Undergraduate Handbook

University of Kansas
School of Engineering
Department of
Aerospace Engineering

Department Chairman:
Professor Mark S. Ewing
Administrative Office:
2120 Learned Hall

Chairman’s Letter

Welcome to the University of Kansas and the Department of Aerospace Engineering.

Most likely you have entered our program because of your fascination with things that fly - aircraft, spacecraft, balloons, etc. This is a fascination you share with all the department faculty and alumni. Some of you might be interested in the problems associated with flight in the atmosphere (Aeronautics). Others will be interested in problems associated with operation in space (Astronautics). The Bachelor of Aerospace Engineering will prepare you for a career in either path. The program is designed to provide you with the basic understanding of the physical world, the mathematics needed to model and analyze these problems, as well as the specific technology that applies these ideas and principles to aerospace vehicles and systems.

Because you are preparing for a 40-year career and no one can imagine what new challenges and opportunities you will face, this program must emphasize the concepts and methods that will always be important, i.e. the laws of nature and mathematical methods. Unfortunately, it is impossible to learn in four years all you will need during your career. You should consider this program as the start of a lifelong experience of education and discovery. The faculty goal is to help you develop the ability and confidence to build on these basic principles to learn what is needed to be successful in the Aerospace Industry.

When you have completed the program and earned your BS you will be able to enter industry, government organizations including NASA, a branch of the military or continue your education in graduate programs. The purpose of this handbook is to clearly identify the resources, the academic program, the graduation requirements, and the department rules and procedures that define the Aerospace Engineering Program. A similar Handbook is available which defines all the graduate programs offered by the department. If you have a question about the program, first look in this handbook. If this does not provide a satisfactory answer, contact your adviser or see me.

A detailed definition of the program is given in Section 3. During the first year you will be taking the basic sciences, mathematics, and communication courses that form the key foundation for the rest of the program. Also, you will take an Introduction to Aerospace Engineering course. In the second year you will continue to take advanced mathematics and basic science as well as engineering science courses. The engineering science courses apply the principles you have mastered in the basic sciences and mathematics to the solution of engineering problems. In the third year you will learn the unique nature of aerospace engineering. These courses will cover the major disciplines of Aerospace Engineering: - fluid mechanics and aerodynamics, propulsion, structures, and flight dynamics. You will have courses in complementary topics including computer graphics and instrumentation. Finally in your fourth year, you have the opportunity to see how all the individual specialized technologies are used to design a vehicle. You learn to make tradeoffs and perform design iterations to arrive at a final design.

Throughout the program you have the opportunity to take elective courses from the College of Liberal Arts and Sciences. These are referred to as Humanities and Social Science electives. Finally you will take a course called Aerospace Colloquium all eight semesters in the program. This course is a seminar series in which practicing engineers from industry or government organizations present lectures based upon their experiences. This series of courses gives you an insight into to profession of Aerospace Engineering you are preparing for.

Again, welcome.

Section 1: Department Overview

1.1 Department History

The Bachelor of Science in Aerospace Engineering degree was approved by the Kansas Board of Regents in 1941. Since the first graduating class in 1944 the department has graduated over 1000 students. The BS in Aerospace Engineering has been continuously accredited by first the Engineering Council for Professional Development, and lately by the Accreditation Board of Engineering and Technology, Inc. The review by the Accreditation Board assures the quality of the program. The department also offers graduate programs at both the Master and Doctoral levels. The department programs are annually reviewed by the department Advisory Board made-up of representatives from industry and the government. This review assures that graduates of our programs meet the needs of the profession.

1.2 General Description of BS Program

The focus of the BS program in Aerospace Engineering is the design of aerospace vehicles and components. This is accomplished in a four year academic program that consists in the 1st year of basic sciences, mathematics, and communication courses. These courses form the key foundation for the rest of the program. Also, you will take an Introduction to Aerospace Engineering course that will give you an overview of the BS program. In the second year you will continue to take basic mathematics and science as well as engineering science courses. The engineering science courses apply the principles you have mastered in the basic sciences and mathematics to the solution of engineering problems. In the third year you learn the unique nature of aerospace problems. These courses cover the major subdivisions of Aerospace Engineering - fluid mechanics and aerodynamics, propulsion, structures, and flight dynamics. You will also have courses in complementary topics including computer graphics and instrumentation. In your fourth year, you have the opportunity to see how all the individual specialized technologies are used to design a vehicle.

Throughout the program you have the opportunity to take elective courses form the College of Liberal Arts and Sciences. These are referred to as Humanities and Social Science electives. You will take Aerospace Colloquium all eight semesters in the program. This course is a seminar series in which practicing engineers from industry or government organizations present lectures based upon their experiences. Which give you a feel for the Aerospace Engineering profession.

1.3 Aerospace Engineering Faculty

Ron Barrett, Associate Professor of Aerospace Engineering
Dr. Barrett joined the Department in 2005. His research areas include enhancement of transportation related technologies, design, development and testing of unusual uninhabited aerial vehicles, missiles, munitions and adaptive aerostructures. He received his B.S. and Ph.D. degrees in Aerospace Engineering from KU in 1988 and 1993. He attended the University of Maryland, College Park as a US Army Rotorcraft Fellow where he received his MS in Aerospace Engineering in 1990. Dr. Barrett served for 12 years on the faculty of Auburn University, Alabama where he won every teaching award available for his position. He also served as a USAF Faculty Fellow, flight test engineer and a Visiting Professor for one year at The Technical University of Delft, Holland. His work on adaptive aerostructures has yielded many "firsts" including the first fixed- and rotary-wing aircraft to fly using adaptive materials for flight control. He has more than 100 publications and three patents on adaptive rotors, dragless wings and high performance convertible UAVs. In 1998 he was honored for his work in adaptive aerostructures when he claimed Discover Magazine's Discover Award for Aviation and Aerospace Technology. He has consulted for every major US Aerospace corporation and worked for all branches of the DoD, NASA and the NSF. He has taught short courses on Adaptive Aerostructures and Convertible UAV Design in the US, Sweden, Portugal, Germany, Holland, Singapore, India, Ireland, Scotland and England. He especially enjoys interacting with students and has advised and coached more than a dozen award winning AIAA student papers and design teams. He is currently the AIAA Chapter Advisor and maintains active memberships in the AMA, ASEE, ASME, Phi Beta Delta, SAE, SHPE, SPIE, Sigma Gamma Tau and Tau Beta Pi.

Richard Colgren, Associate Professor of Aerospace Engineering.
Dr. Richard Colgren, Associate Professor of Aerospace Engineering, comes to KU from the Lockheed Martin Aeronautics Company in Palmdale, California, where he was a Senior Staff Engineer. Including previous aircraft design and development research at Northrop, he has had 22 years of professional experience within the aerospace industry.He received his B.S.in Aeronautical and Astronautical Engineering from the University of Washington in 1982 and his M.S. in Electrical Engineering in 1987 from the University of Southern California. Dr. Colgren received his Doctorate in Electrical Engineering with an emphasis in systems at the University of Southern California in 1993 with a minor in Aerospace Engineering. He is an Associate Fellow of the American Institute of Aeronautics and Astronautics, among other society and national and international technical committee memberships. He has over 50 publications and holds two patents. He has been an Adjunct Professor at variety of universities including the University of Southern California and California State University, Fresno. His research focus is on intelligent vehicle systems and controls.

David R. Downing, Professor of Aerospace Engineering
Dr. Downing was Chairman of the Department from August 1988 to December 1998. He teaches and conducts research in advanced flight control, display, and instrumentation systems. He received a B.S. in Aeronautical Engineering in 1962, and an M.S. in Instrumentation Engineering in 1963, both from the University of Michigan. He received his Sc.D. in Instrumentation Engineering in 1970 from the Massachusetts Institute of Technology. Dr. Downing has had professional experience at NASA's Electronic Research Center and Langley Research Center, where he served as project manager of Advanced Guidance, Control, and Display for General Aviation Aircraft. Dr. Downing has also been on the faculties of Boston University and Christopher Newport College. He received a NASA Group Achievement Award in 1979 and the School of Engineering Miller Award for Service in 1992. He is an Associate Fellow of AIAA and a member of IEEE, SAE, and ASEE.

Mark Ewing, Chairman and Associate Professor of Aerospace Engineering and Director of the Flight Research Laboratory.

Dr. Ewing joined the department in 1992 and has been Chairman of the Department since January 1999. His expertise is in the areas of engineering mechanics and the analysis, design and testing of lightweight structures. He received his B.S. in Engineering Mechanics form the U.S.A.F. Academy and in 1972, an M.S. in Mechanical Engineering and a Ph.D. in Engineering Mechanics from Ohio State University in 1978 and 1983 respectively. He served in the U.S. Air Force for 20 years, starting with engineering positions as a Turbine Engine Design Analyst and a Propulsion Staff Officer. He was an Instructor in Civil Engineering from 1978 to 1980 and Associate Professor in Engineering Mechanics from 1983 to 1989 at the USAF Academy. Dr. Ewing closed his Air Force career as Chief of the Analysis and Optimization Branch, and Senior Research Engineer in the Structures Division, Flight Dynamics Directorate, Wright Laboratory. In 1994, Dr. Ewing was selected as the Outstanding KU Aerospace Engineering Educator. He also was presented with the 1994 Henry E. Gould award for the KU School of Engineering Outstanding Educator.

Saeed Farokhi, Associate Dean of The Graduate School, Professor of Aerospace Engineering, and Department Graduate Advisor.

Dr. Farokhi joined the Department in 1984. He specializes in propulsion and fluid mechanics. He received a B.S. degree in Aeronautical and Astronautical Engineering in 1975 from the University of Illinois, then received his M.S. and Ph.D. in Aeronautics and Astronautics from MIT in 1976 and 1981, respectively. His professional experience includes working four years as a Design and Development Engineer and Project Leader in the Gas Turbine Division of Brown, Boveri, and Co. in Baden, Switzerland. In 1989, Dr. Farokhi received both the Burlington Northern Foundation Faculty Achievement Award for his distinguished service to engineering research and the Miller Professional Development Award from the KU School of Engineering. He also received the 1990 and 1997 Henry E. Gould Award for Outstanding Teaching from KU, and was selected to receive the Outstanding Aerospace Educator Award in 1990, 1993, 1997 and 1999. Dr. Farokhi was appointed to John E. and Winifred E. Sharp Teaching Professorship in 1995. He has served as the Director of Flight Research Laboratory at KU from 1990 to 1995. Dr. Farokhi was named the Associate Dean of Graduate School in 2004 where he is in charge of the Graduate Program and Dissertation Status review, Preparing Future Faculty and Preparing Future Professional programs and the Graduate Division of The College of Liberal Arts and Sciences. He has served as the National President of the Sigma Gamma Tau, The Honor Society of Aerospace Engineering, in 2000-2003. Dr. Farokhi is a Fellow of ASME, an Associate Fellow of AIAA and a member of SAE, ASEE, APS , Phi Beta Delta, and the American Academy of Mechanics.

Rick Hale, Associate Professor of Aerospace Engineering.

Dr. Hale joined the department of Aerospace Engineering at the University of Kansas in 1998. His expertise is in the areas of engineering mechanics, experimental mechanics, and composite materials and structures. He received his B.S. in Aerospace Engineering from Iowa State University in 1988, his M.S. in Mechanical Engineering from Washington University in 1991, and his Ph.D. in Engineering Mechanics from Iowa State University in 1995. Dr. Hale was a Senior Project Engineer for the Boeing Company (formerly McDonnell Douglas Aerospace) from 1989 to 1998, where he worked on composite design and analysis processes, fiber placement, and structural concepts in advanced design. He was a member of Boeing's Parametric Composite Knowledge System team, which received the 1999 Technical Contribution Award from the St. Louis section of the AIAA. Dr. Hale holds three U.S. and one international patent for composite design processes, with further national and international patents in review. Dr. Hale was selected as the Outstanding Aerospace Engineering Educator for 1999-2000, 2001-2002 and 2003-2004, was a Bellows Scholar for the KU School of Engineering for 2000-2001, and received the Gould Award for Outstanding Education or Advising in Engineering in 2002, 2003 and 2005. In 2003 Dr. Hale also received the W.T. Kemper Fellowship for teaching excellence, as well as the KU School of Engineering Miller Professional Development Award for distinguished research in the engineering profession. Dr. Hale is a senior member of AIAA, and is a member of SAE, SEM, SAMPE, ASEE, Tau Beta Pi, Sigma Gamma Tau, Pi Mu Epsilon, and Phi Beta Theta.

Chuan-Tau Edward Lan, Emeritus Professor of Aerospace Engineering.
Dr. Lan has been at the University of Kansas since 1968 teaching theoretical and applied aerodynamics, flight dynamics and applied mathematics. He received his B.S. in Civil Engineering degree at the National Taiwan University in 1958, MS degree in Civil Engineering at the University of Minnesota in 1963, and his Ph.D. is in Aeronautics from the New York University in 1968. Dr. Lan is an Associate Fellow of AIAA and a member of Sigma Gamma Tau and Tau Beta Pi. He received the AIAA Aerodynamics Award for 2000. He also received the Outstanding Aerospace Educator Award by the graduating class in 1991 and Excellence in Graduate Teaching in 2001, chosen by the department's graduate students and sponsored by the KU Center for Teaching Excellence. He is the co-author of a textbook on airplane performance with Dr. Jan Roskam and is the author of a book entitled Applied Airfoil and Wing Theory.

Craig McLaughlin, Associate Professor of Aerospace Engineering.
Dr. McLaughlin joined the faculty of the Aerospace Engineering Department at the University of Kansas in 2007. Before coming to KU, he spent five years in the Department of Space Studies at the University of North Dakota. From 1994-2002 Dr. McLaughlin worked in the Space Vehicles Directorate of the U. S. Air Force Research Laboratory. There he served as principal investigator for formation flying for the TechSat 21 mission and as team lead for the Guidance, Navigation, and Control Team. Before that he provided mission planning design and support for the MightySat II technology demonstration satellite, which captured the first hyperspectral images taken from space. The MightySat II team won the AFRL Commander's Cup Award in 2002. Dr. McLaughlin received his M. S. and Ph. D. in Aerospace Engineering Sciences at the University of Colorado at Boulder in 1994 and 1998 respectively. He received a B. S. in Aeronautical Engineering from Wichita State University in 1992.

Jan Roskam, Emeritus Professor of Aerospace Engineering.
Dr. Roskam has been with the department since 1967. He specializes in aircraft design, aerodynamics, aircraft stability and control, automatic flight control systems, transportation, and applied mathematics. He received an M.S. in Aeronautical Engineering in 1954 from the University of Delft, Holland, and a Ph.D. in Aeronautics and Astronautics in 1965 from the University of Washington in Seattle. He has had 12 years of professional experience with Aviolanda Co. In Holland, Cessna Aircraft Company, and Boeing Company in Wichita and Seattle. Dr. Roskam was elected Outstanding Educator of Aerospace Engineering by the graduating class of 1989 and 1992. He has won numerous national teaching and research awards including being honored as a Fellow of AIAA and SAE. He is a member of Sigma Gamma Tau and Tau Beta Pi. He has published a two volume text on airplane flight dynamics and automatic flight controls, a text on airplane performance (co-authored by E. Lan), and an eight volume set of books on airplane design and he has been widely published in industry journals. He has been actively involved in the design of more than 25 airplanes. Dr. Roskam retired in 2004.

Ray Taghavi, Professor of Aerospace Engineering.
Dr. Taghavi joined the Department in 1991 with expertise in fluid mechanics and propulsion. He received his B.S. in Mathematics from Tehran University in 1965, his M.S. in Aerospace Engineering from Northrop University in 1978, and his Ph.D. in Aerospace Engineering from the University of Kansas in 1988. Dr. Taghavi has had professional experience at NASA's Lewis Research Center from 1986 to 1991, where he supported the NASA's High Speed Research (HSR) Program. His research activities included supersonic jet noise, excitation & control of shear layers, and mixing enhancement of swirling flows. Dr. Taghavi was selected to receive the Outstanding KU Aerospace Educator Award in 1995. He was the recipient of the 1999 SAE Ralph R. Teetor National Educational Award and the 1999 Spahr Professorship Award from the KU School of Engineering, and was also selected as one of the 1999 Boeing Welliver Faculty Fellows. Dr. Taghavi is the recipient of the 2001 AIAA Abe M. Zarem National Educator Award. He is a fellow of ASME, an associate fellow of AIAA, and a member of SAE, ASEE, Sigma Gamma Tau, and Tau Beta Pi.

1.4 Advising System

All students are assigned a faculty adviser when they join the department. This adviser will normally continue to advise the same students throughout the B.S. program. A student can request a change in adviser through the Department Secretary. Student progress is documented by the Academic Requirements Tracking System (ARTS) form which is accessible via the Kyou Portal on the internet. Each student will see his/her adviser at least once a semester during pre-enrollment for the following semester. Advisers are available for consultation on any topic related to the student's activities at KU. In particular, students are encouraged to see their adviser as soon as a problem or concern is identified. This assures that all the student services provided by the university, e.g. career counseling, tutoring and study workshops, and are utilized as needed during the student's career at KU. If for any reason a student cannot reach his/her adviser, the student can always make an appointment with the Department Chairman.

1.5 Scholarships

All freshman scholarships are awarded through the Deans office. The deadline for return of completed scholarship applications to the Deans office, for entering freshman, is February 1 and the deadline for transfer students is March 15. Scholarships for upperclassmen are also available. The deadline for application is February 15 of each year.

1.6 Cooperative Programs

Because of the fact that all Aerospace Engineering courses are taught only once each academic year it has not been possible to setup standard cooperative programs, i.e. alternate semesters of academic course work and work periods. If a student were to miss a semester in the junior or senior year at least one semester would be added to his/her program in addition to the time lost during the work assignment.

1.7 Employment Opportunities and Placement Services

Aerospace Engineers are employed by a wide range of industries and organizations. Typical examples are:

Aircraft and Spacecraft Manufacturers
Aircraft and Spacecraft Operators
Research Labs: NASA, Federal Aviation Administration, Department of Defense
Armed Forces: U.S. Air Force, U.S. Navy, U.S. Marine Corps, U.S. Army, U.S. Coast Guard
Aerospace Component Manufacturers
Automobile Manufacturers
Universities
Consulting Engineering Companies

Employment opportunities in engineering, in general (but in Aerospace Engineering if particular), are cyclic. It is a fact, however, that even in poor times, unemployment among engineers so, typically, the lowest of all occupations. This is because an engineer is trained to solve problems (almost any type of problem) - in a logical fashion. This capability is desired by industry and government almost regardless of the type of engineering degree a person has. For that reason, engineers of all types find it easy to shift into jobs not requiring engineering backgrounds at all, if they so desire.

Students seeking permanent, as well as, summer jobs are encouraged to use the Engineering Career Services, in room 1001 Eaton Hall. ECS provides individual career counseling and conducts career workshops to help prepare students for interviewing and resume preparation. They also assist students in setting up appointments with the companies and other organizations which conduct on campus interviews.

1.8 Student Organizations

The University offers a wide variety of student organizations the aerospace engineering students can join. Student organizations of particular interest to aerospace engineering students are listed below:

American Astronautical Society (AAS)

This is the student chapter of the premier professional society for astronautics and space in the USA. The student chapter promotes space interest across the entire student community with regular meetings, field trips, guest speakers, movie nights, and has an important outreach component for K-12.

American Institute for Aeronautics and Astronautics (AIAA)

The aerospace professional society on campus is the AIAA. There is an active student branch at the University of Kansas, which organizes technical and social meetings throughout the academic year. It is highly recommended that aerospace students become active in AIAA for status in the profession, career development and career motivation.

Experimental Balloon Society (XBS)

XBS is an organization that gives students the opportunity to make high altitude balloon payloads and to participate in the launch and recovery of those payloads. These balloons can carry payloads of up to 12 lb to altitudes around 110,000 feet. This allows cheap testing of payloads at 1/3 the way into the internationally distance to space (100km). The club shows students the full lifecycle of a project, from the design phase, to building, then actually flying the project. Current Projects include: Rocket launch at high altitude, video acquisition, telemetry transmission and communications.

Rocket System Development Organization (RSDO)

RSDO is an organization open to students interested in the designing, building and flying of rockets. Members put theory into practice by designing, constructing and testing hardware and systems that will ultimately be used to build a flight capable rocket. Projects have included: hybrid rocket motors, gas/liquid propellant rocket motors, “kit” rocketing and development of computer programs for propulsion system performance analysis.

Sigma Gamma Tau

SGT is the aerospace engineering national honor society in which membership is by invitation only. Students with exceptional scholastic performance are eligible for membership and will be invited by the campus chapter. Technical and social meetings are held throughout the academic year.

Society of Automotive Engineers (SAE)

The Society of Automotive Engineers sponsors a radio-controlled aircraft design, build, fly competition each year. KU teams have become a national force, having placed 1st, 4th and 3rd in the national competitions in the last four years.

Society of Women Engineers (SWE)

The Society of Women Engineers is a national, professional, educational organization of engineers, and men and women with equivalent engineering experience, dedicated to the advancement of women in the engineering profession. There is an active student chapter of SEE on campus open to all engineering students and faculty who are interested in the goals of the organization.

Tau Beta Pi

This is an engineering national honor society in which membership is by invitation only. Students with exceptional scholastic performance in all engineering desciplines are eligible for membership and will be invited by the campus chapter.

1.9 Faculty and Student Responsibilities

At the start of a university career students quickly discover life in college is very different from life in high school. Students at a college or university are rightly treated as adults. Much of what you do will be your responsibility. The faculty and staff will not monitor your progress or performance. They will provide any assistance you need but generally you will have to request help. You will prosper or fail due to your own actions. To assist you in this new environment a clear definition of what are your responsibilities and what are the responsibilities of the faculty is useful.

Consider first the responsibilities of the faculty. Each professor may use a different set of guidelines or rules in running a class. It is the faculty's responsibility to define the rules to be used in terms of attendance, grading policy, assignments, and class schedule. If a faculty member does not provide this information or if the rules or procedures are unclear, it is recommended the student discuss this with the faculty member.

Next consider the student's responsibilities. Once the faculty defines the course requirements, it is the student's responsibility to follow the guidelines including coming to lectures and laboratories on time, submitting the assignments on time, and taking all examinations. If for any reason the student will not be able to attend class or take a test it is expected that the student notify the professor before the absence. Although there is no single set of rules for handling such situations, each faculty member has a set of rules. It is also the student's responsibility to obtain the information and course material presented when the student failed to attend a lecture. This includes changes in assignments or test dates. Your professor may be willing to provide this information if the absence had prior approval or if it involved an emergency.

Each student is expected to use his/her initiative in using the university libraries and related material available in other facilities as needed. There are workshops and special lectures available to show students how to use the extensive resources provided by the university and it is the student's responsibility to seek help.

Section 2: Admission

Students are admitted into the BS Program both directly after high-school graduation and as a transfer student with advanced credits from other universities or junior colleges. The admission procedures and criteria are listed below.

2.1 Admission Directly From High-School

Students may enter the Department of Aerospace Engineering as freshmen, but all admissions (both in-state and out-of-state), are on a selective basis. General requirements for admission to the university are included under Admission in the General Information section of the Undergraduate catalog. Students from foreign institutions are not accepted directly into the school, but may apply for transfer after at least one semester in the College of Liberal Arts and Sciences or in some other U.S. institution.

To be considered for admission to the Department of Aerospace Engineering, all applicants must meet or exceed minimum academic standards. Admission is on a competitive basis following a review of an individual's achievements considering factors such as: 1) high school record, 2) class standing, 3) scores on national tests, 4) adviser recommendation, and 5) trend of grades.

Priority Admissions. Applications received before December 1, shall be put through an admissions standards screening and the following shall be granted admission regardless of enrollment limitations:

> For beginning in-state freshmen: be a graduate of an accredited Kansas high-school or the equivalent, have an overall grade point average of 3.0 or better, and meet eligibility requirements for MATH 121 (Minimum math ACT of 28, 3 years of mathematics including 2 years of algebra and 2 years of trigonometry).
>
> For beginning out-of-state freshmen: be a graduate of an accredited high school or the equivalent, be in the top 15 percent of the graduating class or the equivalent, have an over all grade point average of 3.0 or better with grades of A or B in mathematics and science, and meet eligibility requirements for MATH 121 (Minimum math ACT score of 28, 3 years of mathematics including 2 years of algebra and 2 year of trigonometry).

Regular Admissions. Applicants who were not admitted by application of the above screening standards or who applied after December 1 shall be placed on a standby status until February 1.

Following February 1, each department will accept, in order of rank, the number of applicants to reach the department quota. In no case shall admission be granted to students with below minimum academic standards. If the quota is not reached, applications received after February 1 shall be considered with the same rules applying.

Minimum Academic Standards for Admission. To be considered for admission to the Department of Aerospace Engineering, all students must be graduates of an accredited high-school or the equivalent, be in the top 50% of the graduating class or the equivalent, and meet eligibility requirements of MATH 104 (Minimum math ACT of 22, 2 years of algebra).

All transfer students must have overall college grade point averages of 3.0 or better. Transfers between engineering departments, including change from undecided, must be approved by the receiving department. Admission decisions for transfer applicants are made after February 1.

2.2 Admission as a Transfer Student

Students who wish to transfer into the B.S. in Aerospace Engineering from Universities or junior colleges must send a completed application for admission form and a current official transcript to the Office of Admission, Room 126 Strong Hall. Transfer credits are evaluated by the Office of Admissions for all courses whose equivalent at KU would be offered by the College of Liberal Arts and Sciences. Transfer credits for courses normally offered by the School of Engineering will be evaluated by the appropriate engineering department. Only courses in which a grade of C or better was obtained will be granted transfer credit. Courses graded Pass/Fail will not be granted transfer credit. All transfer students must take their last 30 hours of credits while enrolled in the KU School of Engineering to be eligible to graduate from the University of Kansas.

Students currently enrolled in another school at the University of Kansas or another department in the School of Engineering who wish to transfer TO the department of Aerospace Engineering must fill out a Request for Transfer. The student must then submit the request form and a current copy of his/her ARTS form to the Aerospace Engineering Department office in Room 2120 Learned Hall. Transfers between engineering departments, including a change from undecided, must be approved by the receiving department. Admission decisions for transfer applicants are made after February 1.

2.3 Enrollment Management Program

To insure appropriate enrollments in the upper level Aerospace Engineering courses, the department has established an enrollment management policy. The department plans to maintain a freshman enrollment of approximately 60. Students are advised to apply by the December 1 deadline to maximize their chances of being accepted. In any given year the number of qualified applications may not fill the quota. In these cases all applications received after the February 1 will be evaluated on a case by case basis.

Section 3: Graduation Requirements

3.1 General Requirements

To graduate with the Bachelor of Science degree in Aerospace Engineering the student must complete a published curriculum in force at the time of entry or beyond. This curriculum consists of a distribution of required courses in English, mathematics, basic sciences, engineering sciences, and Aerospace Engineering. In addition to these required courses, each candidate must take approved Technical Electives and approved Humanities and Social Science Electives. The student must complete the required courses taken at KU with at least a 2.0/4.0 grade point average in all courses taken at KU as well as at least a 2.0/4.0 grade point average in all engineering courses taken at KU. The student must also take 30 hours of credit while enrolled in the KU School of Engineering.

Note: The curriculum is constantly under review by the faculty and may change during a four year period. For this reason a student can select any published program in effect from the time of his/her entry in the program to the program in effect at the time of graduation. The student should advise his/her adviser which program is to be used and then all the requirements listed in this published program must be satisfied.

3.2 Specific Requirements for BS Degree in Aerospace Engineering

The program requirements for students entering the program in the fall semester 2006 are detailed in Table 3.1. When students plan their course selections each semester they should be aware of two important facts: rigid prerequisites exist for each course. This is to assure students are adequately prepared to take a specific course. Second, the Aerospace courses listed in Table 3.1 are only offered once a year. Detailed descriptions of the Aerospace courses are given in Appendix B. Detailed descriptions of the other required courses can be found in the university's undergraduate catalog.

Table 3.2 presents the recommended 4-year sequence of courses. The prerequisite sequence is shown in Figure 3.1. This is the recommended sequence for students who are prepared to enter the program directly, and who are full-time students without other time consuming activities, e.g. part-time work, ROTC, intercollegiate sports, band, or other student activities. Many students who are involved in nonacademic, time-consuming activities take more than 4 years to graduate. A typical 5 year sequence of courses is given in Table 3.3 as a guide. Students who believe they may plan to take more than 4 years are strongly advised to discuss this with their adviser or the Department Chairman. Note that many courses may be taken in the summer either at KU or other universities and junior colleges.

3.3 Requirements for Enrollment in Junior Level Aerospace Courses

Enrollment in junior-level aerospace courses is limited to students who have received grades of C or higher in all first- and second-year courses in mathematics, physics, ME 312, CE 301, CE 310, AE 245, AE 345, and AE 445.

3.4 Mid-year Graduation

For students who would be eligible to graduate after 4 ½ years <u>except</u> that the second design course has not been completed, it is possible to substitute for the second design course, i.e., AE 522 or AE 523 or AE 524, in the fall semester. The substitution must not only be four hours but also must have four hours of design activity equivalent to the second design courses. The recommended substitution is AE 721 - Aircraft Design Laboratory I. Both the student's adviser and the department Chair must approve any other substitution. Students who plan to take these options and graduate in December are advised to discuss this with their adviser as soon as possible.

3.5 Credit / No Credit and Correspondence Courses

The department does not permit the use of any Credit/No Credit or Correspondence courses to fulfill degree requirements. This applies to courses taken at KU or at other institutions.

3.6 Dual Degrees

Some students, because of a broad interest or specific career plan, elect to pursue two Bachelors degrees simultaneously. In such cases the student must satisfy the requirements of both degrees. This must also involve an additional 30 hours of credit beyond the first degree. Because of the desire to minimize the time and effort of the student and due to the complexities involved, it is strongly recommended the student make his/her plans known to his/her adviser. In addition, the student should coordinate his/her program with an adviser from the second department.

3.7 Co-Enrollment in the BS and Graduate Programs

Often students, in the last semester of their BS program, will not have a full course load. These students can enroll in up to 6 hours of graduate courses that will count toward the Master of Science in Aerospace Engineering Degree. To be co-enrolled, the student must apply and be accepted in the graduate program. Also, the student must announce to both his/her adviser and the office of the Dean of Engineering which courses are to be used to complete the requirements for the BS and which courses should be counted toward the Master of Science degree.

3.8 Math / Science Option

The 3-hour Math/Science course requirement for students graduating <u>with a pre-2007 curriculum</u> may be satisfied by any mathematics or science course in a calculus-based 300- or above level course in Math or Science. Students considering taking the spacecraft design track should take PHSX 313, which is a prerequisite for AE 560 and AE 523.

Table 3.1

Effective: Oct. 31, 05

Required Courses for B.S. Degree in Aerospace Engineering

Engineering Courses

			Hours
AE	245	Intro to Aero Engineering	3
AE	290, 291	Aerospace Colloquium	2
AE	345	Fluid Mechanics	3
AE	360	Introduction to Astronautics	3
AE	421	Aero Computer Graphics	4
AE	430	Aero Instrumentation Lab	3
AE	445	Aircraft Aerodynamics & Performance	3
AE	507	Aerospace Structures I	3
AE	508	Aerospace Structures II	3
AE	510	Aero Materials & Processes	4
AE	521	Aero Systems Design I	4
AE	522	Aero Systems Design II	4
or			
AE	523	Spacecraft Design	
or			
AE	524	Propulsion System Design	
AE	545	Fundamentals of Aerodynamics	5
AE	550	Dynamics of Flight I	3
AE	551	Dynamics of Flight II	4
AE	571	Fundamentals of Aircraft Reciprocating Propulsion Systems	3
AE	572	Fundamentals of Jet Propulsion	3
AE	590	Aerospace Seminar	1
CPE	121	Introduction to Computers in Engineering	3
Or			
EECS	138	Introduction to Computing	
CE	301	Statics and Dynamics	5
CE	310	Strength of Materials	4
ME	312	Basic Engineering Thermodynamics	3
ECE	319	Circuits	4
		Sub-Total	77

Science and Mathematics Courses

CHEM	184	Foundations of Chemistry	5
PHYS	211	General Physics I	4
PHYS	212	General Physics II	4
MATH	121	Calculus I	5
MATH	122	Calculus II	5
MATH	220	Differential Equations	3
MATH	290	Linear Algebra	2
MATH	223	Vector Calculus	3
		Sub-Total	31

Other Required and Elective Courses

Written Communication (ENGL 101, 102)	6
An Economics course	3
Humanities and Social Science Electives	11
Technical Electives	9
Sub-Total	29
Grand Total	**137** hrs.

Table 3.2

Effective Oct. 31, 05

Recommended 4 Year Course Sequence for BS in Aerospace Engineering

Freshman

Fall Semesters				Spring Semesters			
MATH	121	Calculus I	5	MATH	122	Calculus II	5
ENGL	101	Composition	3	ENGL	102	Comp. & Lit.	3
CHEM	184	Chemistry I	5	PHSX	211	Physics I	4
AE	245	Intro. To Aerospace	3	H&SS		Electives	3
AE	290	Aero. Colloquium	0.2	CPE	121	Intro to Engr Compt	3
			16.2	or EECS	138	Intro to Computing	
				or AE	211	Basic MATLAB	
				AE	291	Aero. Colloquium	0.3
							18.3

Sophomore

Fall Semesters				Spring Semesters			
MATH	220	Differential Equations	3	AE	360	Intro to Astronautics	3
MATH	290	Linear Algebra	2	EECS	316	Circuits	3
CE	301	Statics & Dynamics	5	EECS	318	Circuits Lab	1
PHSX	212	Physics II	4	AE	445	Aerodynamics	3
AE	345	Fluid Mechanics	3	ME	312	Thermodynamics	3
AE	290	Aero. Colloquium	0.2	or CPE	221	Basic Engr Thermo	
			17.2	CE	310	Strength of Materials	4
				AE	291	Aero. Colloquium	0.3
							17.3

Junior

Fall Semesters				Spring Semesters			
AE	507	Aero. Structures I	3	AE	508	Aero Structures II	3
AE	550	Dyn. Of Flight I	3	AE	551	Dyn. Of Flight II	4
AE	571	Reciprocating Propulsion	3	AE	572	Jet Propulsion	3
AE	545	Aerodynamics	5	AE	421	Compt Graphics	4
Math	223	Vector Calculus	3	AE	430	Aero Instrumentation	3
AE	290	Aero. Colloquium	0.2	AE	291	Aero. Colloquium	0.3
			17.2				17.3

Senior

Fall Semesters				Spring Semesters			
AE	521	Aircraft Design I	4	AE	522/3/4	Design II	4
AE	510	Materials & Manuf.	4	TE/H&SS		Electives	12
TE/H&SS		Electives	9	AE	291	Aero. Colloquium	0.3
AE	590	Senior Seminar	1				16.3
AE	290	Aero. Colloquium	0.2				
			18.2				

*Additional Requirements
Humanities and Social Science Requirements:14 hours including an Economics course, one humanity & one Social Science and two courses in one department. Technical Elective Requirements: **9** hours including one Aerospace Engineering Course-

Table 3.3

Recommended 5 Year Course Sequence for BS in Aerospace Engineering

	Fall Semester				Spring Semester		
Year 1							
MATH	121	Calculus I	5	MATH	122	Calculus II	5
ENGL	101	Composition	3	ENGL	102	Comp. & Lit.	3
H&SS		Electives	3	PHSX	211	Physics I	4
AE	245	Intro To Aerospace	3	AE	291	Aero. Colloquium	0.3
AE	290	Aero. Colloquium	0.2				12.3
			14.2				
Year 2							
MATH	220	Differential Equations	3	AE	360	Intro to Astronautics	3
MATH	290	Linear Algebra	2	EECS	316	Circuits	3
CE	301	Statics & Dynamics	5	EECS	318	Circuits Lab	1
PHSX	212	Physics II	4	CE	310	Strength of Materials	4
AE	290	Aero. Colloquium	0.2	CPE	121	Intro to Engr Compt	3
			14.2	or EECS	138	Intro to Computing	
				or AE	211	Basic MATLAB	
				AE	291	Aero. Colloquium	0.3
							14.3
Year 3							
AE	345	Fluid Mechanics	3	AE	445	Aerodynamics	3
AE	507	Aero Structures	3	AE	508	Aero Structures II	3
MATH	223	Vector Calculus	3	ME	312	Thermodynamics	3
CHEM	184	Chem I	5	or CPE	221	Basic Engr Thermo	
AE	290	Aero. Colloquium	0.2	AE	430	Aero Instrumentation	3
			14.2	AE	291	Aero. Colloquium	0.3
							12.3
Year 4							
AE	550	Dyn. Of Flight I	3	AE	551	Dyn. Of Flight II	4
AE	571	Reciprocating Propulsion	3	AE	572	Jet Propulsion	3
AE	545	Aerodynamics	5	AE	421	Computer Graphics	4
H&SS		Electives	3	H&SS		Electives	3
AE	290	Aero. Colloquium	0.2	AE	291	Aero. Colloquium	0.3
			14.2				14.3
Year 5							
AE	521	Aircraft Design I	4	AE	522/3/4	Design II	4
AE	510	Materials & Manuf.	4	TE		Electives	6
H&SS		Electives	3	H&SS		Electives	3
TE		Electives	3				14
AE	590	Senior Seminar	1				
			15				

*Additional Requirements:
Humanities & Social Science Requirements: 14 hours including an Economics course, one Humanity & one Social Science and two courses in one department.
Technical Electives Requirements: **9** hours including at least one Aerospace Engineering course.

**Students in the Spacecraft Design track (AE 560 and 523) must take PHSX 313, Physics III.

Section 4: Humanities and Social Science Electives

4.1 Purpose and Requirements

The purpose of the Humanities and Social Science Electives (H&SS) is indicated by the following statement taken from the Accreditation Board for Engineering and Technology's 2000 criteria for accrediting programs in engineering which states:

In the interest of making engineers fully aware of their social responsibilities and better able to consider related factors in the decision-making process, institutions must require coursework in the humanities and social sciences as an integral part of the engineering program. This philosophy cannot be overemphasized. To satisfy this requirement, the courses selected must provide both breadth and depth and not be limited to a selection of unrelated introductory courses.

This is accomplished by requiring that students take 14 hours of Humanities and Social Science courses offered by the College of Liberal Arts and Sciences. In the 14 required hours of courses, the student is required to take an Economics course, at least one course designated as a humanity, and at least two courses in one department.

4.2 Catalog and Timetable Codes

To assist students in satisfying the H&SS requirements a code has been established and indicated for each course in both the university catalog and the timetable. This code is:

- H: Humanities
- N: Natural Sciences and Mathematics
- S: Social Sciences
- U: Course does not satisfy a distribution requirement
- W: World Civilization

4.3 Typical H&SS Electives

To assist the student in selecting courses that satisfy the H&SS requirements, Table 4.1 presents a list of courses which have been approved by the department. Students are not limited to taking courses from this list, see section 4.5.

4.4 Foreign Languages

Up to 6 hours of non-native foreign language courses can be used to satisfy the H&SS requirement.

4.5 Course Substitution Petition

If a student wants to take a course, not listed in Table 4.1, the student needs the approval of his/her adviser and must document this by filing a Course Substitution Petition with the department secretary, signed by his/her adviser. This form will be filed in the student's academic folder.

Table 4.1 Approved Humanities & Social Science Electives

Approved Humanities and Social Science Courses

The following contains a list of approved H&SS elective grouped into topic areas. Students do not have to stay within a topic area, but can form their own set of electives. Courses marked with (*) are humanities.

Area Studies (East Asia)

EALC	105	Living Religions of the East
EALC	106	Understanding China and Japan
EALC	364	People of Japan and Korea
*HIST	118	China and Japan
*HIST	586	Modern China
*HIST	589	Modern Japan
*HIST	595	Business and Industry in Japan

Area Studies (Latin America)

ANTH	382	Peoples of South America
ANTH	386	Folk Cultures of Latin America
GEOG	591	Geography of Latin America
*HIST	120	Colonial Latin America
*HIST	121	Modern Latin America
*HIST	572	South America in the 20th Century
*HIST	573	Latin America in the 19th Century
*HIST	575	History of Mexico
*HIST	576	History of Central America

Business and the Economy

ECON	520	Microeconomics
ECON	522	Macroeconomics
ECON	640	Labor Economics
*PHIL	360	Moral Issues in Business
SOC	525	Sociology of the Economy
SOC	526	Industrial Sociology
*HIST	651	History of American Business

Communications

*LING	104	The Nature of Language
*LING	312	Introductory to Phonology
*LING	320	Language in Culture and Society
COMS	238	Cases in Persuasion
COMS	330	Effective Business Communications
COMS	331	Persuasive Speaking
COMS	548	Theories of the Interview
JOUR	104	Communications in Society

Table 4.1 Approved Humanities & Social Science Electives (Continued)

Energy Resources and the Environment

ECON	510	Energy Economics
ECON	610	Resource Economics and Environmental Policy
*PHIL	152	Introduction to the Logic of Science

Government

POLS	150	Introduction to Comparative Politics
POLS	501	Contemporary Political Thought
SOC	340	The Community
*HIST	128	History of the United States through the Civil War
*HIST	129	History of the United States since the Civil War

The Individual

*PHIL	140	Introduction to Philosophy
*PHIL	160	Introduction to Ethics
*PHIL	670	Contemporary Ethics Theory
PSYC	104	General Psychology
PSYC	406	Individual Differences
PSYC	318	Cognitive Psychology
PSYC	590	Nonverbal Communication
PSYC	685	Human Factors Psychology

Minorities

AFS	104	The Peoples of Africa
AFS	106	The Black Experience in America
AFS	332	Introduction to African Literature
AMS	522	American Racial and Ethnic Relations
ANTH	378 Indians	Contemporary North American
*ENGL	574	Black American Literature
*HIST	260	Growth of African Civilization I
*HIST	619	History of the American Indian
SOC	534	Comparative Racial and Ethnic Relations

Religion

AMS	290	Varieties of Religious Experience in America: Past and Present
*CLSX	148	Greek and Roman Mythology
*HIST	373	The Supreme Court and Religious Issues in the United States
*HIST	522	The Age of Religious Wars 1540-1648
*PHIL	350	Philosophical Issues in Religion
*PYYC	104	General Psychology
*REL	171	Religion in American Society
*REL	339	History of Religion in America

*REL	485	New Religious Movements

Table 4.1 Approved Humanities & Social Science Electives (Continued)

Science

*HIST	404	Technology: Its Past and Future
*HIST	407	History of Science in the United States
*HUM	510	Science, Technology, and Society
SOC	622	Sociology of Science

Society

SOC	104	Elements of Society
SOC	130	Comparative Societies
SOC	320	Introduction to Social Organization
PSYC	360	Social Psychology
PSYC	492	Psychology and Social Issues
SOC	341	Urban Sociology
PSYC	570	Group Dynamics
*HIST	128	History of the United States Through the Civil War

General

*HIST	128	History of the United States Through the Civil War
*HIST	129	History of the United States Since the Civil War
*HIST	651	History of American Business
PSYC	104	General Psychology
*PHIL	140	Introduction to Philosophy
*PHIL	160	Introduction to Ethics

Section 5: Technical Electives

5.1 Purpose

The purpose of the Technical Elective courses is to allow the student to select advanced courses in one or more areas that are of special interest. Each student must take at least 9 hours of Technical Electives of which a minimum of 3 hours must be Aerospace Engineering courses. The satisfaction of this requirement can be accomplished by several methods as listed below.

5.2 Approved Technical Electives

Table 5.1 lists courses that have been reviewed by the Aerospace Faculty and are approved for use as Technical Electives. A maximum of 3 hours of AE 592 can be used as a technical elective. The student is responsible for either verifying that all prerequisites are satisfied or that permission is received from the instructor. The student should be aware that not all the courses listed in Table 5.1 are available each semester. For detailed descriptions of the Aerospace Engineering courses see the Department's Graduate Handbook. For other courses see the Graduate Catalog.

5.3 Focus Area

The department recognizes, however, that some students would like to focus their technical electives on one aspect of aerospace engineering. To help students select their technical electives, the department has compiled lists of appropriate courses that would form focus areas. Table 5.2 contains recommended courses for focus area in Aerodynamics, Propulsion, Structures, Flight Dynamics and Control, Vehicle Design, Astronautics, and Manufacturing. It is also possible for a student, working with an adviser, to create other focus areas.

5.4 Course Substitution Petition

If a student wants to take a course, not listed in Table 5.1, as a Technical Elective, the student needs the approval of his/her adviser and must document this by filing a Course Substitution Petition with the department secretary, signed by his/her adviser. This form will be filed in the student's academic folder.

5.5 Reserve Officer's Training Corps (ROTC)

A student enrolled in one of the ROTC programs can receive 5 hours of Technical Electives credit if the ROTC program is completed. If the student does not complete the ROTC program, no Technical Elective credits are awarded. Students in ROTC may not use flight training courses (AE 241 and 441 or AE 592) to satisfy Tech Elective requirements.

5.6 Mathematics Minor

A student needs to take 3 courses more than those required for the AE BS degree. Therefore a student who elects to take 6 hours of Mathematics as a Technical Elective would only need one extra Mathematics course beyond the AE BS degree.

Table 5.1 Approved Technical Electives

The following courses are approved as Technical Electives for the BS program.

AEROSPACE ENGINEERING

AE	241	Private Flight Course*	1
AE	441	Advanced Flight Training*	1-3
AE	560	Spacecraft Systems	3
AE	592	Special Projects in Aerospace Engineering	1-3
AE	701	Structural Design	3
AE	704	Dynamics and Vibrations	3
AE	705	Structural Vibrations and Modal Testing	4
AE	707	Aerospace Structural Loads	3
AE	708	Aerospace Structures III	3
AE	709	Structural Composites	3
AE	710	Adv. Structural composites	3
AE	712	Techniques of Engineering Evaluation	3
AE	721	Aircraft Design Laboratory I	4
AE	722	Aircraft Design Laboratory II	4
AE	724	Propulsion System Design & Integration	3
AE	725	Numerical Optimization & Structural Design	3
AE	730	Advanced Experimental Fluid Dynamics	3
AE	731	Supersonic Aerodynamics Laboratory	1
AE	732	Flight Test Principles & Practice	3
AE	743	Compressible Aerodynamics	3
AE	745	Applied Wing and Airfoil Theory	3
AE	746	Computational Fluid Dynamics	3
AE	748	Helicopter Aerodynamics	3
AE	750	Applied Optimal Control	3
AE	751	Advanced Airplane Dynamics	2
AE	753	Digital Flight Controls	3
AE	754	Missile Dynamics	3
AE	760	Spacecraft Systems	3
AE	765	Orbital Mechanics	3
AE	766	Spacecraft Attitude Dynamics and Control	3
AE	767	Spacecraft Environments	3
AE	771	Rocket Propulsion	3
AE	772	Fluid Mechanics of Turbomachinery	3
AE	790	Special Problems in Aerospace Engineering	1-3

* Will not count as a Technical Elective for ROTC students

MATHEMATICS

MATH	526	Applied Mathematical Statistics I	3
MATH	527	Applied Mathematical Statistics II	3
MATH	542	Vector Analysis	2
MATH	590	Linear Algebra	3
MATH	627	Probability	3
MATH	628	Mathematical Theory of Statistics	3
MATH	646	Complex Variables and Applications	3

Table 5.1 Approved Technical Electives (Continued)

MATH	647	Applied Partial Differential Equations	3
MATH	648	Calculus of Variations	3
MATH	781	Numerical Analysis I	3
CIVIL ENGINEERING			
CE	710	Structural Mechanics	3
CE	721	Experimental Stress Analysis	3
CE	767	Introduction to Fracture Mechanics	3
ELECTRICAL ENGINEERING and COMPUTER SCIENCE			
EECS	360	Signal Analysis	3
EECS	461	Probabilistic Analysis	3
EECS	562	Intro to Communication Systems	4
MECHANICAL ENGINEERING			
ME	508	Numerical Analysis of Mech Engr Problems	3
ME	612	Heat Transfer	3
ME	708	Intro. To Microcomputer Applications	2
ME	731	Convective Heat and Momentum Transfer	3
ME	742	Machine Stress Analysis	3
ME	761	Theory of Finite Element Method	3
ME	770	Conductive Heat Transfer	3
ME	774	Radiative Heat Transfer	3

Table 5.2 Recommended Focus Area Courses

I. Aerodynamics Focus - Coordinators Lan & Farokhi

AE	712	Techniques of Engineering Evaluation
AE	730	Advanced Experimental Fluid Dynamics
AE	743	Compressible Aerodynamics
AE	745	Applied Wing & Airfoil Theory
AE	746	Computational Fluid Dynamics
AE	748	Helicopter Aerodynamics
AE	772	Fluid Dynamics of Turbomachinery
AE	840	Aerodynamics of Viscous Fluids
AE	845	Advance Computational Aerodynamics
AE	941	Hypersonic Aerodynamics I
MATH	646	Complex Variables
MATH	647	Applied Partial Differential Equations
MATH	781	Numerical Analysis I

II. Structures Focus - Coordinators Ewing & Hale

AE	704	Dynamics and Vibration
AE	705	Structural Vibration and Modal Testing
AE	709	Structural Composites
AE	725	Numerical Optimization and Structural Design
MATH	590	Linear Algebra
MATH	646	Complex Variables
MATH	647	Applied Partial Differential Equations
MATH	648	Calculus of Variations
AE	803	Aeroelasticity

III. Propulsion Focus (Farokhi & Taghavi)

AE	524	Propulsion Systems Design
AE	771	Rocket Propulsion
AE	772	Fluid Mechanics of Turbomachinery
ME	612	Heat Transfer
MATH	646	Complex Variables
MATH	647	Applied Partial Differential Equations
MATH	781	Numerical Analysis I

IV. Dynamics & Control Focus - Coordinators Downing & Colgren

AE	750	Applied Optimal Control
AE	751	Advanced Airplane Dynamics
AE	753	Digital Flight Controls
AE	754	Missile Dynamics
AE	766	Spacecraft Attitude Dynamics and Control
MATH	590	Linear Algebra

Table 5.2 Recommended Focus Area Courses (continued)

MATH	627	Probability
MATH	646	Complex Variables
MATH	648	Calculus of Variations

V. Configuration Design Focus - Coordinator Colgren

AE	522	Aero Systems Design II
AE	721	Aircraft Design Laboratory I
AE	722	Aircraft Design Laboratory II

VI. Manufacturing Focus - Coordinator Hale

ME	607	Computer Aided Manufacturing
ME	528	Mechanical Design IB (follow-on to ME 428~ AE 510)
ME	627	Automotive Design & Manufacturing
ME	706	Industrial Robotics
MATH	627	Probability
MATH	628	Statistics
BUS	637	Advanced Statistics
BUS	704	Total Quality Management
BUS	719	Operations Management

VII. Astronautics Focus - Coordinator Trevor Sorensen

AE	523	Spacecraft Design
AE	560	Spacecraft System
AE	760	Spacecraft System
AE	765	Orbital Mechanics
AE	766	Spacecraft Attitude Dynamics and Control
AE	767	Spacecraft Environments
AE	771	Rocket Propulsion
GEOG	526	Remote Sensing
GEOG	726	Remote Sensing
EECS	360	Signal Analysis
EECS	461	Probabilistic Analysis
EECS	562	Introduction to Communication Systems
MATH	627	Probability
MATH	628	Mathematical Theory of Statistics

Section 6: Department Research and Facilities

6.1 Introduction

All faculty members are active in funded and unfunded research. If a student is interested in becoming involved in research he/she should contact the appropriate faculty member. Undergraduate students can receive academic credit for research performed by enrollment in AE 592 Special Projects in Aerospace Engineering.

6.2 Research Facilities

Each Student during his/her career in the department will have the opportunity to work with a broad range of experimental equipment as well as modern computer software packages. This equipment and the faculty coordinator are listed below.

6.2.1 On-Campus Facilities

Aerodynamics/Fluid Dynamics Laboratories

The Closed Circuit Subsonic Wind Tunnel, shown on the left, has a 36" by 51" test section and a maximum speed of 200 mph. This tunnel is equipped with a six-component strain-gauged balance and computerized data acquisition system. The Department's laser Doppler velocimeter and hot-wire anemometer can be used in this tunnel. Flow visualization techniques include a laser light sheet, smoke, helium bubbles, and surface oil streak-line methods. A computerized, two-axis traversing system is available for flow field mapping. The test section and operator's station is located in Room 1180 of Learned Hall. Coordinator: S. Farokhi

The Open Circuit Subsonic Wind Tunnel has a 21" by 30" test section and a maximum speed of 120 mph. This tunnel is useful for fundamental fluid mechanics experiments due to its low turbulence factor. The Department's laser Doppler velocimeter, hot wire anemometer, and helium bubble system can be used in this tunnel. Coordinator: D. Downing

The Supersonic Wind Tunnel, pictured on the right, has a 2" by 3¼" test section with a Mach number range of 1.5 to 3.0. The tunnel is a blow-down type equipped with a Schlieren system and pressure measurements. This tunnel is located in Room 1180, Learned Hall. Coordinator: S. Farokhi

The Water Tunnel has a 60' long open channel, 29" wide and 34" deep. Water is pumped to the channel at a rate of 1500 gal/min. The maximum water speed is about 1 ft/sec. This facility is mainly used for flow visualization purposes by using dye injection around models. The water tunnel is located in Room 1161, Learned Hall and is shared with the Department of Civil Engineering. Coordinator: R. Taghavi

Propulsion Laboratory

The Mal Harned Propulsion Laboratory consists of a test cell capable of testing gas turbine engines up to 8,000 pounds of thrust, as well as reciprocating engines. The control room is equipped with basic engine testing instrumentation. This facility is located in the Department's hangar at Lawrence Airport. Coordinator: R. Taghavi

The Structural Dynamics and Acoustics Laboratory consists of a modal test system, an acoustics data acquisition system and a structural control system, located in Nichols Hall.

The Modal Test System is used to determine the vibratory “signature” of structures using vibration data from various sensors, including piezoceramic accelerometers. For example, the signature, or modal characteristics, of an aircraft component may be determined in order to properly design a control system or prevent aerodynamic flutter. The system is based on a PC with a 32-channel analog-to-digital board. Vibration excitation is provided by both an electrodynamic shaker and a modal hammer. Coordinator: M. Ewing

The Acoustical Data Acquisition System is used to measure sound in support of structural acoustics research. The system is based on a PC with a 32-channel analog-to-digital board. Coordinator: M. Ewing

The Structural Control System is used to provide positional and vibrational control of a flexible structure. Current research is focused on controlling flexible space structures. The system is based on a 486 PC with a 32-channel analog-to-digital board. The computer controls actuators, including a linear stepper motor, via a precision power amplifier. Coordinator: M. Ewing

Mechanical Testing Facilities

Mechanical Testing Facilities are shared with the Departments of Mechanical and Civil Engineering. These facilities provide testing capabilities for articles ranging from material coupons to large-scale structures. Available test equipment includes 222 kN and 89 kN MTS servo-hydraulic test machines, a 489 kN Instron servo-hydraulic test machine, 267 kN and 107kN Baldwin hydraulic test machines and instrumentation including extensometers, load cells, strain gages and digital data acquisition systems. Additional equipment for experimental stress analysis includes a reflection polariscope and a portable four beam Moiré interferometer.

Composites Materials Laboratory

The Composites Materials Laboratory is a shared facility with the Department of Mechanical Engineering. The composite lay-up facility is a 40 m2 "clean" room with a 6 m2 lay-up table and 1.3 m3 of -30° C material cold storage. The composite tooling and processing laboratory encompasses 50 m2, and contains a radial diamond saw, 17.8 cm diamond blade precision sectioning saw, 22.9 cm abrasive cutter, two hydraulic specimen mounting presses, orbital and vibrating polishers and a microhardness tester. Sample inspection and documentation is aided with a Nikon Epiphot inverted reflected light photomicroscope capable of magnification to 1000X, with Polaroid and 35mm film or digital video capture. Composite manufacturing equipment includes a filament winding machine and an electronically controlled filament plate winder. The composite curing facility encompasses 140 m2 and includes an autoclave for curing thermoset and thermoplastic composite materials, 107 kN and 667 kN electrically heated water cooled platen presses, and electronically controlled ovens. The autoclave is rated to 2.4 MPa and 370° C and has a usable space of 30x30x91 cm. The small oven is rated to 370° C and has a usable space of 51x51x46 cm. The composite materials laboratory also houses an electronically controlled walk-in curing oven capable of 260° C, with a usable space of 1.5x1.8x3.0 m.

Textile weaving is enabled by a 122 cm Macomer twenty-harness computer driven dobby loom. Fiber placement capability is provided with four robotic arms. Equipment includes a five-axis ASEA IRB 6 industrial robot with a payload of 6.0 kg, a six-axis Intellidex 605 table mounted robot with a payload of 5.4 kg, and two seven-axis Intellidex 705 floor mounted robots with a payload of 5.4 kg each. The ASEA has a maximum reach of 1.2 m, with a base rotation of 340°, a shoulder rotation of 80°, an elbow rotation of 65°, wrist rotation of ±90°, and a tool spin of ±180°. The Intellidex machines have a reach of 0.7-1.5 m, a large shoulder and forearm rotation of ±135º, a small shoulder and upper arm rotation of ±115º, an outboard axis rotation of ±170º, and a tool spin axis rotation of a full 360º. Coordinator: R. Hale

Nondestructive Evaluation Laboratory

The nondestructive evaluation laboratory is a shared facility with the Department of Civil Engineering. Available equipment includes a SONIX CSF1000-3X digital 3-axis automated immersion ultrasonic scanning system (pictured at left) with capabilities for A-scan, B-scan and C-scan testing in through-transmission or pulse-echo mode. Current equipment provides a scanning envelope of 0.8x0.9x1.2 m. In addition, the laboratory houses a combination digital acoustic emission acquisition and analysis, and low frequency ultrasonic generation, acquisition and analysis system. Acoustic emission and ultrasonic inspection capabilities are enhanced by state of the art data acquisition software running on PC workstations. Finally, the laboratory has an ultrasonic flaw detector. These systems are used for laboratory and field-testing and inspection of materials and structures. Coordinators: R. Hale and G. Ramirez

The Department of Civil Engineering also provides access to the Engineering Microanalysis Laboratory, which equipped with a Philips 515 Scanning Electron Microscope, an ELMDAS Digital Image Acquisition System, and an EDAX PV-9900 Energy Dispersive Spectrometer with light element capability. Specimens are coated using a Technics Hummer X Sputter Coater. Coordinator: D. Darwin

Instrumentation Laboratory

The Instrumentation Laboratory is equipped with basic electronic and measurement instrumentation. The Department's laser Doppler velocimeter, hot wire anemometer, and flow visualization equipment is located in this laboratory. This facility is located in Room 1152 Learned Hall. Coordinator: Ray Taghavi

Design Laboratory

The Aerospace Vehicle Design Laboratory consists of a general work area equipped with PC and work station computer terminals and printers. Specialized software design packages (interactive computer-aided design programs - ACAD, and Advanced Airplane Analysis programs - AAA) are resident on the laboratory's computers. Coordinator: M. Ewing

Section 7: Professionalism

7.1 Introduction

When entering the BS program in Aerospace Engineering you are choosing to prepare for a profession. An individual who receives a BS in Engineering is considered a professional and is prepared to enter and practice the profession. As with all professions, you will be entitled to the honors and privileges associated with the profession as well as the responsibilities associated with that profession.

The honors associated with being a graduate engineer include receiving the publics respect and trust, the financial rewards, and the eligibility to join professional societies. The responsibilities include the providing of fair, equitable, and competent services to the society. It is important you be aware of these responsibilities and start to incorporate them into your everyday method of operation and your being.

In the remainder of Section 7 you will find a discussion of ethics, professional literature, professional student activities, and two articles containing advice from experienced engineers.

7.2 Ethics

All professions have published a Code of Ethics which governs the conduct of individuals in that profession. These codes are established by professional societies. These rules of conduct are especially important when the public safety is at stake. Society, including you, depends on professionals following these rules. For example, when you enter a building or cross a bridge you assume the engineers who designed and built these structures were ethical and competent in their jobs. The same is expected by members of society when they fly on an airliner. The Code of Ethics established by the **AIAA** is reproduced in Appendix D.

It is also important to recognize that it is not enough to follow the Codes of Ethics, when you graduate. You need to start to be ethical during your studies.

A very Serious Ethical Issue is Cheating.

It is the policy of the department to severely punish cheating in exams, quizzes, laboratory work and other assignments which are part of the Aerospace Engineering curriculum. Laboratory reports must be prepared independently by each student. Students should be aware of the following consequences.

1. **A student caught cheating once will receive an F for that assignment or class.**
2. **A student caught cheating twice will be expelled from the school.**

If a student has questions as to whether a particular activity would be considered cheating, he or she should have the issue clarified by the professor before proceeding with the activity.

7.3 Professional Student Activities

In any profession, the true professional becomes active in one or more professional societies. For the aerospace engineering profession, the professional societies are the American Institute of Aeronautics and Astronautics (AIAA) and the Society of Automotive Engineers (SAE). Every aerospace engineering student should, to enhance his own career, join at least one of these societies. The AIAA has an active student branch on campus, and in Wichita, KS. The SAE has active branches in Kansas City, MO and in Wichita, KS.

7.4 Reference Literature

One of the most fundamental ethical requirements is that the individual does everything possible to be competent. One way to accomplish this is to continue to keep current in the state-of-the-art. One element to this is to read the standard aerospace publications. The following is a list of standard aerospace publications:

1. American Institute of Aeronautics and Astronautics publications.

    A. AIAA Journal
    B. Journal of Aircraft
    C. Journal of Spacecraft and Rockets
    D. AIAA Student Journal
    E. Journal of Propulsion and Power
    F. Aerospace America*
    G. Journal of Guidance, Control and Dynamics
2. Aviation Week and Space Technology (U.S., weekly)*
3. Aircraft Engineering (British, monthly)
4. Jane's All The World Aircraft (British, annual)
5. Flight International (British, weekly)
6. World Aviation Directory
7. Business and Commercial Aviation (U.S., monthly)
8. American Society of Mechanical Engineers
    A. Journal of Fluids Engineers
    B. Journal of Gas Turbines?
    C. Journal of Turbomachinery
    D. Journal of Heat Transfer
9. Space News (weekly)
10. American Astronautical Society
    A. Space Times
    B. Journal of Astronautical Sciences

* Copies are kept for faculty and student reference in the Department Office, 2120 Learned Hall.
Students are encouraged to read any or all of the magazines in this list regularly.
Preferably, a student should take out a personal subscription to one of these magazines.

7.5 Words of Wisdom from Experienced Engineers

Finally, it is important to learn from experienced engineers. The first is by R.B. Holloway of the Boeing Company, and the second is an article published in the AIAA student Journal by David Kohlman. The thoughts presented in these articles reflect the philosophy of the faculty of the Aerospace Engineering Department.

WHAT ENGINEERS NEED TO KNOW BESIDES ENGINEERING: A PROFESSIONAL'S ADVICE

Richard B. Holloway
The Boeing Company
Wichita, Kansas

Your first contact with a prospective employer is usually either through an interview or an application for employment. Quite often this application form is all we in industry ever have on which to base our evaluation of a prospective engineer. Therefore, it is very important that these forms be filled out carefully and completely. Nearly always the student tends to complete an application too rapidly. Think what kind of an impression you make on your prospective employer if words are misspelled.

I must point out that of all the characteristics that are included on an application the single one that is looked at most carefully is your grade point average. We are not necessarily after the bookworm student who makes straight A's, although such a student probably has the technical expertise we may be seeking. Most of all, we want persons who have actively participated in extracurricular activities, are good speakers and writers, who are personable and get along well with others, and who have at the same time achieved reasonable academic credentials.

When you are considering where to apply for employment, I would urge you to consider the total job rather than just the salary. By this I mean, take a very careful look at the company's background, history, and long-term prospects. Don't sacrifice a long-term career advantage for a short-term dollar gain. After all it is the area under the salary-time-history curve that counts.

To make a good impression on your boss or on anyone who is interviewing you, you should know something of the significant history and developments in your field. That is, who were the pioneers and what did they do? For example, I would expect an engineer applying for employment on the aerodynamics staff to know what the Karman-Tsien equation is, and who Von Karman and Tsien were. If your professors don't give this type of historical perspective to you, I don't feel they are doing their job. Of course, there is nothing to keep you from digging it out yourself, and you will enjoy doing it. Another thing which may prove helpful in the future is the name of the authors of your textbooks. If you are using Mr. X's textbook you had better know his name, so that you can blame him for your lack of knowledge at a later date!

Now I want to discuss some of the factors which are important in your career as a young engineer after you are hired.

Responsibility and Challenge

You should do your best to develop a good personal attitude and a broad sense of responsibility to your employer, to your profession, to your associates and to the public. By this I mean that you are a professional, and you should act like one. Be proud to be an engineer. When asked what you do for a living, don't say I Work for XYZ. Company. Say instead, I am an engineer for the XYZ Company. I strongly suggest that you read and understand the ECPD Canon of Ethics for Engineers. It provides a good interpretation of the high standard of personal integrity that is required of a professional engineer.

Responsibility is made of many small things which used to be called a gentleman's characteristics, e.g., punctuality. Don't be late to the boss's meeting; don't overstay lunch without good reason. In other words, deliver an honest days work for a days pay.

Don’t assume that because a problem is not your specialty, it is not your responsibility. It is easy to say it’s not my job to worry about that. It may not be--but it is your responsibility to make sure that someone is worrying about that problem. This requires going out of your way to communicate--a subject so important that I will return to it several times in this discussion. A modern trend in engineering is toward many interdisciplinary types of study and effort. The day of strict subject specialization may be gone and we may soon find the biggest demand is for those engineers who can find their way around in several allied fields.

Young engineers usually want to work on something new and sensational, because that is where they feel the greatest challenge lies. They especially would like to preliminary design work, because in exciting movies they have seen someone making sketches on paper that suddenly appear as the real article.

Change in engineering is inevitable. By this I mean that nearly every engineer will at some time be asked to pull up stakes and move to another location. He will be asked to change his field of endeavor. He may be asked to drop a project overnight that he has worked on for several years and to start a new project. He will be asked to learn new techniques, to abandon old prejudices and biases, to work with new people and in new environments. This requires continuous learning. Change is inevitable and provides a challenge in our profession which is rarely equaled in any other. The young engineer should look forward to this adventure.

Engineering and Common Sense

You should be fully aware that engineering is a science of approximation. Don’t be misled by digital computer answers out to the 10th decimal place. Never forget that the compute answer is only as good as the computer inputs, and don’t try to draw a 6H line through 2B data. Never use a complex method to get an answer if a simple one will do and don’t expect a precise answer to every problem. They are disillusioned to learn in practice that there are nearly always several satisfactory answers to every problem and the choice of which one is finally utilized often depends on things beyond the control of the engineer, such as cost or timing. Practically every engineering problem today must be presented in terms of alternatives, and the expression “Trade” Study is a very common one in industry today.

Another problem is the occasional young engineer who is misled by theory and so does not obey his common sense. For example, the load factor of an airplane in level flight is supposed to be inversely proportional to the cosine of the bank angle. This theoretical expression shows that for a bank angle of 90o bank angle the airplane is going to lose altitude because the lift vector no longer has a vertical component, and therefore the airplane is no longer in level flight. This is a simple example of an equation that no longer applies. This sort of problem is much tougher when the application is more subtle. You should always try to keep in mind the limitations of any theoretical expressions you are applying.

An incident I recall involves a study we were doing once using a DC-3 for low-speed single-engine flight. In order to conduct and analog computer study to supplement the flight test work, we needed the stability derivatives of the DC-3. We called upon an engineer at the Douglas Company and asked him if we could have a set of stability derivatives for the DC-3. He told us, “Sonny, when the DC-3 was built, stability derivatives had not even been invented.” This is just another example of the fact that you can build a pretty good flying machine with very little complex theory, and I sometimes wonder today if we aren’t making a 100 X 100 matrix analysis an end in itself rather than a tool of engineering.

Personal Records

In doing your personal work you should always date every page and put your initials in the corner. Note for whom the information is being prepared. You should establish a personal file of all the programs on which you work and keep careful notes. When you make a significant decision, and you will make many, write down the reasons. First of all, someone else may have to take over your work in case you get hit by a truck. Second, you may be required to defend your work many years later. Legal problems involved in aircraft and automobile accidents today may eventually require individual engineers to provide a defense in court of their actions in the design of that aircraft or automobile. Many companies take each engineer's work sheets and bind them into data books which are property of the company forevermore. After all, the company for which you work has paid for the information and it rightfully belongs to them. Your boss has every right to be very, very unhappy with you if you tell them that you threw away the handwork, which you did to come up with an engineering answer.

One of the areas in which young engineers are traditionally weak is writing. Much engineering data eventually is presented in the form of a technical report. The most common mistake that a young engineer makes in writing a technical report is in assuming that the reader knows as much about the subject as the writer does. This is very seldom true, and frankly, rarely does the reader want to know as much about it as the writer does. In writing a report, consider first what the information if going to be used for. Consider to whom it is addressed and who will be using it. Organize it to make it easy for the reader--not for the writer. You should always write so that the chief engineer can understand it without having to ask questions. He wants to be able to assimilate the few really important conclusions of your work and he does not have time to understand every little detail.

Your boss will probably mark up your first reports pretty badly. He does not do this to criticize you, but only because he wants to improve the report. Think of this type of correction in the same manner you accept the classwork your professor's grade and you will get along all right. Any engineer can become a good writer if he will work at it.

Graphs, Lettering, and Scales

Many people, usually mathematicians, claim that mathematics if the language of engineering, but in most cases the results of mathematical manipulation is presented as graphs. Hence, graphs may be considered the language of engineering. Learn how to make good graphs. Good line work is necessary, and good lettering is essential. Graphs on which the words are typed are merely an indication that the engineer who drew the graph cannot letter. Organize your graph so that you have plenty of room to put in descriptive notes. You should select a title that proves some useful information. Never label a graph by its coordinates. That is, your boss does not want to see a plot of X vs. Y which has in the title block X vs. Y. You cannot expect him to understand the significance of The X vs. Y unless you have a good, carefully worded title to tell him what it is.

The selection of scales for graphs is quite often an area where engineers get into trouble. The scale selection rules on the accompanying chart will keep you out of trouble. Even if you forget these rules, here again common sense is all you really need.

Learn to Communicate

Learn to express yourself simply and clearly. I knew a chief engineer who quite often asked for one-minute lectures on fairly complex subjects and if the expositor could not provide it, the chief's comment was, "Well, evidently you do not understand it very well yourself." You should be aware that there are one-minute explanations, one-hour explanations, and one-week explanations, and know how to handle each. You must learn to speak effectively because much engineering time these days is spent in making talks and presentations. For better or for worse, the flip chart has become a way of life in most engineering organizations.

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Your boss will probably mark up your first reports pretty badly. He does not do this to criticize you, but only because he wants to improve the report. Think of this type of correction in the same manner you accept the class work your professors grade and you will get along all right. Any engineer can become a good writer if he will work at it.

One of my pet peeves is the introduction of fancy nomenclature and acronyms. Sometimes I think programs have been sold mainly on the basis of having a clever catch title rather than having any valid technical content. It is not safe to assume that the chief engineer is going to understand or adopt a fancy acronym that you work up to express some subject. If you introduce nonstandard nomenclature, you run the risk of being misunderstood. Define your nomenclature very carefully, and if you must introduce an acronym, make it logical.

Mistakes in Your Early Career

A young engineer must learn not to be afraid to admit that he made a mistake. When you make a mistake, make haste to let it be known--you may save someone’s life. You note that I say “when you make a mistake” not “if you make a mistake”, because assuredly you will make mistakes--we all do. It is always better to have a mistake pointed out as quickly as it is discovered rather than have it lie dormant and come back to haunt you years later.

Sometimes young engineers get discouraged on their first job because they are asked to perform work which seems simple and unchallenging. Because of this they may feel the work is not too important and may fail to exert their best efforts. Don’t make that mistake! Your boss, not you, is the only valid judge of how important your job is. You should always treat your work assignments as if each one is the most important effort in the company. That is the kind of attitude that gets noticed by your boss, and the only attitude that will take you to the top.

Advanced Degrees

A Master of Science degree is often required in order to become a supervisor in a technology area. This is not a hard and fast rule, but it is pretty obvious that the man with the MS is likely to get ahead a little bit faster than the man without one. In fact, the appearance of the Ph.D. degree in industry is becoming more and more common these days.

I think that by far the best way to get your MS degree is to get to work in industry, then go to school part-time at night so that you can correlate practical work that you do in the daytime with the advanced theoretical work you study at night. You will learn faster if you are getting inputs from both sources and your boss will be impressed with your eagerness. The MS graduates that we have hired right out of school are hardly more useful to us than B.S. graduates for at least a year. Beyond that time they probably do advance a little faster but not as fast as the man who has received practical experience at the same time he has worked toward his advanced engineering degree.

There is hardly any doubt, however, that the Doctorate degree must be obtaining on a full-time study basis. Before you invest the time and effort required to get the doctorate, you should very carefully evaluate what the potential payoff will be. Today, unfortunately, many engineers in industry have found very little benefit having a Ph.D. Hopefully this situation will not persist.

The Value of Competition

Finally, after you have become a successful engineer and perhaps a supervisor, do not ever stop growing in your practical knowledge and in your dealings with people. Pride in your own company should never conflict with your understanding of the value of industrial competition. The free enterprise system, rooted in the concept of competition for sales by delivery of a superior product, continually assures the best possible products and maximum technical advancement. No other system has ever been devised which gives the consumer so much in return for his money.

Many examples of product improvement by competitive pressure are evident in the commercial airplane business. For example, the Douglas Company was first to offer a commercial transport equipped with J-75 type engines, an action that cause Boeing to significantly change its thinking about the types of aircraft it was offering. The General Dynamics Convair 990 was the first commercial jet to utilize turbofan engines. Today, all Boeing commercial jets are powered with turbofan engines. Needless to say, Boeing has also contributed its share of technical innovations.

The airlines and the passengers have benefited immensely by these changes, none of which would have been introduced without a free competitive climate. The better airline service and lower fares permitted by these changes helped make possible the phenomenally rapid growth of the airline industry.

Engineering and Social Changes

Changes ahead in our society will involve engineers more than ever before. Environmental problems relating to pollution of air and water, noise, traffic, adequate low-cost housing, and related concerns will not be solved without the application of engineering skills. The young engineer should inform himself as to the nature of our social problems and become involved in providing solutions to them. The role of engineers in improving living standards for people all over the world has never been as significant as today.

YOUR FIRST FIVE YEARS

David L. Kohlman
Aerospace Engineer

Embarking on your first full-time job in engineering is one of the most exciting challenges you will encounter during your career. And the first five years of your career may well be the most important. For how you plan and manage these early and critical years will shape your entire future and determine whether your career remains exciting and challenging for you, or becomes dull and routine.

There is a significant difference between the college campus and the industrial, professional environment. You will be required to make many adjustments and changes in your life. Don't forget the personal and professional habits which you adopt during these first five years will probably be with you for a lifetime. Therefore, it is important to be constantly aware of the quality of your performance and to frequently appraise yourself with respect to your goals as you build an initial reputation, which will be difficult to change.

The following guidelines are suggested to help in formulating your own personal five-year plan and in assessing your development as a professional.

1. **Have a Plan**.
Don't drift through your career only reacting to random events and opportunities. Formulate specific goals and a timetable in terms of responsibility, position, salary, and professional skills. Keep the plan flexible, because you and your values will change considerably with time. But a specific plan will provide direction to your life and offer a means of evaluating the random opportunities which appear in everyone's career, usually when they are least expected.

2. **Communicate**
Engineering students are traditionally weak in communication skills. Yet those skills are at least as important as your technical skills. Almost everything you do as an engineer must be communicated to other people. Proper spelling, grammar, sentence structure, and precise word usage are only the foundations of good communication. Organization, conciseness, clarity, and smoothness are also necessary. Anything less, will impair your effectiveness and limit the probability that your ideas and innovations will be adopted. Your oral and written communications serve as advertisements for your professional skills. Don't be shortchanged by inadequate language skills.

3. **Be Dependable**
Supervisors and management in every field of endeavor, place a premium on the ability to get things done. Establish that reputation early. Whenever your boss assigns you a task, he wants to be able to stop worrying about it because he knows it will be done right and on time. If he can do this, you've made his job easier, insured you'll get the important assignments, and taken a big step toward your success as an engineer.

4. **Go the Second Mile**
Decide early in your career that you will always try to do more than what is expected of you. That is the only way you can fulfill one of the basic laws of success: always be underpaid! If you're not worth more than you're getting paid, then you don't deserve a raise. Try to anticipate the next step in your assignment. Then you will be able to work more efficiently, with less supervision, and will experience the satisfaction of answering your boss's next request with "I've already done that and here are the results." Remember,

someday you may be the one issuing assignments and making decision.

5. **Keep Learning**

Your college degree is only the beginning of a lifelong process of education. In the world of science and technology, there is a time-to-double available knowledge of about ten years (give or take a few). Unless your knowledge increases correspondingly, you will start becoming obsolete on graduation day.

Many employers have formal education programs for new engineers to teach company policy, procedures and practical skills. But most of your education must be self-initiated. A very important step is to join a professional or technical society appropriate to your field. This will expose you to a vast array of educational opportunities: magazines, journals, technical meetings, short courses, seminars, and taped lectures. Take advantage of these valuable resources.

Eventually you may choose to return to graduate school to specialize or significantly improve your knowledge in some area. The important thing, however, is to continue learning throughout your career, one way or another. Set the pattern now, during your first five years, and you'll never be obsolete.

6. **Read**

There is more to life than engineering, and part of being a true professional is to be knowledgeable in fields beyond engineering. Setup a five year plan of reading which includes the following elements: A book a month from diverse areas such as history, economics, politics, sociology, psychology, business, fiction, etc.

A good weekly news magazine such as Time, Newsweek, U.S. News and World Report.
A special news magazine in your field such as Aviation Week and Space Technology.
A good metropolitan daily newspaper.

This is only a minimum. Include other magazines, books, papers, etc. which interest you and broaden your outlook on the world. You must be aware of what's going on in the world, well beyond your own borders, to become a successful professional with significant responsibilities.

Set aside a specific time each day to read. Only 30 minutes a day covers an amazing amount of reading over a year. Always carry a book or magazine with you to take advantage of all the times you have to wait for someone or something. Finally, set a strict limit on TV watching and stick to it. Television is addictive and usually the biggest deterrent to reading.

7. **Make Friends**

A successful professional recognizes his co-workers are colleagues, not competitors. A pleasant, friendly personality will gain you many friends who will not only make your work environment enjoyable, but will teach you many valuable lessons as a result of their experiences, both successful and unsuccessful. Colleagues who are good friends are good for sounding out new ideas, evaluating results, troubleshooting problems, and listening to trial run presentations. And it is colleagues with whom you openly and frequently communicate, who are necessary to make Kohlman's Law work positively for you: It's not who you know, but who knows what you know.

Above all, develop a positive attitude. Someone who complains, gripes, and is constantly finding fault, poisons the atmosphere of an office and quickly becomes unpopular. If things are really that bad, change jobs.

8. **Assess Your Situation**

To actively direct the course of your career, you must periodically assess where you are and where you are going in relation to your plans and goals. If you're not making adequate progress, it's time for a change in yourself, your situation, or your goals.

Don't be afraid to change companies when it becomes necessary or an outstanding opportunity occurs. But do be cautious about switching too quickly or too often. Except for very unusual circumstances, you owe a new employer at least two or three years of service so that he can realize a return on his investment in you. Also, an employer is unlikely to groom you for advancement or entrust you with major responsibilities if you have a record of job hopping every few years.

9. **Enjoy Life**

If you can't enjoy life both on and off the job, something is seriously wrong. Find out what you enjoy most and shape your career and your leisure time accordingly. Develop a hobby, expand friendships, and broaden you outlook well beyond the world of engineering--become a whole person. Otherwise you may well find a big salary, promotions, and responsibility are empty rewards.

Have a successful first five years and a successful career is almost assured. Enjoy!

Appendix A

THE DEPARTMENT OF AEROSPACE ENGINEERING ADVISORY BOARD
And
ALUMNI STEERING COMMITTEE

A. 1 The Aerospace Engineering Advisory Board

The Advisory Board serves as an overview group for the Department of Aerospace Engineering. It provides guidance in planning and assists in maintaining the effectiveness of the education program. Its functions include:

1. Reviewing of curriculum and courses, the development of recommendations for revisions.
2. Assisting in the formulation, structuring and promotion of future development programs.
3. Assisting in the determination of new technology areas in which research activities should be initiated.
4. Assisting the Department in its efforts to communicate with industry, prospective students and the general public.

Members of the Advisory Board are drawn from Aerospace organizations outside the university and university officials. The external members include senior engineers from aerospace companies, government laboratories and federal agencies.

A.2 The Alumni Steering Committee

The Alumni Steering Committee advises the Department on a wide range of matters of interest to the alumni. Members include a diverse group of alumni.

Appendix B

Detailed Description of Aerospace Engineering Courses

Listed below are detailed descriptions of the undergraduate courses. These listings include the prerequisites, current textbooks, course topics, and faculty coordinator. If students have any questions concerning a particular course they should talk to their advisor or the course coordinator.

AE 211 Basic MATLAB, Simulink and Stateflow (3)Programming in MATLAB and modeling in Simulink and Stateflow for aerospace and other engineering applications. Course is offered within a computer laboratory environment. Contents include: Plotting and Graphics, Toolboxes, Cells, Structures, and M-Files, Handle Graphics and User Interfaces, MEX-files, LTI Viewer and SISO Design Tool, S-Functions, and Solvers.
Prerequisite: MATH 121, LAB

AE 241 Private Flight Course (1) One hour of academic credit is given upon the awarding of the private pilots license by the Federal Aviation Administration. Required documentation includes a letter from the FAA designated examiner giving the check ride and a copy of the private license. Note: The Department of Aerospace Engineering provides no ground or flight instruction.
Prerequisite: Aerospace Engineering Student & Consent of instructor.
Textbook: None
Coordinator: Department Chair
Topics: None
Estimated Content: Engineering Science 1 credit of 100%

AE 242 Private Flight Aeronautics (3) Three hours of academic credit is given for the successful completion of the FAA private pilot's written examination. Required documentation is a copy of the written examination score. Open enrollment. Note: The Department of Aerospace Engineering does not provide any ground school classes.
Prerequisite: Aerospace Engineering Student & Consent of instructor.
Textbook: None
Coordinator: Department Chair
Topics: None
Estimated Content: Engineering Science 3 credits of 100%

AE 245 Introduction to Aerospace Engineering (3) Basic aeronautical and astronautical technology with focus on aerospace vehicle performance and design.
Co-requisite: Math 104.
Textbook: *Introduction to Aerospace*. V.U. Muirhead and David R. Downing. 1996 edition, Published by V.U. Muirhead, Lawrence, KS.
Coordinator: David Downing
Topics: 1) Aerospace History, 2) Engineering & Mathematical Concepts, 3) Operational Environments, 4) Gasdynamics, 5) Propulsion Systems, 6) Materials & Structures, 7) Stability & control, 8) Navigation & Guidance, 9) Flight Path and Performance Determination, 10) Flight Safety, and 11) Vehicle Design.
Estimated Content: Engineering Science 3 credits or 100%

AE 250 Mathematics of Engineering Systems (2.5) Development of models for mechanical, electrical and structural systems using linear differential equation. Solution of these systems of equations utilizing classical method, Laplace transform and matrix techniques. (Same as CE 250, C&PE 250, EPHX 250, and ME 250)
Prerequisite: MATH 122 and concurrent enrollment in MATH 250.
Textbook: Same as MATH 250
Coordinator: Staff
Topics: 1) First order linear equations, separation of variables, numerical methods: Modified Euler an Runge Kutta fourth order 2) Models of electric circuits and mechanical systems 3) Laplace transform function 4) Gauss elimination, vector spaces, linear independence, linear transformations 5) Characteristic polynomial, undetermined coefficients, reduction of order, variation of parameters, existence and uniqueness 6) Matrices, systems of equations 7) Tests
Estimated Content: Engineering Math 2.5 credit hours or 100%

AE 290 Aerospace Colloquium (0.2) This is a required course for all aerospace engineering majors each fall semester. Topics of importance and new developments are discussed by aerospace industry representatives and representatives of FAA, DOT, DOD, NASA, related sciences and engineering disciplines. A forum for student activities at all levels.
Prerequisite: None
Textbook: None
Coordinator: Ray Taghavi
Topics: Various aspects of aerospace engineering
Estimated Content: Engineering Science .2 credits or 100%

AE 291 Aerospace Colloquium (0.3) A spring term continuation of AE 290.

AE 292 Aerospace Industrial Internship (1) This is a required course for all aerospace engineering majors who are in the Co-op program. Engineering internship in an approved company. Internship hours do not satisfy any course requirements for the bachelors degree in Aerospace Engineering but will appear on the official transcript.
Prerequisite: Completion of freshman year
Textbook: None
Coordinator: Department Chair
Topics: Introduction to engineering procedures
Estimated content: Engineering Science 1 credit or 100%

AE 360 Introduction to Astronautics (3) The history of astronautics, including rocketry and space flight. Fundamentals of astronautics, including space environment, astrodynamics and the analysis and design of spacecraft systems. Design, construction and launch of a prototype earth-satellite using a high-altitude balloon.
Prerequisite: MATH 220
Textbook: *Understanding Space: An Introduction to Astronautics*, Sellers, J., et al., McGraw-Hill Primis Custom Publishing
Coordinator: Staff
Topics: 1) Rocketry and Spacecraft History, 2) The Environment of Space, 3) Astrodynamics (the 2-body orbital problem), 4) Spacecraft Propulsion, 5) Spacecraft Attitude Determination and Control, 6) Spacecraft Electrical Power, 7) Spacecraft Thermal Control, 8) Spacecraft Configuration, Structures, and Mechanisms, 9) Spacecraft Communications, 10) Spacecraft Command, Telemetry & Data Handling, 11) Design, construction and flight of a prototype space vehicle
Estimated Content: Math & Basic Science .25 credits or 8%, Engineering Topics 2.25 credits or 75%, Engineering Design .5 credits or 17%

AE 345 Fluid Mechanics (**3**) Study of fundamental aspects of fluid motions and basic principles of gas dynamics with application to the design and analysis of aircraft. Open enrollment.
Prerequisites: CE 301, AE 245: or co-enrolled in CE 301 and AE 245
Textbook: *Fundamentals of Fluid Mechanics*. B.R. Munson, D.F. Young and T.H. Okiishi. John Wiley & Sons, 2002.
Coordinator: C. Edward Lan
Topics: 1) Fluid properties, 2) Fluid Statics, 3) Fluid Dynamics, 4) Fluid Kinetics, 5) Control volume analysis, 6) Differential analysis, 7) Dimensional analysis, 8) Viscous effects, 9) Flow over immersed bodies.
Estimated Content: Engineering Science 2 credits or 100%

AE 390 Aerospace Industrial Internship 1) This is a required course for all aerospace engineering majors who are in the Co-op program. Engineering internship is an approved company. Summer session. Internship hours do not satisfy any course requirements for the bachelors degree in Aerospace Engineering but will appear on the official transcript.
Prerequisite: Completion of sophomore year.
Textbook: None
Coordinator: Department Chair
Topics: Assisting in design or system study
Estimated content: Engineering Science 1 credit or 100%

AE 421 Aerospace Computer Graphics (4) Elements of tow- and three-dimensional descriptive geometry with emphasis on spatial visualization and applications to aerospace vehicles and systems.
Prerequisite: None
Textbook: *Modern Graphic Communication.* Giesecke, et.al, Prentice-Han
Coordinator: Rick Hale
Topics: Various aspects of engineering graphics.
Estimated content: Engineering Science 4 credits or 100%

AE 430 Aerospace Instrumentation Laboratory (3) Review and hands-on laboratory experiments with basic electronic elements (resistors, capacitors, conductors, transistors, linear circuits, logic devices and integrated circuits). Overview and hands-on laboratory experiments using various experimental techniques available to the aerospace engineers (pressure probes, thermocouples, strain gauges, hot-wire anemometer, Laser Doppler velocimeter & flow visualization techniques).
Prerequisite: AE 440, EECS 319.
Textbook: Class notes
Coordinator: Ray Taghavi
Topics: 1) Introduction and overview 2) AC and DC circuits 3) Resistors 4) Capacitors 5) Conductors 6) Transistors 7) Logic devices 8) Integrated circuits 9) Pressure probes 10) Temperature probes 11) Strain gauges 12) Hot wire anemomtry 13) Laser Doppler velocimetry 14) Flow visualization techniques (smoke, dye, helium bubbles, schlieren, shadowgraph) 15) Special projects 16) Tests
Estimated content: Engineering Science 3 credits or 100%

AE 441 Advanced Flight Training (1-3) One hour of academic credit is given for the successful completion of advanced flight training beyond the private pilot rating. One hour is given for each of the following: commercial, instrument rating, certified flight instructor. The Aerospace Engineering Department provides no ground or flight instruction.
Prerequisite: AE 241.
Textbook: None
Coordinator: Department Chair
Topics: None
Estimated content: Engineering Science 1-3 credits or 100%

AE 445 Aircraft Aerodynamics and Performance Catalog Data (3) Study of airfoil and wing aerodynamics component drag, static and special performance, and maneuvers of aircraft
Prerequisite: AE 345, CE 301
Textbook: *Airplane Aerodynamics and Performance*. C.E. Lan and J. Roskam. DARCorp, 120 E 9th St., Lawrence, KS.
Coordinator: C. Edward Lan
Topics: 1) Atmospheric properties, 2) Basic aerodynamic principles and applications, 3) Airfoil theory, 4) Wing theory, 5) Airplane drag, 6) Airplane propulsion systems, 7) Propeller theory, 8) Fundamentals of flight mechanics, 9) Climb performance and speed, 10) Take-off and landing performance, 11) Range and endurance, 12) Maneuvers and flight envelope, 13) Laboratory.
Estimate Content: Engineering Science 2.5 credits or 83%; Engineering Design 0.5 credit or 17%

AE 490 Aerospace Industrial Internship 1) This is a required course for all aerospace engineering majors who are in the Co-op program. Engineering internships in an approved company. Summer semester, Internship hours do not satisfy any course requirements for the bachelors degree in Aerospace Engineering but will appear on the official transcript.
Prerequisite: Completion of junior year.
Textbook: None
Coordinator: Department Chair
Topics: Design and analysis problems
Estimated content: Engineering Design 1 credit or 100%

AE 491 Aerospace Industrial Internship 1) This is a required course for all aerospace engineering majors who are in the Co-op program. Engineering internships in an approved company. Fall semester, internship hours do not satisfy any course requirements for the bachelors degree in Aerospace Engineering but will appear on the official transcript.
Prerequisite: Completion of junior year.
Textbook: None
Coordinator: Department Chair
Topics: Design and analysis problems
Estimated content: Engineering Design 1 credit or 100%

AE 492 Aerospace Industrial Internship 1) This is a required course for all aerospace engineering majors who are in the Co-op program. Engineering internships in an approved company. Spring semester. Internship hours do not satisfy any course requirements for the bachelors degree in Aerospace Engineering but will appear on the official transcript.
Prerequisite: Completion of junior year.
Textbook: None
Coordinator: Department Chair
Topics: Design and analysis problems
Estimated content: Engineering Design 1 credit or 100%

AE 507 Aerospace Structures I (3) Introduction to the analysis and design of aerospace structure. Analysis topics include: stress, deflection and (buckling) stability analysis of aerospace structures undergoing extension, torsion and bending. Design exercises focus on highly stressed structural components, which tend to be strength-limited, as well as wing and fuselage structures, which tend to be buckling-limited. Introduction to material selection and manufacturing.
Prerequisites: CE 310 and MATH 220 or MATH 320. LEC
Textbook: *Aircraft Structures*, Mark S. Ewing, printed yearly, and *Fundamentals of Aircraft Structural Analysis*, Howard D. Curtis.
Coordinator: Mark Ewing
Topics: 1) Production of Aerospace Structures, 2) Aerospace Loads, 3) Strength of Aerospace Materials, 4) Design of Connections, 5) Design of Beams (especially tubes) in Extension, Bending and Torsion, 6) Stress and Deflection Analysis of Thin-Walled Beams, 7) Stress and Deflection Analysis of Semimonocoque Structures, 8) Buckling of beams (especially tubes), panels, and stiffened panels, 9) Design of wing and fuselage structures.
Estimated content: Engineering Science 1.5 credits or 50%; Engineering Design 1.5 credits or 50%

AE 508 Aerospace Structures II (3) Indeterminate structures, basic structural principles, matrix notation, Castigliano's theorems, displacement method. Rod, beam, shaft, membrane elements; two and three dimensional trusses, curved beams, spar elements, membrane element.
Prerequisite: AE 507.
Textbook: *Fundamentals of Aircraft Structural Analysis*, Howard D. Curtis.
Coordinator: Rick Hale
Topics: 1) Matrix algebra 2) Computer calculations 3) Castigliano's theorems, 4) Displacement method, 5) Springs, rods, beams, membranes, 6) Large scale structure
Estimated content: Engineering Science 3 credits or 100%

AE 510 Materials and Processes (4) Material behavior of materials used in aerospace vehicles, especially alloys of aluminum, iron (steel), titanium, and nickel as well as ceramics, plastics and composites. Material selection criteria. Manufacturing processes common to the aerospace industry. Material selection and manufacturing process design exercises.
Prerequisite: AE 507, PHSX 351, and CHEM 184
Textbook: *Manufacturing Engineering and Technology*. Serope Kalpakjian, 4^{th} edition, Prentice-Han, 2001.
Coordinator: Rick Hale
Topics: 1) Material behavior and selection criteria for metal alloys, ceramics, polymers, composites, 2) Material selection exercises, 3) Manufacturing processes, to include forming, material removal, joining, surface treatment, measurement, testing and inspection, automation, computer-aided manufacture, safety, and economics, 4) Design of manufacturing processes.
Estimated content: Engineering Science 2 credits or 50%; Engineering Design 2 credits or 50%

AE 521 Aerospace Systems Design I (4) Preliminary design techniques for an aerospace system. Aerodynamic design, drag prediction, stability and control criteria, civil and military specifications. Weight and balance, Configuration integration, design and safety, design and ethics.
Prerequisite: AE 421, AE 508, AE 551, AE 572.
Textbook: *Airplane Design*. J. Roskam. DARCorp
Coordinator: Ron Barrett
Topics: 1) Configuration sizing to a given specification, 2) Configuration layout design, 3) Initial tail and control surface selection, 4) Weight and balance calculation, 5) Drag prediction, 6) Design for stability and control, 7) Inboard profile development, 8) Landing gear layout design, 9) Structural layout design, 10) Performance calculation, 11) V-N diagrams loads estimation
Estimated content: Engineering design 4 credits or 100%

AE 522 Aerospace Systems Design II (4) Preliminary design project of a complete aerospace system. **Prerequisite:** AE 521.
Textbook: *Airplane Design*. J. Roskam, DARCorp.
Coordinator: Ron Barrett
Topics; 1) Organization of technical work, 2) Organization of technical groups, 3) Management theory and practice, 4) PERT theory and application, 5) How to motivate engineers, 6) Engineering liability
Estimated content: Engineering Design 4 credits or 100%

AE 523 Spacecraft Systems Design I (4) Preliminary design project of a complete spacecraft system.
Prerequisite: AE 521, AE 560 and PHSX 313.
Textbook: *Space Mission Analysis and Design*, 3^{rd} ed., Wertz, James R., and Larson, Wiley J., 1999. Microcosm Press, Torrance, CA and Kluwer Academic Publishers, Dordrecht, Netherlands.
Coordinator: Staff
Topics: 1) Mission design, 2) Spacecraft environment, 3) Astrodynamics, 4) Spacecraft propulsion, 5) Launch systems, 6) Atmospheric flight, 7) On-board power systems, 8) Thermal Control, 9) Attitude control, 10) Communication systems, 11) Command systems, 12) Structures, 13) Configuration design, 14) Cost estimation
Estimated content: Engineering Design 3 credits or 75%: Engineering Science 1 credit or 25%

AE 524 Propulsion Systems Design I (4) Preliminary design project of a complete propulsion system, including airframe.
Prerequisite: AE 521.
Textbook: *Aircraft Engine Design*, 24th Ed., Mattingley, Heiser and Pratt, AIAA Educational Series, 2002
Coordinator: Saeed Farokhi
Topics: Aerodynamic and structural design of aircraft engine components including inlets, compressors and fans, combustion chamber, turbines, afterburners, mixers, and exhaust systems. This course often includes aircraft design and engine matching studies.
Estimated content: Engineering Design 4 credits or 100%

AE 545 Fundamentals of Aerodynamics (5) Basic gas dynamic equations, potential flow for airfoils and bodies, airfoil transformations, thin airfoil theory, finite wing, subsonic similarity rules, one and two dimensional supersonic flow, boundary layers, heat transfer and laboratory experiments.
Prerequisite: AE 445, ME 312, and MATH 220 or MATH 320. LEC
Textbook: *Fundamentals of Aerodynamics*, 3rd Ed., John Anderson, McGraw-Hill Publishing Co., 2001.
Coordinator: Saeed Farokhi
Topics: 1) Basic gasdynamic equations. 2) Potential flow for airfoils and bodies, 3) Thin airfoil theory, 4) Finite wing, 5) Introduction to compressible fluids, 6) One dimensional compressible flow, 7) Waves, 8) Wings in compressible flow, 9) Laminar flow, 10) Transition, 11) Turbulent flow, 12) Laboratory
Estimated content: Engineering Science 5 credits or 100%

AE 550 Dynamics of Flight I (3) General equations of motion of rigid airplanes and reduction to steady state flight situation. Steady state forces and moments. Stability derivatives. Static stability, control and trim. Trim envelope. Relationships with handling quality requirements. Engine-out flight. Effects of the control system. Implications to airplane design.
Prerequisite: AE 445 and MATH 290, and MATH 220 or MATH 223.
Textbook: *Airplane Flight Dynamics and Automatic Flight Controls, Part I.* J. Roskam, DARCorp
Coordinator: Richard Colgren
Topics: 1) Equations of motion of a rigid airplane and specialization to steady state flight, 2) Development of mathematical and physical models for the aerodynamic and thrust forces and moments; stability derivatives, 3) Static stability and control and airplane trim; trim envelope and design implications, 54) Engine-out flight, 5) Effects of the flight control system, 6) Handling qualities, 7) General four dimensional trim formulation, 8) Nosewheel lift-off
Estimated content: Engineering Science 2.5 credits or 83%; Engineering Design .5 credits or 17%

AE 551 Dynamics of Flight II (4) General equations of motion of rigid airplanes and reduction to perturbed state flight situations. Perturbed state forces and moments. Stability derivatives. Dynamic stability, phugoid, short period, dutch roll, roll, spiral and other important modes. Transfer functions and their application. Relationships with handling quality requirements. Fundamentals of classical control theory and applications to automatic flight controls. Implications to airplane design.
Prerequisite: AE 445, ME 312, and MATH 220 or MATH 320. LEC
Textbook: *Airplane Flight Dynamics an Automatic Flight Controls, Parts I and II*. J. Roskam, DARCorp
Coordinator: David Downing
Topics: 1) General equations of motion of a rigid airplane and specification to perturbed state flight, 2) Development of mathematical and physical model for the aerodynamic and thrust perturbed forces and moments dimension less and dimensional stability derivatives, 3) Dynamic stability of airplanes: Phugoid, short period, spiral, roll, dutch roll. Degenerate modes. Design specifications, 4) Transfer functions and applications, 5) Handling qualities and relation to design, 6) Frequency response of linear systems, bode plots and example applications, 7) Classical closed loop control theory, bode method, root locus method and example applications, 8) Basic stability augmentation systems: angle-of-attack and angle or sideslip feedback, yaw dampers, pitch dampers, 9) Basic autopilot modes: pitch angle hold, bank angle hold, heading hold
Estimated content: Engineering Science 3 credits or 80%: Engineering Design 1 credit or 20%

AE 560 Space System (3) Fundamentals of spacecraft systems and subsystems. Spacecraft systems engineering, space environment; basic astrodynamics; and the following spacecraft subsystems; attitude determination and control; electrical power; thermal; propulsion; structures and mechanisms; command, telemetry, and data handling; and communications.
Prerequisite: AE 507, EECS 318, MATH 124, and ME 312 or equivalents
Textbook: *Fundamentals of Space Systems*, Pisacane, V.L., and Moore, R.C., Oxford University Press, New York, 1994.
Coordinator: Staff
Topics: 1)Spaceflight History, 2) Spacecraft Systems Engineering, 3) Space Environment, 4) Basic Astrodynamics, 5) Spacecraft Propulsion, 6) Spacecraft Attitude Determination and Control, 7) Spacecraft Subsystems, 8) Spacecraft Reliability and Quality Assurance
Estimated content: Engineering Science 3 credits or 100%

AE 571 Fundamentals of Airplane Reciprocating Propulsion Systems (3) Study of the basic principles of operation and systems of internal and external combustion engines with emphasis on airplane reciprocating engines. Cycle analysis, propeller theory, propeller selecting and performance analysis.
Prerequisite: AE 440 and ME 312
Textbook: *Internal Combustion Engine Fundamentals*, John B. Heywood, McGraw Hill
Coordinator: Ray Taghavi
Topics: 1) Introduction and overview, 2) Review of thermodynamics principles, 3) Air Standard cycles, 4) Fuel-air-cycles, 5) Actual engine cycles, 6) Airplane engine components, 7) Propeller (theory, operation, types & selection, 8) Carburetion, 9) Aviation fuels and engine knocks, 10) Ignition systems, 11) Lubrication systems, 12) Induction systems, supercharging and exhaust systems, 13) Laboratory
Estimated content: Engineering Science 3 credits or 100%

AE 572 Fundamentals of Jet Propulsion (3) Lecture and laboratory, study of basis principles of propulsion systems with emphasis on jets and fan systems., Study of inlets, compressors, burners, fuels, turbines, jets, methods of analysis, testing, performance; environmental considerations.
Prerequisite: AE 545, AE 571.
Textbook: *Air Breathing Propulsion,* Saeed Farokhi, 2003.
Coordinator: Saeed Farokhi
Topics: 1) Introduction to jet propulsion and combustion chemistry, 2) Propulsion fundamentals, 3) One dimensional steady compressible flow: isentropic, adiabatic, heat addition, frictional, 4) Thermodynamics of air breathing jet propulsion systems: ramjet, turbojet, turbofan, turboprop and turboshaft, 5) Inlets & nozzles 6) Combustions and Flame Temperature, 7) Axial compressors, 8) Centrifugal compressors, 9) Turbines, 10) Matching turbine/compressor, 11) Turbomachinesm
Estimated content: Engineering Science 3 credits or 100%

AE 590 Aerospace Seminar (1) Presentation and discussion on Career Planning, Human Behavior, Decision Analysis, Management, Planning and Decision Making, Technical Communications, Project Management, Engineering Economics, Personal Financial Planning, and Engineering Ethics.
Textbook: *The Successful Engineer*, 1993, J. Campbell Martin, McGraw-Hill, Inc.
Coordinator: Mark Ewing
Topics: 1) Career Planning, 2) Human Behavior, 3) Decision Analysis, 4) Management, Planning and Decision Making, 5) Technical communications, 6) Project Management, 7) Engineering Economics, 8) Personal Financial Planning, and 9) Engineering Ethics.
Estimated content: Engineering Science 1 credit or 100%

AE 592 Special Projects in Aerospace Engineering (1-5) Directed design and research projects in aerospace engineering.
Prerequisite: Consent of instructor.
Textbook: Specified according to topic
Coordinator: Staff
Topics: Student choice with faculty approval
Estimate content: Engineering Design 1-5 credits or 100%
Note: A maximum of 3 hours of AE 592 credit can be used to satisfy the technical elective degree requirement.

AE 704 Dynamics and Vibrations (3) This course presents problems in engineering dynamics and vibrations. Topics include applications of generalized forces and coordinates, and lagrange equations and a study of the performance of single and multiple degrees of freedom in vibrational systems. (Same as CE 704)
Prerequisite: AE 508
Textbook: *Structural Dynamics*. Paz. Van Nostrand, Reinhold Publishing Co.
Coordinator: Staff
Topics: 1) Free vibration of single degree of freedom system, 2) Forced vibration of single degree of freedom system and harmonic loading, 3) Impact loading of single degree of freedom systems, 4) Fourier analysis of single degree of freedom system, 5) Free vibration of multiple degree of freedom system, 6) Forced vibration of multi-degree of freedom system, 7) Eigenvalue analysis of vibration problem. 8) Modal analysis and uncoupling technique, 9) Lagrange equations of motion, 10) Stiffness and flexibility formulation of differential equations of motion.
Estimated content: Engineering Science 3 hours or 100%

AE 705 Structural Vibrations and Modal Testing (4) Classical theory of structural vibrations; single and multiple degree of freedom, free and forced vibration; theory of modal summation; measurement techniques for dynamic data, and methods of identifying modal parameters from measurement data. Numerous laboratory and computational projects.
Prerequisite: AE 508
Textbook: *Mechanical Vibrations*. S.S. Rao
Coordinator: Mark Ewing
Topics: 1) Free vibration, 2) Harmonic excitation, 3) Transient excitation, 4) Multiple degree of freedom systems, 5) Continuous systems, 6) Modal summation theory, 7) Dynamic finite elements, 8) Dynamic measurement techniques, 9) Modal model parameter estimation, and 10) Modal testing laboratories.
Estimated content: Engineering Science 2 hours or 50%: Engineering Design 2 hours or 50%

AE 707 Aerospace Structural Loads (3) This course discusses steady state spanwise and chordwise airloads, windshears, gusts, landing gear loads, bird strike, traumatic loads, and special commercial and military load requirements.
Prerequisite: AE 507, AE 545
Textbook: *Aerospace Structures; Loads*. Howard W. Smith
Coordinator: Staff
Topics: 1) Structural Specifications, 2) Mass Properties, 3) Ground Loads, 4) Air Loads, 5) Self-equilibrating Loads, 6) Paneling, 7) Load Factor Distribution, 8) Trauma, 9) Special Loads, 10) Emergency Landing, and 11) Introduction to Dynamic Loads.
Estimated content: Engineering Science 3 hours or 100%

AE 708 Aerospace Structures III (3) This course presents modern methods in aircraft structural analysis, and computer solutions of linear problems of elastic structures. Also discussed are orthotopic panels, effects of buckling non-linearity, and structural optimization.
Prerequisite: AE 508
Textbook: *Analysis and Design of Flight Vehicle*; Structures. E.F. Bruhn
Coordinator: Staff
Topics: 1) Loads, 2) Trauma, 3) Structural analysis, 4) Thermal stress, 5) Repeated loads, 6) Static stability, and 7) Coupled static failure
Estimated content: Engineering Design 3 hours or 100%

AE 709 Structural Composites (3) This course presents fiber materials, tapes, cloths, and resin systems; general anisotropic theory, elastic constants, and stiffness matrix formulation; computer analysis, strength, and theory of failure, and provides an introduction to design with composites, preliminary design, and manufacturing.
Prerequisite: C&PE 184, AE 508 or CE 761 and AE 510 or ME 600 or CE 710
Textbook: *Analysis and Performance of Fiber Composites*, Agarwab, B.D. and Bratman, L.J., Wiley Interscience, 1990.
Coordinator: Rick Hale
Topics: 1) Fiber materials, 2) Anisotropic theory, 3) Computer analysis, and 4) Design
Estimate content: Engineering Science 2 hours or 67%; Engineering Design 1 hour or 33%

AE 712 Techniques of Engineering Evaluation (3) This course discusses the formulation of problems arising in aerodynamics, heat transfer, stress analysis, thermodynamics and vibrations. Also discussed is the expression of these problems in a form amenable to quantitative evaluation by dimensional reasoning, analog techniques, relaxation methods and classical analysis.
Prerequisite:
Textbook: Class notes
Coordinator: C. Edward Lan
Topics: 1) Curve fitting and approximation, 2) Review of some solution techniques of linear ordinary differential equation, 3) Matrix differential equations 4) Numerical methods for solving differential equations, 5) Methods of asymptotic expansions, 6) Introduction to partial differential equations, 7) Some applications of perturbation methods to partial differential equation, 8) Approximate solution of partial differential equations, 9) Calculus of variations, 10) Matrix eigenvalue problems, and 11) Theory of a complex variable and integral transforms.
Estimated content: Engineering Science 3 hours or 100%

AE 721 Aircraft Design Laboratory I (4) This course provides Aerospace Engineering students with an opportunity to gain more in-depth airplane design education through team design work involving detailed design efforts in such areas as: landing gear design, systems design, propulsion system integration, structures design and aerodynamic design.
Prerequisite: AE 507, AE 521, AE 545, AE 551 and AE 571 (AE 521 may be taken concurrently)
Textbook: *Airplane Design, Parts I-VIII*. Jan Roskam
Coordinator: Richard Colgren
Topics: Team design of a civil or military airplane
Estimated content: Engineering Design 4 hours or 100%

AE 722 Aircraft Design Laboratory II (4) This course provides Aerospace Engineering students with an opportunity to gain more in-depth airplane design education through team design work involving detailed design efforts in such areas as: landing gear design, systems design, propulsion system integration, structures design and aerodynamic design.
Prerequisite: AE 507, AE 521, AE 545, AE 551 and AE 571 (AE 521 may be taken concurrently)
Textbook: *Airplane Design, Parts I-VIII*. Jan Roskam
Coordinator: Ron Barrett
Topics: Team design of a civil or military airplane
Estimated content: Engineering Design 4 hours or 100%

AE 724 Propulsion System Design and Integration (3) Theory and design of propulsion systems for both low and high speed aircraft and their integration into the overall configuration are presented. Internal and external design and analysis of inlets and nozzles including their effect on the external aerodynamics of the aircraft, as well as engine/; inlet compatibility and the problems of matching both steady and dynamic characteristics to obtain peak, stable performance are also discussed.
Prerequisite: AE 521 and AE 572
Textbooks: Class notes
Coordinator: Saeed Farokhi
Topics: 1) Review of propulsion systems and their operational characteristics, 2) Aircraft performance and demands placed on the propulsion system, 3) Propulsion system and engine selection to meet aircraft design requirements, 4) Integration of the engine, inlet and nozzle into the total configuration, 5) Inlet design and analyses, 6) Engine/inlet compatibility; steady state and dynamic, 7) Nozzle design and performance, 8) Airframe/propulsion systems, 9) Propulsion system testing and evaluation in flight and in ground facilities, and 10) Design project.
Estimated content: Engineering Science 1 hour or 33%; Engineering Design 2 hours or 67%

AE 725 Numerical Optimization & Structural Design (3) Classical theories of unconstrained and constrained optimization. Numerical techniques for unconstrained optimization, including the steepest descent, conjugate gradient and Newton's methods. Numerical techniques for constrained optimization, including sequential approximate problem techniques as well as the method of feasible directions. Computer aided solutions to practical structural design problems in Aerospace Engineering using commercially available software. Includes a final design project.
Prerequisite: MATH 220 and 290 or junior status.
Textbook: *Optimum Design*. Jasbir S. Arora
Coordinator: Mark Ewing
Topics: 1) Optimum Design Problem Formulation, 2) Theory of Optimization, 3) Linear Programming Methods, 4) Approximate Numerical Methods, 5) Practical Design Optimization, and 6) Final Design Project
Estimated content: Engineering Science 2 hours or 67%: Engineering Design 1 hour or 33%

AE 730 Advanced Experimental Fluid Dynamics (3) This course includes theory, operation and hands-on laboratory experiments on various flow measurement techniques including: multi-hole directional pilot probes, hot-wire anemometry, laser-Doppler velocimetry and particle image velocimetry. Flow visualization techniques including smoke injection, dye injection, helium bubbles, etc. are presented.
Prerequisite: AE 430, AE 545, or consent of instructor
Textbook: *Experimental Techniques for Engineers*. J.P. Homan, Class notes
Coordinator: Ray Taghavi
Topics: 1) General Concepts, 2) Multi-hole directional pilot probes, 3) Hot-wire anemometry, 4) Laser-Doppler velocimetry, 5) Particle image velocimetry, 6) Flow visualization using water dye injection, 7) Smoke flow visualization, 8) Flow visualization by helium bubbles and tufts, and 9) Final experimental design project
Estimated content: Engineering Science 2 hours or 67%: Engineering Design 1 hour or 33%

AE 731 Supersonic Aerodynamics Laboratory (1) Supersonic wind tunnel and shock tube operation, techniques, and instrumentation are presented, as well as flow study and model testing.
Prerequisite: AE 545
Textbook: Course notes
Coordinator: Ray Taghavi
Topics: 1) Schlieren, 2) Supersonic nozzle flow, 3) Pressure and force measurements in supersonic flow, and 4) Moving shock waves in tunnels
Estimated content: Engineering Design 1 hour or 100%

AE 732 Flight Test Principles and Practice (3) This course presents aerodynamic structural and/or power plant instrumentation and measurement of aircraft in flight for analytical evaluation.
Prerequisite: AE 550
Textbook: Class notes and various reference materials on reserve
Coordinator: David Downing
Topics; 1) Introduction to flight test, 2) The atmosphere, 3) Principles of air data measurements, 4) Air data system calibration techniques and procedures, 5) Ground tests prior to flight: weight and balance, in flight CG determination, inertial measurement, 6) Performance testing principles, 7) Performance data analysis and correction procedures: takeoff and landing, climb, cruise and descent, 8) Non-steady state performance measurements: energy concepts, and acceleration, climb and maneuvering determination, 9) Stability and control measurements, 10) In-flight thrust measurement: reciprocating and turboprop turbojet and turbofan, and 11) Flight test instrumentation: probes and sensors; calibration and corrections: data recording and transmission; databases and data analysis, and pre and post flight checks
Estimated content: Engineering Science 2 hours or 67%: Engineering Design 1 hour or 33%

AE 743 Compressible Aerodynamics (3) This course presents advanced supersonic flow theory for aircraft and space vehicles. Naiver-Stokes equation, method of characteristics, separated flows, and real gas effects are also presented.
Prerequisite: AE 545
Textbook: *Modern Compressible Flow*. John Anderson, McGraw-Hill 3rd Edition, 2002.
Coordinator: Saeed Farokhi
Topics: 1) Equations of compressible flow, 2) Shock polar, pressure-deflection diagram, 3) Fanno and Rayleigh flow, 4) Normal and oblique shocks, 5) Expansion waves 6) Wave-wave interaction, 7) One dimensional unsteady flows, 8) Shock tube 9) Conical flows and conical shocks with numerical solutions 10) Method of characteristics 11) Transonic flow 12) Hypersonic flow 13) Real gases
Estimated content: Engineering Science 1 hour or 33%P: Engineering Design 2 hours or 67%

AE 745 Applied Wing and Airfoil Theory (3) Applications of potential flow theory to aerodynamics of airfoil sections, wings and wing-body combinations are presented. This course also provides an introduction to high angle-of-attack and transonic aerodynamics.
Prerequisite: AE 545
Textbook: *Applied Airfoil and Wing Theory*. C. Edward Lan. Cheng Chung Book Company, Taipei, 1988
Coordinator: C. Edward Lan
Topics; 1) Fundamental equations and similarity rules, 2) Flow singularities, 3) Methods of flow singularities in 2-D flow, 4) Methods of flow singularities in 3-D flow, 5) Wing design, 6) Aerodynamics of low aspect-ratio wings, 7) Transonic flow, and 8) High angle-of-attack aerodynamics.
Estimated content: Engineering Science 3 hours or 100%

AE 746 Computational Fluid Dynamics (3) This course presents applications of numerical techniques and digital computers in solving fluid flow problems. Solutions involving incompressible and compressible flows, and inviscid and viscous flows are also discussed. Also included are finite difference techniques for different types of partial differential equations governing the fluid flow.
Prerequisite: AE 545
Textbook: *Computational Fluid Mechanics and Heat Transfer*, J.C. Tannehill, D.A. Anderson, & R.H. Pletcher, 1997
Coordinator: C. Edward Lan
Topics: 1) Fluid Dynamic Equations, 2) Mathematical behavior of P.D.E., 3) Grid generation and finite-difference methods. 4) Inviscid flow solutions, 5) Viscous flow solutions. 6) Advanced topics
Estimated content: Engineering Science 3 hours or 100%

AE 748 Helicopter Aerodynamics (3) Included in this course are helicopter components and their functioning; rotor aerodynamics, performance, stability and control; aeroelastic and vibrations.
Prerequisite: AE 551
Textbook: *Helicopter Performance, Stability and Control*. R.W. Prouty. Krieger Publishing Co. 1995
Coordinator: Ron Barrett
Topics: 1) Aerodynamics of Hovering Fight, 2) Aerodynamics of Vertical Flight, 3) Aerodynamics of Forward Flight, 4) Blade Airfoils, 5) Rotor Flapping, 6) Trim, 7) Stability and Control Analysis, and 8) Aeroelastic and Dynamic Problems
Estimated content: Engineering Science 3 hours or 100%

AE 750 Applied Optimal Control (3) This course provides an introduction to optimal control for multi-input/multi-output control system design. Also discussed are continuous regulator and non-zero set point (servo) problems; advanced controller structures including control rate weighing and proportional-integral form, and problems taken from aerospace applications including autopilot designs.
Prerequisite: AE 551 or consent of instructor
Textbook: Class notes
Coordinator: David R. Downing
Topics: 1) State variable formulation, 2) Linear regulator, 3) Non-zero set point problem, 4) Advanced control structures, 5) Autopilot application, 6) Estimator designs, and 7) Tests
Estimated content: Engineering Science 2 hours or 67%: Engineering Design 1 hour or 33%

AE 751 Advanced Airplane Dynamics (2) This course presents theory of elastic airplane stability and control using quasi-steady math models. This course further provides an introduction to theory of nonlinear airplane stability and response behavior. Also included are toll and pitch coupling phenomena, and Lyapunov stability and approximate inverse Laplace transform methodology. Airplane response to atmospheric turbulence using power spectral density methods and Lagrangean dynamics are also presented.
Prerequisite: AE 551
Textbook: *Airplane Flight Dynamics and Automatic Flight Control, Part II*. J. Roskam, DARCorp
Coordinator: David Downing
Topics; 1) Aerodynamic influence coefficients, 2) Structural influence coefficients, 3) Matrix solutions to elastic airplane stability and control derivatives, 4) Examples of nonlinear airplane responses, 5) Pitch and roll coupling, 6) Lyapunov stability theory, 7) Approximate inverse Laplace transforms applied to nonlinear differential equations, 8) Modeling of atmospheric turbulence, 9) Power spectral density, 10) Response of airplanes to turbulence, and 11) Lagrangean dynamics
Estimated content: Engineering Science 1.5 hours or 75%: Engineering Design 0.5 hours or 25%

AE 753 Digital Flight Controls (3) Introduction to the analysis and design of digital flight control systems including a review of continuous linear control theory, typical flight control structures, effects of digital implementation, mathematical model of a digital computer, Z-transforms, Z-plane analysis of digital systems, and direct digital design in the Z-plane.
Prerequisite: AE 551 or permission of instructor
Textbook: *Discrete Time Control Systems*. 2nd edition. K. Ogata. Prentice Hall
Coordinator: David Downing
Topics: 1) Review of Continuous Linear Control Theory, 2) Typical Flight Control Structures, 3) Effects of Digital Implementation, 4) Mathematical Model of a Digital Computer, 5) Z-transforms, 6) Z-plane Analysis of Digital Systems, and 7) Direct Digital Design in the Z-plane
Estimated content: Engineering Science 2 hours or 67%: Engineering Design 1 hour or 33%

AE 754 Missile Dynamics (3) This course includes design of missile configuration; general equations of motion; aerodynamics of missiles in subsonic through hypersonic flight regimes; theory of missile trajectory; linear and nonlinear theories of missile flight dynamics; introduction to guidance and control; launching problems, and free flight dispersions.
Prerequisite: AE 551
Textbook: Class notes
Coordinator: C. Edward Lan
Topics: 10 Missile aerodynamics, 2) Missile trajectories, 3) Simple angular motion and applications, 4) Linear theory of missile flight dynamics, 5) Special topics in missile dynamics, and 6) Guidance techniques and control of guided missiles.
Estimated content: Engineering Science 2 hour or 67%: Engineering Design 1 hour or 33%

AE 760 Spacecraft Systems (3) Fundamentals of spacecraft systems and subsystems. Spacecraft systems engineering, space environment; basic astrodynamics; and the following spacecraft subsystems; attitude determination and control; electrical power; thermal; propulsion; structures and mechanisms; command, telemetry, and data handling; and communications. Same as AE 560 with the addition of a research paper. Not available for students that have taken AE 560.
Prerequisite: AE 507, EECS 318, MATH 124, and ME 312 or equivalents
Textbook: *Fundamentals of Space Systems*, Pisacane, V.L., and Moore, R.C., Oxford University Press, New York, 1994.
Coordinator: Staff
Topics: 1)Spaceflight History, 2) Spacecraft Systems Engineering, 3) Space Environment, 4) Basic Astrodynamics, 5) Spacecraft Propulsion, 6) Spacecraft Attitude Determination and Control, 7) Spacecraft Subsystems, 8) Spacecraft Reliability and Quality Assurance
Estimated content: Engineering Science 3 credits or 100%

AE 765 Orbital Mechanics (3) This course discusses the motion of space vehicles under the influence of gravitational forces, as well as two body trajectories, orbit determination, orbital transfer, universal variables, gravity assist trajectories, and mission planning using patched conics. Rendezvous and promiximity operations are also discussed.
Prerequisite: MATH 220 and MATH 290 and CE 301 or equivalent.
Textbook: *Fundamentals of Astrodynamics*, Bate, Mueller, and White, Dover, New York, New York, 1971
Coordinator: Staff
Topics: 1) Two-body orbital mechanics, 2) Orbit determination from observation, 3) Basic orbital maneuvers, rendezvous and proximity operations 4) Position and velocity as a function of time
Estimated content: Engineering Science 2.5 hours or 83%: Engineering Design 0.5 hours or 17%

AE 766 Spacecraft Attitude Dynamics and Control (3) Dynamics of rigid spacecraft; attitude control devices including momentum exchange, mass movement, gravity gradient and reaction rockets, and design of feedback control systems for linear and bang-bang control devices are presented.
Prerequisite: AE 551 or permission of instructor
Textbook: *Modern Spacecraft Dynamics and Control*. Marshall H. Kaplan. John Wiley Publishers, 1977
Coordinator: Staff
Topics: 1) Fundamental spacecraft dynamics, 2) Attitude maneuvers, 3) Attitude control devices, 4) Automatic attitude control, and 5) Special problems
Estimated content: Engineering Science 2.5 hours or 83%

AE 767 Spacecraft Environments (3) Fundamentals of spacecraft environments. Description and analysis of the natural environment in which spacecraft operate post-launch. Includes optical, electromagnetic, corpuscular radiation, plasma, and dust from low Earth orbit, through outer heliosphere.
Prerequisite: PHSX 212 required, PHSX 313 or PHSX 351 recommended.
Textbook:
Coordinator: Staff
Topics:
Estimated Content:

AE 771 Rocket Propulsion (3) This course presents basic elements of rocket propulsion: systems, propellants and performance.
Prerequisite: AE 572 or equivalent
Textbook: *Elements of Rocket Propulsion*, 5th edition. George Sutton, John Wiley Publishers, 1992
Coordinator: Ray Taghavi
Topics: 1) Classification of types of rocket engines, 2) Definitions and fundamental relationships for flow, thrust, efficiency and other performance parameters, 3) Nozzle theory and thermodynamic relations for ideal and real rockets, 4) Heat transfer, principles and application, 5) Rocket vehicle performance, forces, equations, staging, performance calculations, temperature of combustion (Stochiometry), and 6) Design of liquid and solid propellant rockets.
Estimated content: Engineering Science 2.5 hours or 83%: Engineering Design 0.5 hours or 17%

AE 772 Fluid Mechanics of Turbomachinery (3) Fundamentals of two and three- dimensional flows in turbo machinery. Study of secondary flows and losses; flow instabilities in axial flow compressors (stall and surge); aerodynamic design of multistage axial flow compressor; noise associated with a transonic axial flow compressor; turbine blade cooling; calculation of stresses and blade life estimation in axial flow turbines, and fundamentals of radial flow turbomachinery.
Prerequisite: AE 572 or consent of instructor
Textbook: *Air Breathing Propulsion.* Saeed Farokhi, 2003
Coordinator: Saeed Farokhi
Topics: 1) Axial flow compressor, 2) Axial flow turbine, 3) Radial flow turbomachinery
Estimated Content: Engineering Science 2 hours or 67%: Engineering Design 1 hour or 33%

AE 790 Special Problems in Aerospace Engineering (1-5) This course offers directed studies of advanced problems in Aerospace Engineering.
Prerequisite: Open to graduate students with departmental approval
Textbook: None
Coordinator: Staff
Topics: Student choice with faculty approval
Estimated content: Engineering Design 1-5 hours or 100%

Appendix C

AIAA Code of Ethics

Precept

The AIAA member to uphold and advance the honor and dignity of the aerospace profession and in keeping with high standards of ethical conduct:

I. Will be honest and impartial, and will serve with devotion his employer and the public;
II. Will strive to increase the competence and prestige of the aerospace profession;
III. Will use his knowledge and skill for the advancement of human welfare.

Relations with the public

1.1 The AIAA member will have proper regard for the safety, health, and welfare of the public in the performance of his professional duties.
1.2 The member will endeavor to extend public knowledge and appreciation of aerospace science and its achievements.
1.3 The member will be dignified and modest in explaining his work and merit and will ever uphold the honor and dignity of his profession.
1.4 The member will express an opinion on a professional subject only when it is founded on adequate knowledge and honest conviction.
1.5 The member will preface any ex parte statement, criticisms, or arguments that he may issue by clearly indicating on whose behalf they are made.

Relations with Employers and Clients

2.1 The AIAA member will act in professional matters as a faithful agent or trustee for each employer or client.
2.2 The member will act fairly and justly toward vendors and contractors, and will not accept from vendors or contractors any commissions or allowances which represent a conflict of interest.
2.3 The member will inform his employer or client if he is financially interested in any vendor or contractor, or in any invention, machines, or apparatus, which is involved in a project or work of his employer or client. The member will not allow such interest to affect his decision regarding services which he may be called upon to perform.
2.4 The member will indicate to his employer or client the adverse consequences to be expected if his judgment is overruled.
2.5 The member will undertake only those professional assignments for which he is qualified. The member will engage or advise his employer or client to engage specialists and will cooperate with them whenever his employers or clients interest are served best by such an arrangement.

2.6 The member will not disclose information concerning the business affairs or technical processes of any present or former employer or client without his consent.
2.7 The member will not accept compensation - financial or otherwise - from more than one party for the same service, or for other services pertaining to the same work, without the consent of all interested parties.
2.8 The member will report to his employer or client any matters within his area of expertise which the

member believes represent a contravention of public law, regulation, health or safety.

Relations with other Professionals

3.1 The AIAA member will take care that credit for professional work is given to those to whom credit is properly due.

3.2 The member will provide a prospective employee with complete information on working conditions and his proposed status of employment and after employment will keep him informed of any changes in them.

3.3 The member will uphold the principle of appropriate and adequate compensation for those engaged in professional work, including those in subordinate capacities.

3.4 The member will endeavor to provide opportunity for the professional development and advancement of those in his employ or under his supervision.

3.5 The member will not injure maliciously the professional reputation, prospects, or practice of another professional.

3.6 The member will cooperate in advancing the aerospace profession by interchanging information and experience with other professionals and students, and by contributing to public communication media, to the efforts of engineering and scientific societies and schools.