The Aeronautical Engineering Major @ the United States Air Force Academy

September 2002

THE AERONAUTICAL ENGINEERING MAJOR

Successful completion of the Aeronautical Engineering Major leads to the degree of Bachelor of Science in Aeronautical Engineering. This degree is accredited by the Engineering Accreditation Commission of the Accreditation Board of Engineering and Technology. The aeronautical engineering profession involves the design, development, testing, manufacturing and maintenance of all atmospheric flight systems. Air Force aeronautical engineers are strongly involved in the national commitment of maintaining global air superiority through the deployment of state-of-the-art aircraft for the US Air Force. The Aeronautics Department at USAFA contributes actively to this commitment by preparing cadets for service to the Air Force as skilled entry level aeronautical engineers with competencies in six disciplines:

1. Aerodynamics
2. Aircraft and Aircraft Engine Design
3. Aerospace Materials and Structures
4. Propulsion
5. Aircraft Flight Mechanics
6. Experimental and Computational Investigations

Aerodynamics

The purpose of the Aerodynamics Discipline is to teach cadets how and why airplanes fly. With the foundations of flight and aerodynamics initially studied in the core engineering course, ***AeroEngr 315, Fundamentals of Aeronautics***, cadets acquire more in-depth knowledge on the principles of aerodynamics, fluid mechanics and gas dynamics with regard to flow physics of solid objects in flight. As airplanes fly faster, the flow physics affecting aerodynamic performance become more complex. Understanding these effects, and being able to use theory and mathematics to design airplanes correctly requires cadets to first learn the fundamentals and then build upon this understanding by applying the fundamentals to the aerodynamics of winged aircraft. Three courses in this discipline establish the foundations in aerodynamics that cadets use in the senior-year design courses, ***AeroEngr 481 & 482,*** to design, build and test specific aircraft.

Required Courses:

AeroEngr 341. Aeronautical Fluid Mechanics
AeroEngr 342. Aerodynamics.
AeroEngr 442. Advanced Aerodynamics

Electives:

AeroEngr 446. Introduction to Hypersonics
AeroEngr 447. Advanced Applied Aerodynamics

Aircraft and Aircraft Engine Design

The objective of the aircraft and aircraft engine design discipline is to teach cadets how to use their knowledge of aerodynamic principles to design and build an aircraft system, or to design an aircraft engine system or component, to meet specific customer needs. A two-course sequence is used to accomplish this objective. In the lead course, ***AeroEngr 481,*** cadets learn the fundamentals of engineering design. Then, depending on preference, cadets continue their design experience by working on a real aircraft design (***AeroEngr 482***), or a real aircraft engine design (***AeroEngr 483***). In both courses, cadets have strong interaction with and very often present the results of their design project to industry engineers.

Required Courses:

AeroEngr 481, Introduction to Aircraft and Propulsion System Design plus one design elective

Design Electives:

AeroEngr 482. Aircraft Design
AeroEngr483. Aircraft Engine Design.

Aerospace Materials and Structures

The primary purpose of the Aerospace Structures and Materials Discipline is to give cadets basic knowledge and understanding of how aerospace structures are designed and built. Aircraft have very special but fundamentally simple requirements: they must be strong, failsafe and lightweight. Engineers designing or working on modern day aircraft systems must know how to make safe, lightweight structures. This means they must understand how to use composite materials and sturdy construction design strategies. Building on the foundations developed in ***EngrMech 120***, cadets learn the physical fundamentals affecting the design of basic aerospace structures. Emphasis is placed on learning to predict how beams bend, twist or buckle, and fail, and then using such knowledge to design lightweight safe structures. Following the required course, ***EngrMech 330,*** cadets select from the elective shown below to learn more about aircraft structures, or more about modern materials, or more about modeling and design using finite element analysis. **Materials** (requirement: ***EngrMech 330, Static Analysis of Structures***, and one Structures and Materials elective).

Required Courses:

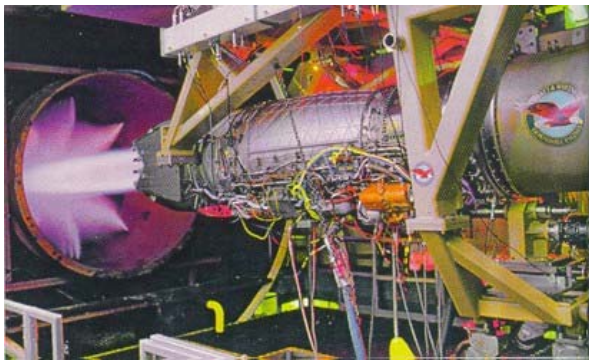
EngrMech 330. ***Static Analysis of Structures*** **plus one elective from the list below**

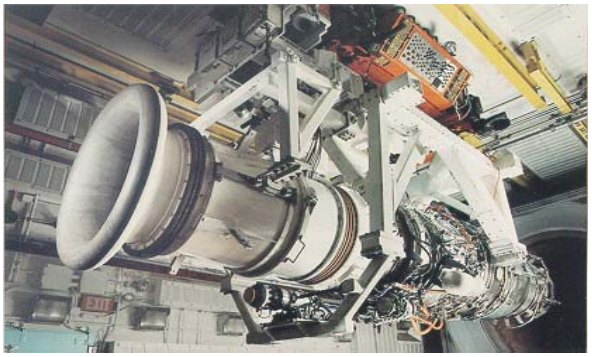
Materials and Structures Electives:

EngrMech 332. Aerospace Structures.
EngrMech 350. Mechanical Behavior of Materials.
EngrMech 431. Introduction to Finite Element Analysis.
EngrMech 450. Aerospace Composite Materials.
AeroEngr 436. Aeroelasticity.

Propulsion

The primary purpose of the propulsion discipline is to provide fundamental knowledge and understanding of air-breathing propulsion systems. The required introductory course teaches the principles of propulsion to include a description and study of turbine engine components. Following this, cadets learn about many modern-day engines such as turbofans, turboprops, ramjets and scramjets. Cadets also learn about rocket systems and rocket nozzles. Since the gas flow through these systems is often very fast, cadets learn the fundamentals of compressible gas dynamics: shock waves, heat transfer, and friction effects in fast moving gas streams. Emphasis is placed on teaching these fundamentals using many real-world applications especially with regard to systems currently being used in Air Force airplanes.



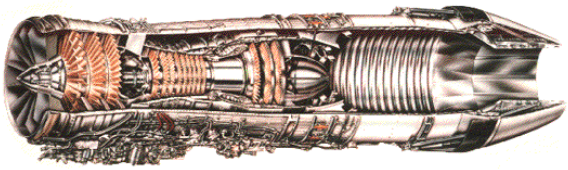


Required Courses:

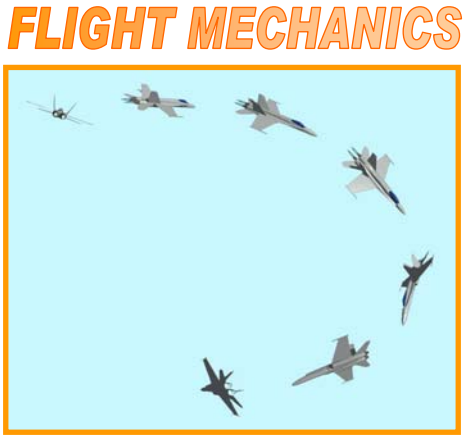
AeroEngr 361, Propulsion I.

Electives:

AeroEngr 466. Propulsion II.
AeroEngr 483. Aircraft Engine Design (capstone design course).
AeroEngr 495. Special Topics.
AeroEngr 499. Independent Study.



Aircraft Flight Mechanics, Stability and Control



The objective of the aircraft flight mechanics, stability and control discipline is to teach cadets the fundamentals of aircraft performance, stability, and control. Aircraft in flight experience many different forces. In addition to understanding how aircraft behave in takeoff, landing, maneuvering, and cruise modes, cadets learn how design insights are used to achieve controlled flights for conventional and high performance aircraft. Learning how aircraft are controlled in flight is an important aspect of this discipline. All aircraft have a variety of specially designed control surfaces, and a variety of sensors that tell how the aircraft is behaving. Together, these devices control the flight of the aircraft. To design these devices correctly, engineers first need to understand the forces acting on and influencing the motion of the aircraft, and the processes used to sense aircraft responses as intelligible signals that can be fed to a control system to improve the flight of the aircraft. A three-course sequence teaches these fundamentals

Required Courses:

EngrMech 320. Dynamics.

AeroEngr 351. Aircraft Performance and Static Stability.

AeroEngr 352. Aircraft Dynamics Stability and Control.

Electives:

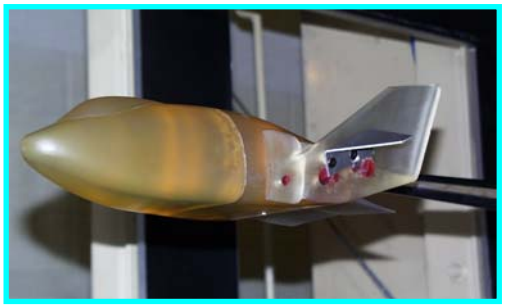
AeroEngr 456. (plus lab) Flight Test Techniques. (department permission required)

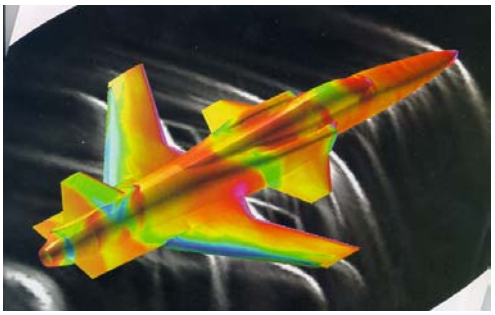
AeroEngr 457. Aircraft Feedback Control Systems.

AeroEngr 456, Flight Test Techniques, is a unique offering at USAFA. Based around four flights in a Cessna T-41D aircraft at USAFA, cadets learn to develop, execute, and present the results from performance and flying qualities of this aircraft. In the final project, cadets conduct a flight test evaluation of the Northrop T-38A supersonic advanced trainer aircraft at the Air Force Flight Test Center, Edwards Air Force Base, CA.

Experimental and Computational Investigations

The primary purpose of the experimental and computational investigations discipline is to teach cadets how to gain understanding of aerodynamic phenomena through the use of experimental and computational methods. In one required course, cadets learn how to plan and conduct wind tunnel experiments in which the lift and drag forces acting on aircraft models are measured. They also learn to analyze and interpret these measurements so that good decisions can be made about the design of new aircraft. Throughout the curriculum, cadets learn how to use computer models to understand the physics associated with air flowing over aircraft wings and bodies. This understanding promotes the development and evaluation of new ideas about how to make aircraft fly faster, higher, further and with greater maneuverability. In ***AeroEngr 442, Advanced Aerodynamics,*** cadets learn the fundamentals of computational fluid dynamics (CFD), and how to use existing CFD codes to obtain information on an actual problem. Electives involving research are available.





Required Courses:

AeroEngr 471. Aeronautical Laboratory.

Electives:

AeroEngr 495. Special Studies.

AeroEngr 499. Independent Study. (cadet research)

AERONAUTICS MAJOR COURSE REQUIREMENTS: 158 Semester Hours

A. 94 Semester hours of academic core courses to include the following core alternates:

Astro 320	Intro to Astronautics for the Engineer and Scientist (replaces Astro 410)
Math 356	Probability and Statistics for Engineers and Scientists (replaces Math 300)

B. 15 Semester hours of other core courses:

9 Semester hours of Commandant's academic core courses (Military Strategic Studies)
6 Semester hours of Director of Athletics core courses (Physical Education)

C. 48 Semester hours of major's courses:

1.	Math 243	Calculus III
2.	Math 245	Differential Equations and Matrices
3.	Math 346	Engineering Math
4.	EngrMech 320	Dynamics
5.	EngrMech 330	Static Analysis of Structures
6.	AeroEngr 341	Aeronautical Fluid Mechanics
7.	AeroEngr 342	Aerodynamics
8.	AeroEngr 351	Aircraft Performance and Static Stability
9.	AeroEngr 352	Aircraft Dynamic Stability and Control
10.	AeroEngr 361	Propulsion I
11.	AeroEngr 442	Advanced Aerodynamics
12.	AeroEngr 471	Aeronautics Laboratory
13.	AeroEngr 481	Introduction to Aircraft and Propulsion System Design
14.	Design Elective	
	a. AeroEngr 482	Aircraft Design or
	b. AeroEngr 483	Aircraft Engine Design
15.	AeroEngr Elective (See information below)	
16.	Structures and Materials Elective (see information above)	

AeroEngr Elective:
You will choose your elective(s) based on a chosen "specialty" from the six disciplines discussed above. The AeroEngr Elective must be either one of the Structures and Materials Electives or one of the following:

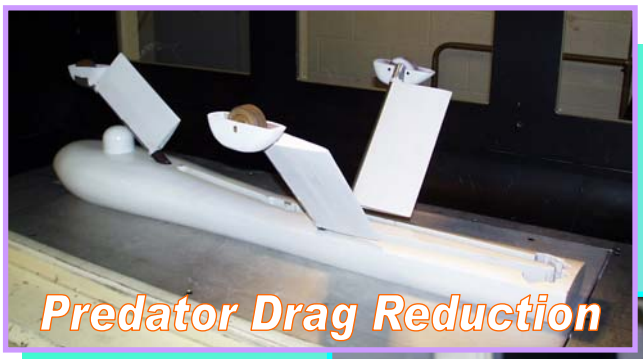
a.	EngrMech 432	Finite Element Analysis (prereq: EngrMech 431)
b.	MechEngr 441	Heat Transfer
c.	AeroEngr 446	Introduction to Hypersonics
d.	AeroEngr 447	Advanced Applied Aerodynamics
e.	AeroEngr 456	Flight Test Techniques (department permission required)
f.	AeroEngr 457	Aircraft Feedback Control Systems
g.	AeroEngr 466	Propulsion II
h.	MechEngr 467	Energy Conversion
i.	AeroEngr 482	Aircraft Design (if not used as design option)
j.	AeroEngr 483	Aircraft Engine Design (if not used as design option)
k.	AeroEngr 495	Special Topics (3 sem hrs only, Dept permission required)
l.	AeroEngr 499	Independent Study (3 Sem hrs only, Dept permission req.)
m.	Other Engineering or Basic Science courses with department permission.	

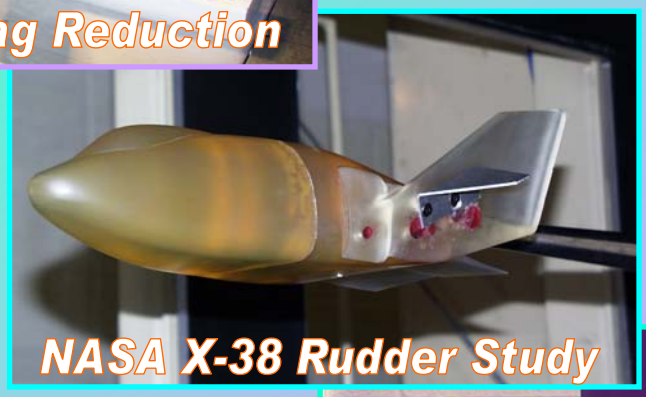
Check your APS and the Curriculum Handbook for the proper sequence of technical core and prerequisite courses to enable you to take AEROENGR 315 and AEROENGR 241 in your third class year. (Normal sequence: AEROENGR 315 - FALL; AEROENGR 241 - SPRING). To get the latest information, please talk to an aero advisor:

Class of 2005 Advisors	
Maj Keith Boyer (AIC)	3-2619
Dr. Julie Albertson	3-2612
Dr. Tom Yechout	3-9089
Maj Bob Kraus	3-4315

Class of 2006 Advisors	
Maj Scott Wells (AIC)	3-3480
LtCol Dave Wetlesen	3-2969
LtCol John Bode	3-8495
Dr. Tom Cunningham	3-1746

AIR FORCE APPLICATIONS FOR CADET AERONAUTICAL RESEARCH PROJECTS





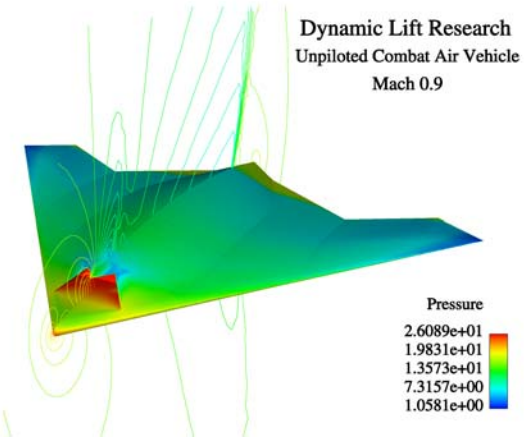
AERONAUTICS LABORATORY

Stretching across 55,000 square feet and valued at $120M, the Aeronautics Laboratory is arguably the finest undergraduate research facility in the world. In addition to full classroom support, cadet and faculty teams conduct well over 30 AF, DoD, and NASA sponsored research projects annually, valued in excess of $1.6M.

Major Tunnels	Engine Test Cells	Other Teaching Aids
1’ x 1’ Trisonic 3’ x 3’ Subsonic 3’ x 3’ Low Speed 15” x 20” Water 3’ x 2’ Cascade	F-109 Turbofan J-85 Turbojet J-69 Turbojet Rocket Auto Engine T-63 Turboshaft	Flight Simulator Smoke Tunnel 12” Low Speed Tunnels 1” Supersonic Tunnels Laminar Flow Tables High Perf Computer Center

AIR FORCE OPPORTUNITIES FOR AERONAUTICAL ENGINEERS

Aeronautical engineers are responsible for the research, design, development and testing of the aerospace vehicles that put the "Air" in Air Force. The Aeronautical Engineering major qualifies you for an aeronautical engineering AFSC (62EXA; Development Engineer, Aeronautical) and many other AFSCs. As an aeronautical engineer you may be involved in "hands on" aeronautical research and development of aircraft, missiles and propulsion systems. At some point in your Air Force career, you can expect to work on programs ranging from basic research through full-scale development of major weapon systems. Your work may involve experimentation, technical analysis of aeronautical systems performance, flight test or program management of aeronautical systems under development. Aeronautical Engineering majors are eligible for graduate programs in Aeronautical Engineering. Officers with Aeronautical Engineering majors are academically qualified for USAF Test Pilot School as a test pilot, test navigator or flight test engineer. Approximately 100 flight test engineer positions are open in the Air Force. These positions are staffed by individuals who regularly fly in flight test or test chase aircraft.



Other Air Force Specialty Codes that you will be qualified for include:

AFSC	Duty Title	Minimum Grade Requirement*
11EX	Experimental Test Pilot	2 Lt
12EX	Experimental Test Navigator	2 Lt
21AX	Aircraft Maintenance/Munitions	2 Lt
22SX	Space and Missile Maintenance, Missile	2 Lt
61SXA	Scientist, Analytical	2 Lt
62EXG	Developmental Engineer, Project	2 Lt
62EXF	Developmental Engineer, Flight Test	2 Lt
63SX	Acquisition Manager	2 Lt

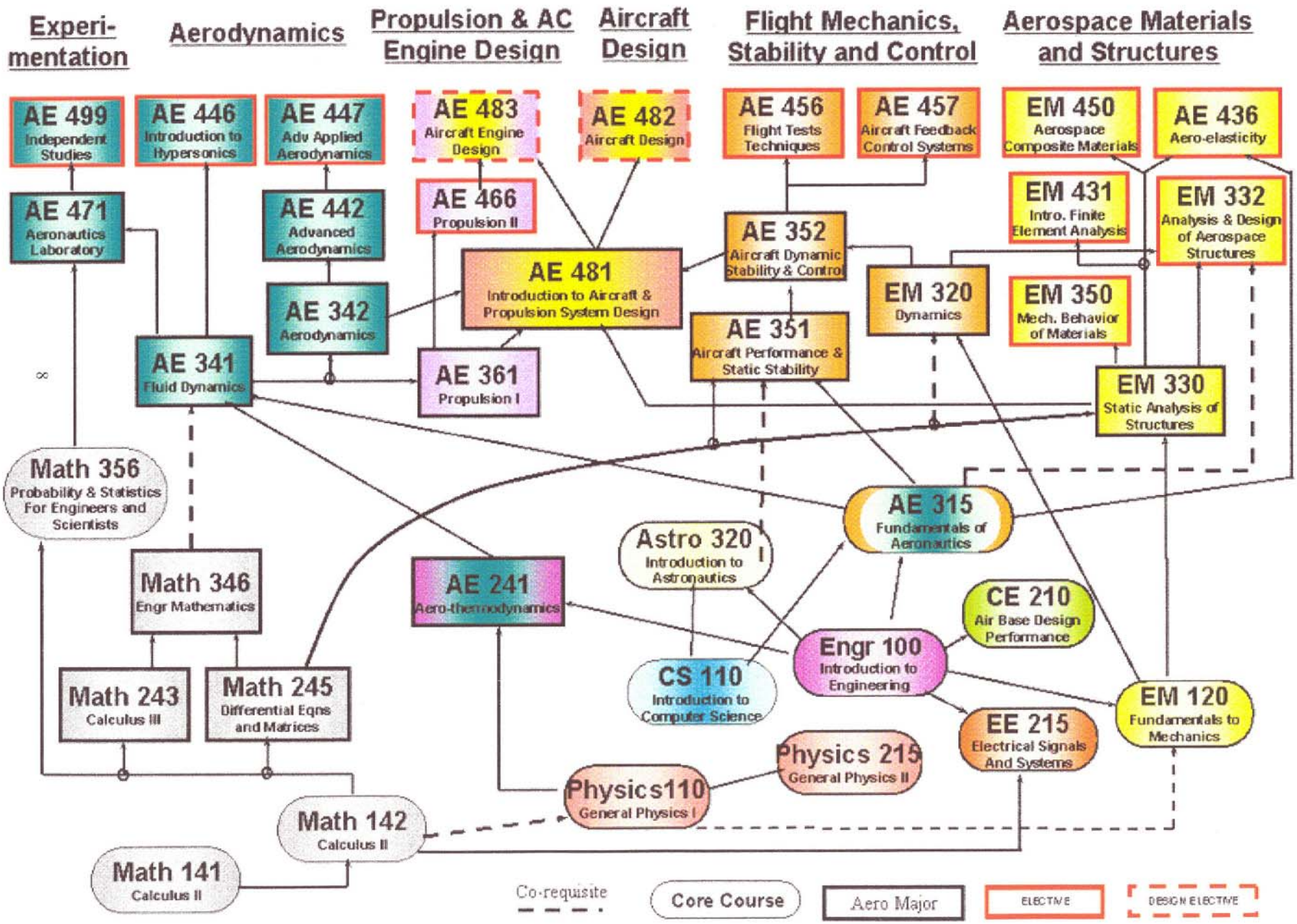
- See AFI 36-2105 for a more complete explanation of requirements

ASSIGNMENTS

Air Force Material Command is the primary organization you can expect to work for as an Aeronautical Engineer in the USAF. However, all other commands use engineers in a variety of different capacities. As an aeronautical engineer in AFMC, you will most likely be assigned to one of the following bases:

Arnold AFS, Tennessee	Kirtland AFB, New Mexico
Brooks AFB, Texas	Los Angeles AFB, California
Edwards AFB, California	Robbins AFB, Georgia
Eglin AFB, Florida	Tinker AFB, Oklahoma
Hill AFB, Utah	Wright-Patterson AFB, Ohio

AERONAUTICAL ENGINEERING MAJOR



MISSION STATEMENTS, PROGRAM OPERATIONAL GOALS AND PROGRAM CURRICULAR OUTCOMES

USAF Academy Mission Statement

To inspire and develop young men and women to become Air Force Officers with knowledge, character, and discipline; motivated to lead the world's greatest aerospace force in service to the nation.

Aeronautical Engineering Department Mission Statement

To support the USAFA Mission by developing and inspiring young men and women to become Air Force officers with a specialization in aeronautical engineering.

Aeronautical Engineering Department Vision Statement

To operate a preeminent department of aeronautics committed to producing second lieutenants of exemplary character, and professional competence in aeronautical engineering, motivated and devoted to public service in the United States Air Force.

***Aeronautical Engineering* Program Operational Goals**

Program Operational Goals – statements that describe the expected accomplishments of graduates during the first few years after graduation

The goal of the Aeronautical Engineering Program is to prepare cadets to become Air Force Officers who:

1. Possess breadth of integrated, fundamental knowledge in engineering, basic sciences, social sciences, and humanities; and depth of knowledge in aeronautical engineering.
2. Communicate effectively.
3. Work effectively on teams and grow into team leaders.
4. Are independent learners, and as applicable, are successful in graduate school.
5. Can apply their knowledge and skills to solve Air Force engineering problems, both well- and ill-defined.
6. Know and practice their ethical, professional, and community responsibilities as embodied in the United States Air Force Core Values.

***Aeronautical Engineering* Program Curricular Outcomes**

Program Curricular Outcomes – statements that describe what students are expected to know and are able to do by the time of graduation, the achievement of which indicates that the student is equipped to achieve the Program Educational Objectives

1. Use fundamental knowledge to solve aeronautical engineering problems commensurate with a Bachelor of Science degree.
2. Plan and execute experimental and computational investigations, and interpret and analyze data from such investigations to formulate sound conclusions.
3. Develop and evaluate an engineering design that meets customer needs.
4. Use oral and writing skills to communicate effectively.
5. Work effectively as a member of a multidisciplinary team.
6. Demonstrate the skills to engage in independent learning.