREDIT: Credit given for college-level courses equivalent to USAF Academy courses but taken at another accredited college, university, or secondary school. A cadet must request this credit and submit a transcript. Transfer credit standards are the following:

- a. A grade of "B" or higher is generally required for transfer credit for any course in the curriculum.
- b. Departments giving mandatory placement examinations to the incoming fourth-class may give transfer credit for core courses when the combination of scores on entrance or placement examination and prior course work is justified even though the course grade is below "B". A department head may ask the Dean of the Faculty to request the Office of Student Academic Affairs withdraw transfer credit. All transfer/validation credits may be applied toward graduation requirements; however, at least 125 semester hours must be taken at USAF Academy (or USAF Academy-sponsored exchange programs) to meet minimum residency requirements. Transfer/validation credit is coordinated with academic departments by DFVRR.

TURNBACK: A cadet who has been transferred from one class to the next succeeding class (e.g., medical, administrative). If a cadet in deferred turn back status fails to meet graduation requirements by the end of the calendar year in which the cadet's original class graduates, the Academy Board will transfer the cadet to the next succeeding class and the cadet will be designated as a turn back.

UNDERLOAD: A course load less than minimum requirements reflected in Chapter 2.

VALIDATION CREDIT: Credit given for passing a validation examination or as a result of completing an accelerated or advanced course. A cadet who has passed college-level courses for which transfer credit is not awarded or who has extensive knowledge of a subject acquired without a formal course may be able to pass a validation examination. Validation examinations for fourth-class core courses are usually scheduled in the summer. For other courses, a cadet petitions the appropriate department and may be given an examination if the cadet can furnish evidence to indicate that they have a reasonable chance of passing. Occasionally, an academic department may invite a cadet to take the examination. A cadet who passes a validation examination or who makes an acceptable score on a College Board Advanced Placement examination may also earn validation credit. Departments certify this credit to the Office of Student Academic Affairs, Customer Service and Academic Scheduling (DFVRR). The various academic departments may award validation credit in any academic course (excluding Special Topics and Independent Studies courses). Except for core courses, validation credit may not be awarded later than a cadet's sixth semester. No cadet may be given validation credit for a course after attending any class meetings for the same course without expressed approval of the Dean of the Faculty. All transfer and validation credits may be applied toward graduation requirements; however, at least 125 semester hours must be taken at USAF Academy (or USAF Academy-sponsored exchange programs) to meet minimum residency requirements. The specific residency requirement can be found in Chapter 1.

WACQ: A WACQ (Weekend Academic Call to Quarters) is a 60-minute period of **supervised** study beyond normal Academic Call to Quarters and required study consultations outlined on the USAF Academy Form 68. Most often WACQs are accomplished on the weekend and validated weekly by Cadet Academic Officers (CADOs). WACQs are assigned to every cadet on academic probation every grading cycle. CADOs are responsible for assigning the correct number of WACQs to be accomplished each week based upon the probationary cadet's performance using the formula provided on the USAF Academy Form 68. For every F grade earned the previous grading cycle, a probationary cadet will be assigned 3 WACQs per week. For every D grade earned, 2 WACQs will be assigned per week. For every C- grade earned, 1 WACQ will be assigned per week. For cadets with deficient (below 2.0) core or major's GPAs but no deficient grades (C-, D, or F), 1 WACQ will be assigned per week. The cadet can always study more on a given weekend, but that would not relieve the cadet from having **supervised** study for the minimum WACQs each weekend until the next grading cycle. CADOs are expected to provide guidelines for supervised study that help the probationary cadets achieve academic excellence. A probationary cadet may receive credit for 1 WACQ by spending 1 hour in EI with an instructor beyond what is prescribed on the Form 68, at the cadet writing center, at the QRC, or with a

squadron assigned tutor during the week. However, all WACQs must be validated as supervised study by the CADO each week. All WACQs must be accomplished and validated by the CADO before probationary cadets are allowed to utilize passes.

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