

**COURSE SYLLABI
MECHANICAL & AEROSPACE ENGINEERING
UTAH STATE UNIVERSITY**

July 2007

MAE Required Courses		Credits	Offered
ETE2200**	EE for non-majors	4	F/Sum
ENGR2010**	Statics	2	F/S
ENGR2030**	Dynamics	3	F/S
ENGR2140**	Strength of Materials	2	F/S
MAE1200	Engineering Graphics	2	F/S
MAE2160	Material Science	3	F/S
MAE2200	Engr Numerical Mthds I	2	F
MAE2300	Thermodynamics I	3	S/Sum
MAE2450	Numerical Methods II	3	S
MAE2650	Mfg. Processes	3	S
MAE3040	Mechanics of Solids	3	F
MAE3320	Advanced Dynamics	3	F
MAE3340	Instr. & Measurements	3	S
MAE3400	Thermodynamics II	3	F
MAE3420	Fluid Dynamics	3	F
MAE3440	Heat & Mass Transfer	3	S
MAE3800	Design I	2	S
MAE4300	Machine Design	3	S
MAE4400	Fluids/Thermal Lab	2	F
MAE4800	Design II	3	F/S
MAE4800	Design II-Competitions	3	S
MAE5300	Vibrations	3	F

** The syllabi for these courses are available from the department which is responsible for the course.

**Mechanical and Aerospace Engineering
MAE 1200
Engineering Graphics**

Syllabus

Course Description:

MAE 1200 – Introduction to technical sketching, solid modeling, and engineering graphics. Concurrent engineering design process applied to a project. Students start with hand sketches, then move through variational geometry solid models, with tolerance analysis and control, until they have produced a complete set of manufacturing drawings conforming to the ASME standard. 2 credits, F, Sp

Prerequisites: Math 1060

Textbook: No textbook required

Course Objectives:

To provide the student with practical experience in the creation and understanding of Engineering Graphics as used in today's workplace.

Topics Covered:

- Introduction - The Importance of Technical Graphics/Drawing (1 class period)
- The Design Process (1 class period)
- Integrated Design and 3D Modeling (3 class periods)
- Visualization - Sketching & Computer (2 class periods)
- Geometrics - Geometry Construction Shape Description (3 class periods)
- MultiView Drawings - Orthographic Projection - Axonometric Projections, Auxiliary & Section Views (4 class periods)
- Dimensioning & Tolerancing Practices - Geometric Dimensioning & Tolerancing (3 class periods)
- Reading & Constructing Working Drawings (3 class periods)
- Tolerance Analysis (2 class periods)
- Variational Geometry (4 class periods)
- Exams and Instructor Selected Topics (4 class periods)

Class Schedule:

Two 1 hour and 20 minute classes. M-W or T-Th

Contribution of course to meeting the professional component:

This introduction course provides the student with fundamental engineering process. The design assignments given require some synthesis to complete. The class begins the 1.5 year engineering topic requirement.

Relationship of course to program outcomes/objectives:

Knowledge of engineering graphics is considered to be one of the core skills that must be used in the engineering sciences.

Mechanical and Aerospace Engineering
MAE 2160
Material Science

Syllabus

Course Description:

MAE 2160 – Study of atomic and microscopic structures of metals, polymers, ceramics, and composite materials, and how these structures affect material properties. 3 credits, F, Sp.

Prerequisites: Chem 1210 and ENGR 2140

Textbooks: The text is **Material Science & Engineering**, 7th edition, by W.D. Callister. It is an outstanding undergraduate text. Reading assignments out of this text are given each class period and are to be read before the following class period. It is extremely important that you read the text. It is very difficult to understand the material without reading the text and attending lectures.

Course Objectives:

The objective of the course is to teach the fundamental principles of material science so that the student can better understand material behavior, determine the failure of materials, and select appropriate materials for a given application.

Topics Covered:

- Crystalline Structures
- Imperfections in Solids
- Mechanical Behavior of Materials
- Dislocations & Strengthening Mechanisms
- Material Failure
- Phase Diagrams
- Phase Transformations
- Thermal Processing of Metal Alloys
- Metal Alloys
- Polymer Structures
- Composite Materials

Class Schedule:

Three 50 minute classes, M-W-F and six 2-hour labs.

Contribution of course to meeting the professional component:

MAE 2060 is an introduction to material science for engineers. Emphasis is given to material selection for proper engineering design. The relationship between the structure and properties of metals, polymers, and composite materials is presented.

Relationship of course to program objectives:

Students learn the fundamental behavior of materials and rationale for selecting materials for engineering applications.

Mechanical and Aerospace Engineering
MAE 2200
Engineering Numerical Methods I

Syllabus

Course Description:

MAE 2200 –An introduction to Fortran 90/95 and elementary numerical analysis with emphasis on software development. Programming skills developed through extensive practice. After completing the course, students should feel comfortable programming in Fortran90/95, and applying these programming and associated problem solving skills to other courses. 2 credits, F

Prerequisites: Math 1220

Textbooks: The text is **Fortran 95/2003 for Scientists and Engineers**, 3rd Edition, Stephen J. Chapman.

Course Objectives:

To develop programming skills in Foran90/95, and an ability to apply these skills to the solution of engineering problems over a range of areas. Students should develop critical problem solving skills through programming exercises.

Topics Covered:

- Introduction to programming
- Basic elements of Fortran90
- Control structures
- I/O concepts
- Arrays
- Procedures and structured programming
- Additional data types
- Programming applications
- In general, Chapters 1-9 in textbook.

Class Schedule:

One 50 minute class, M and One 75 minute lab/week

Contribution of course to meeting the professional component:

This course addresses the principles and applications of numerical methods.

Relationship of course to program objectives:

Provides the necessary background knowledge for student proficiency in computer-based engineering, including numerical methods, software design and development, and the use of computational tools.

Provides the background in numerical methods necessary for students to succeed in the workplace and graduate school.

Mechanical & Aerospace Engineering
MAE 2300
Thermodynamics I

Syllabus

Course Description:

MAE 2300 - First and second laws of thermodynamics; analysis of open and closed systems; equations of state; power and refrigeration cycles; problem solving methodology. 3 credits, S, Su

Prerequisites: Math 1220, Math 2210 (may be taken concurrently)

Textbooks: *Thermodynamics, An Engineering Approach*, 4th Edition, Cengel and Boles, McGraw-Hill, 2002.

Course Objectives:

Students should gain a fundamental understanding of the principles of classical thermodynamics.

Topics Covered:

- Basic Concepts of Thermo (3 class periods)
- Properties of Pure Substances (6 class periods)
- First Law/Closed Systems (5 class periods)
- First Law/Control Volumes (5 class periods)
- Intro to Second Law (3 class periods)
- More Second Law - Entropy (6 class periods)
- Work Potential: Energy (4 class periods)
- Gas Power Cycles (4 class periods)
- Vapor and Combined Power Cycles (4 class periods)
- Refrigeration Cycles (4 class periods)
- Exams (2 class periods)

Class Schedule:

Three 50 minute classes, M-W-F. No laboratory.

Contribution of course to meeting the professional component:

This course covers the basic principles and applications of the thermal sciences with attention to some of the practical and economic issues of power generation.

Relationship of course to program objectives:

Thermodynamics is the most basic course in the thermal sciences, and is therefore focused primarily on fundamentals.

Mechanical and Aerospace Engineering
MAE 2450
Engineering Numerical Methods II

Syllabus

Course Description:

MAE 2450 –Explores basic tools of numerical analysis, solution to ordinary and partial differential equations, software development using Fortran90/95. 3 credits, Sp.

Prerequisites: MAE 2200, Math 2210, 2250 (may be taken concurrently)

Textbooks: The text is **Numerical Methods for Engineers**, 4th Ed., Chapra and Canale.

Course Objectives:

To develop an ability to solve problems involving using numerical analyses, including those in ordinary and partial differential equations. To strengthen basic programming skills.

Topics Covered:

- Problem formulation, errors and Taylor series
- Root Finding
- Solution of to systems of linear equations
- Solution of systems of nonlinear equations
- Optimization
- Curve Fitting
- Numerical Differentiation and Integration
- Numerical techniques to solve ordinary differential equations
- Numerical techniques to solve elliptic and parabolic partial differential equations

Class Schedule:

Three 50 minute classes, M-W-F

Contribution of course to meeting the professional component:

This course covers the basic principles and applications of numerical methods. Contributes toward the 1 year minimum basic math and science topic requirement.

Relationship of course to program objectives:

Provides the necessary background knowledge for student proficiency in computer-based engineering, including numerical methods, software design and development, and the use of computational tools. Provides the background in numerical methods necessary for students to succeed in the workplace and graduate school.

Mechanical & Aerospace Engineering
MAE 2650
Manufacturing Processes

Syllabus

Course Description:

MAE 2650 – Introduction to manufacturing processes and CAD/CAM. Material forming, machining, finishing, and joining. Integration of manufacturing and CAD, plus the fundamentals and application of statistical process control. 3 credits, Sp.

Textbook: The text is **Manufacturing, Engineering and Technology**, 5th Edition, by Kalpakjian and Schmid.

Course Objectives:

Solid understanding of basic manufacturing processes.

Topics Covered:

- | | |
|---|--|
| ➤ Cutting Tool Materials | ➤ Reaming and Tapping |
| ➤ Metal Removal Methods | ➤ Boring Operations |
| ➤ Machinability of Metals | ➤ Metalworking Materials |
| ➤ Part Design for Productability | ➤ Die Components |
| ➤ Part Design Analysis | ➤ Die Processes |
| ➤ Manufacturing Processing | ➤ Forming Operations |
| ➤ Tolerance Charting | ➤ Process Planning |
| ➤ Workpiece Holding | ➤ Die Lubricants |
| ➤ Ancillary, Auxiliary, and Support Systems | ➤ Milling Operations |
| ➤ Machine Selection | ➤ Broaching and Sawing |
| ➤ Group Technology | ➤ Grinding Operations |
| ➤ Turning Operations | ➤ Lapping and Honing |
| ➤ Shaping and Planning | ➤ Non-Traditional Machining |
| ➤ Drilling Operations | ➤ Geometric Dimensioning & Tolerancing |

Class Schedule:

Three 50 minute classes, M-W-F.

Contribution of course to meeting the professional component:

This course covers the basic principles and applications of manufacturing.

Relationship of course to program objectives:

Provides the background knowledge for student proficiency in manufacturing engineering so that students will succeed in entry-level manufacturing positions.

Mechanical & Aerospace Engineering
MAE 3040
Mechanics of Solids

Syllabus

Course Description:

MAE 3040. Mechanics of Solids. Stress, strain, and deflection due to flexure and shear. Combined stresses, instability, nonsymmetric bending, torsion, and energy methods. 3 credits, F.

Prerequisites: ENGR 2140

Textbooks: The text is **Advanced Mechanics of Materials**, 6th Edition, by Boresi, Schmidt, and Sidebottom.

Course Objectives:

Students use mathematics to formulate and solve engineering problems involving mechanics of solids

Topics Covered:

- Three dimensional stress, strain, and displacement relationships
- Hookes Law
- Failure criteria
- Energy methods
- Torsion
- Nonsymmetrical bending of straight beams
- Shear center for thin wall beams
- Thick-wall cylinders
- Curved beams
- Elastic and inelastic stability of columns
- Stress Concentrations
- Fracture Mechanics

Class Schedule:

Three 50 minute classes; M-W-F

Contribution of course to meeting the professional component:

This is the second course in the area of Mechanics of Solids adding to the students background in engineering science. Three design problems were assignment during the semester which required some synthesis for solution. This contributes toward the 1.5 year engineering topic requirement.

Relationship of course to program objectives:

This course adds to the needed background in the area of solid mechanics in engineering sciences. Students are required to use basic calculus and engineering science to solve engineering problems. Some application of numerical methods for solution of a torsion problem is required. This course adds to the needed understanding of basic engineering sciences necessary to succeed in graduate school or in the work force.

Mechanical and Aerospace Engineering
MAE 3320
Advanced Dynamics

Syllabus

Course Description:

MAE 3320 – Particle and rigid body dynamics. Work and kinetic energy, conservation of energy, impulse-momentum, conservation of linear and angular momentum. Kinematics and kinetics in 2-D and 3-D. Newtonian and Lagrangian Mechanics. 3 credits, F.

Prerequisites: ENGR 2030, MAE 2200 (May be taken concurrently)

Textbooks: The text is **Principles of Dynamics**, 2nd Edition, by Donald T. Greenwood.

Course Objectives:

Students will further develop their ability to define and solve problems in dynamic and kinematics using more advanced techniques.

Topics Covered:

- Kinematics of Particle
- Dynamics of Particle
- Dynamics of System Particle
- Lagrange & Eq.
- Rigid Body Motion
- Vibration Theory

Class Schedule:

Three 50 minute classes; M-W-F

Contribution of course to meeting the professional component:

This required course builds on material taught in Physics and Dynamics to further enable the student to better formulate and solve real world problems

Relationship of course to program objectives:

The entire dynamics – kinematics sequence is considered fundamental to objectives in every aspect of our mechanical engineering program, including manufacturing and aerospace options

**Mechanical and Aerospace Engineering
MAE 3340
Instrumentation and Measurements**

Syllabus

Course Description:

MAE 3340 – Principles and application of mechanical instrumentation and experimentation. Sensing elements, signal conditioning, data acquisition, statistical analysis of data, and instrumentation system design. 3 credits, Sp.

Prerequisites: ENGR 2140, EE 2210, MAE 3400, MAE 3420

Textbooks: The text is **Mechanical Measurements**, 6th Edition, by Beckwith, Marangoni, and Lienhard.

Course Objectives:

Students will utilize state-of-the-art equipment to make standard mechanical engineering measurements and apply calculus-based statistics in the interpretation of the resulting data.

Topics Covered:

- Basic Concepts
- Signals
- Fourier Analysis
- Measurement Systems
- Probability/Statistics
- Uncertainty
- Strain Measurements
- Rosette Analysis
- Optical
- Force Measurement
- Torque Measurement

Class Schedule:

Three 50 minute classes; M-W-F, One 1 hour and 50 minute lab/week

Contribution of course to meeting the professional component:

This required course prepares students to make engineering measurements and present the results. Students make excellent use of these skills acquired in capstone design and other course.

Relationship of course to program objectives:

This course includes an important emphasis on calculus based statistics. The ability to make measurements and correctly interpret the data is fundamental to our program objectives.

**Mechanical and Aerospace Engineering
MAE 3400
Thermodynamics II**

Syllabus

Course Description:

MAE 3400 - Second Law analysis, power and refrigeration cycles, property relations, gas mixtures, psychrometrics, chemical reactions, chemical equilibrium, introduction to heat transfer, steady-state and transient conduction. 3 credits, F.

Prerequisites: MAE 2300, MAE 2200 (may be taken concurrently).

Textbooks: The text is **Thermodynamics, An Engineering Approach**, 6th Edition, by Cengel and Boles and **Fundamentals of Heat and Mass Transfer, 4/E Update Edition**, 5th Edition, by Incropera and DeWitt.

References:

Notes posted to course website

Course Objectives:

To develop a strong understanding of engineering thermodynamics and heat transfer and to be able to use this to solve engineering problems.

Topics Covered:

- | | |
|--|--|
| ➤ Review First Law | ➤ Chemical Equilibrium |
| ➤ Review Second Law | ➤ Simultaneous Reactions |
| ➤ Review Power Cycles | ➤ High Speed Flow |
| ➤ Refrigeration | ➤ Isentropic Flow |
| ➤ Using Partial Derivatives in Thermodynamic Relations | ➤ Basics of Heat Transfer |
| ➤ Gas Mixtures | ➤ Conduction |
| ➤ Ideal & Real Mixtures | ➤ 1-dimensional Conduction Problems |
| ➤ Air & Humidity | ➤ Radial Problems |
| ➤ Saturation, Psychrometric Chart | ➤ Heat Sources |
| ➤ Meteorological Thermodynamics | ➤ Extended Surfaces |
| ➤ Air Conditioning | ➤ Finite Difference Solutions |
| ➤ Fuels & Combustion | ➤ 2-dimensional Conduction |
| ➤ First Law Analysis of Combustion | ➤ Introduction to Transient Conduction |
| ➤ Adiabatic Flame Temperature | ➤ Lumped Capacitance Method |

Class Schedule:

Three 50 minute classes, M-W-F

Contribution of course to meeting the professional component:

This course covers the intermediate principles of thermodynamics and an introduction to heat transfer.

Relationship of course to program outcomes/objectives:

This course solidifies the students' understanding of thermal sciences with applications of multivariate calculus, differential equations, calculus-based physics, and applications of computer methods.

Mechanical and Aerospace Engineering
MAE 3420
Fluid Mechanics

Syllabus

Course Description:

MAE 3420 – Application of fluid dynamic theory to inviscid and viscous, incompressible and compressible, external and internal fluid flows with an emphasis on laminar and turbulent boundary layers. 3 credits, F

Prerequisites: ENGR 2030, MAE 2200, 2300 (MAE 2200 may be taken concurrently)

Textbooks: The text is **Fluid Mechanics – Fundamentals and Applications**, 1st edition, by Yunus A. Cengel and John M. Cimbala.

Course Objectives:

To study fluid dynamic theory with application to inviscid and viscous, incompressible and compressible, external and internal flow problems.

Topics Covered:

- | | |
|---|--|
| ➤ Definition of a fluid, dimension and units | ➤ Potential flows |
| ➤ Properties of a fluid | ➤ Incompressible viscous flows |
| ➤ Flow analysis techniques | ➤ Dimensional analysis and similarity |
| ➤ Pressure, pressure gradient, equilibrium of a fluid element | ➤ Non-dimensionalization of basic equations |
| ➤ Hydrostatics | ➤ Reynolds number regimes, internal and external flows |
| ➤ Buoyancy and stability | ➤ Turbulence and turbulent shear correlations |
| ➤ Rigid body motion | ➤ Flow in a circular pipe |
| ➤ Reynolds transport theorem | ➤ Flow in non-circular ducts |
| ➤ Conservation equations | ➤ Minor losses |
| ➤ Bernoulli's equation | ➤ Boundary layer equations |
| ➤ Differential form of conservation equations | ➤ Experimental external flows |
| ➤ Vorticity and irrotationality | |

Class Schedule:

Three 50 minute classes, M-W-F

Contribution of course to meeting the professional component:

This course covers the basic principles and applications of fluid flow theory appropriate for a student in the aerospace or thermal sciences field of study. Contributes toward the 1.5 year engineering topic requirement.

Relationship of course to program objectives:

The students will be exposed to concepts in the areas of:

- 1) Multi-variable calculus

- 2) Differential equations
- 3) Calculus-based physics
- 4) Fluid mechanics
- 5) Thermal sciences.

Knowledge in these topics contributes to the students understanding of the basic engineering sciences necessary to succeed in graduate school or in the work force.

Mechanical and Aerospace Engineering
MAE 3440
Heat and Mass Transfer

Syllabus

Course Description:

MAE 3440 - Heat and Mass Transfer. Introduction to convection, external flow, internal flow, free convection, boiling and condensation, heat exchangers, radiation and diffusion mass transfer. Includes design project. 3 credits, Sp.

Prerequisites: MAE 3400, MAE 3420, MAE 2450 (may be taken consecutively).

Textbook: The text is **Fundamentals of Heat and Mass Transfer**, 6th Edition, by Incropera and DeWitt.

References:

Notes posted to course website

Course Objectives:

To develop a strong technical knowledge base and problem solving ability in heat and mass transfer. Enhance creativity, cooperative learning, a can-do attitude, design, teaming, and communication skills. Foster independent learning. Provide validation and certification of student achievement.

Topics Covered:

- Review – Steady State and Transient Conduction
- Finite Difference Methods
- Computer Project
- More Finite Difference
- Plane Wall, Convection, Solid
- Multidimensional Effects
- Convection, Boundary Layers
- Similarity, Analogies
- Turbulence
- External Flows, Plates
- Cylinders & Spheres
- Jets, Multiple Obstacles
- Internal Flow, Balances
- Correlations
- Enhancement
- Convection Overview
- Empirical Correlations
- Spheres, Vertical, Enclosures, Free plus Forced
- Boiling
- Project Proposals
- Condensation
- Heat Exchangers, Overall HTC, LMTD
- Effectiveness – NTU
- Radiation, Intensity, Emission, Irradiation, Radiosity
- Blackbody, Planck, Wien, Stefan-Boltzmann, Bond Emission
- Surface Emission, Absorption, Reflection
- Environmental Radiation
- The View Factor
- Radiation, Exchange, Black, Diffuse, Gray
- Shields, Reradiating, Multimode
- Design Project Presentations

Class Schedule:

Three 50 minute classes, M-W-F

Contribution of course to meeting the professional component:

This course covers the principles of thermodynamics and heat transfer.

Relationship of course to program outcomes/objectives:

This course solidifies the students' understanding of thermal sciences with applications of multivariate calculus, differential equations, calculus-based physics, and applications of computer methods. In addition, they do a group thermal design project and communicate their result in a powerpoint presentation as well as a written report.

Mechanical & Aerospace Engineering
ECE 3820 & MAE 3800
Electrical & Mechanical Engineering Design I

Syllabus

Course Description:

ECE 3820 & MAE 3800 - This course prepares electrical and mechanical engineering students for their senior capstone projects. Interdisciplinary engineering design skills are emphasized. Project management techniques, written and oral engineering communication skills are developed through an extensive reverse engineering project and industry speakers. 2 credits, Sp.

Prerequisites: ENGR 2140

Textbooks: The text is **Mechanical Design Process**, by David G. Ullman.

Course Objectives:

At the completion of this course students will be able to:

1. Successfully manage an engineering design project.
2. Apply basic business skills to engineering projects.
3. Work effectively on multidisciplinary engineering design team.
4. Communicate engineering information effectively to a diverse audience of engineers, managers, customers, etc. through oral presentations and written materials.
5. Evaluate and effectively respond to engineering conflicts (technical, personal, ethical).

Topics Covered:

- Project Management
- Business Skills
- Interdisciplinary Team Skills
- Engineering Communication
- Engineering Ethics

Class Schedule:

Two one hour 15 minutes classes, TR

Contribution of course to meeting the professional component:

This course provides the background for managing a design project, functioning on a multidisciplinary team, and communicating through oral and written channels. It includes information on engineering design and application of general education to engineering.

Relationship of course to program outcomes:

1. Students will learn essential project management and implementation skills to enable them to design, prototype and test an effective 801^h to an engineering design problem.
2. Students will gain an understanding of non-technical issues that impact the technical design process (ethics, economics, etc.) and will have experience working on an interdisciplinary team.
3. Students will be able to communicate with a diverse audience (engineers & non-engineers) through written and verbal means

Mechanical and Aerospace Engineering
MAE 4300
Machine Design

Syllabus

Course Description:

MAE 4300 – Computer-aided design and synthesis of mechanisms, mechanical linkages, cams, fasteners, welds, gears, bearings, power transmission components, and lubrication. Component failure analysis based on metal fatigue related to dynamic loading. 3 credits, Sp.

Prerequisites: MAE 3040

Textbooks: The text is **Machine Design – An Integrated Approach**, 3rd Edition, by Robert L. Norton.

Course Objectives:

Students will synthesize and apply dynamics and mechanics background in the analysis and design of machine elements. Real world failure analysis case studies will bring relevance to the course.

Topics Covered:

- Stress
- Failures Resulting from Static Loading
- Failure Resulting from Variable Loading
- Screws, Fasteners, and the Design of Nonpermanent Joints
- Welding, Brazing, Bonding, and the Design of Permanent Joints
- Rolling-Contact Bearings
- Lubrication and Journal Bearings
- Gearing – General
- Spur and Helical Gears
- Bevel and Worm Gears
- Clutches, Brakes, Couplings, and Flywheels
- Flexible Mechanical Elements

Class Schedule:

Three 50 minute classes; M-W-F, One 2 hour and 50 minute lab/week

Contribution of course to meeting the professional component:

This required course is essential in preparing students for the capstone design experience.

Relationship of course to program objectives:

This course is central to program objectives.

**Mechanical and Aerospace Engineering
MAE 4400
Fluids/Thermal Laboratory**

Syllabus

Course Description:

MAE 4400 – Fluids/Thermal Laboratory. Laboratory experiences in observation and measurement of fundamental fluid and thermal phenomena. 2 credits, F.

Prerequisites: MAE 3340, 3440.

Textbooks:

Required textbooks from prerequisite courses. Lab fee: \$30

References:

- 1- Mechanical Measurements by Bechwith, Marangoni, Lienhard, 6th Edition
- 2- Thermodynamics An Engineering Approach by Cengel and Boles
- 3- Fluid Mechanics – Fundamentals and Applications, 1st Edition by Cengel and Cimbala
- 4- Fundamentals of Heat and Mass Transfer, 6th Edition by Incropera and DeWitt

Course Objectives:

Emphasis is upon laboratory technique, presentation of experimental results, evaluation of experimental results, and observation of the physical phenomena.

Topics Covered: (typically several of the following)

- Humidity measurement
- Temperature measurement
- Pressure measurement
- Flow measurement
- Rankine cycle
- Free convection heat transfer
- Transient fluid flow with minor losses
- Wind tunnel measurements
- Flow visualization

Class Schedule:

One 75 minute class, R and one 2 hour 50 minute lab

Contribution of course to meeting the professional component:

This course covers the basic principles and applications of fluid/thermal system measurement appropriate for all mechanical engineering fields of study.

Relationship of course to program objectives:

Provides students with a background in the fundamental areas below, which is necessary for success in graduate school or the engineering workplace.

- 1) Laboratory experiences
- 2) Computer-based engineering

- 3) Communication
- 4) Calculus-based physics
- 5) Fluid mechanics
- 6) Thermal sciences

Mechanical and Aerospace Engineering

MAE 4800

Design II

Syllabus

Course Description:

MAE 4800 – Senior design project, including a technical presentation and a critical design review. 3 credits, F

Prerequisites: MAE 3440, 3800, 4300

Textbooks: No Textbook Required

Course Objectives:

The objective of the senior design project is to utilize engineering fundamentals to complete a design project. Students develop specifications, synthesize a design, analyze design, fabricate, and test an engineering project.

Topics Covered:

- Engineering Specifications
- Project Scheduling
- Documentation
- Effective Presentations

Class Schedule:

One 75 minute class, T

Contribution of course to meeting the professional component:

This course contributes one semester towards design and application of fundamental engineering principles.

Relationship of course to program objectives:

This course contributes directly towards synthesis of mathematics, science, engineering fundamentals, and laboratory and work-based experiences to formulate and solve engineering problems. This course also teaches students to communicate and work effectively on team-based engineering projects.

Mechanical & Aerospace Engineering
MAE 5300
Vibrations

Syllabus

Course Description:

MAE 5300 - Vibration of single and multiple degree of freedom, and discrete mass systems. Natural frequencies and mode shapes for free, damped, and undamped systems. Forcing functions and transient responses. Matrix methods, numerical solution, and random vibrations. 3 credits, F

Prerequisites: ENGR 2030, 2140

Textbooks: The text is **Mechanical Vibrations**, 4th Edition, by Singiresu S. Rao.

Course Objectives:

Students will learn and apply mechanical vibration theory. Emphasis will be on defining and solving practical problems arising from actual case studies.

Topics Covered:

- | | |
|-----------------------|------------------------|
| ➤ Periodic Motion | ➤ Hysteretic Damping |
| ➤ Torsional Vibration | ➤ Coulomb Damping |
| ➤ Pendulums | ➤ Damped-Forced |
| ➤ Energy Methods | ➤ 2 DOF |
| ➤ Lumped Systems | ➤ Rayleigh's Principle |
| ➤ Forced Vibrations | ➤ Nonlinear Vibrations |
| ➤ Trans. Vibrations | ➤ Matrix Methods |
| ➤ Convolution | ➤ Random Vibrations |
| ➤ Damping | ➤ Vibration Testing |

Class Schedule:

Three 50 minute classes; M-W-F

Contribution of course to meeting the professional component:

This required course builds on the background acquired in Physics, Dynamics and Advance Dynamics and contributes toward the 1.5 year engineering topic requirement.

Relationship of course to program objectives:

This course in mechanical vibrations is considered essential to the program objective of providing students with a solid foundation in mechanical engineering fundamentals.

MAE Technical Elective Courses		Credits	Offered
ENR 5500	High Performance Computing	3	F
MAE 5020	Finite Elem Meth I	3	F
MAE 5060	Mech of Comp Mtls I	3	S
MAE 5310	Dynamic Sys & Cntrls	3	F
MAE 5410	Des/Optim Thermal Sys	3	F
MAE 5420	Compress Fluid Flow	3	S
MAE 5440	CFD	3	S
MAE 5500	Aerodynamics	3	F
MAE 5510	Dynamic Atmospheric Flight	3	F
MAE 5520	Dynamic Space Flight	3	F
MAE 5530	Space System Design	3	S
MAE 5540	Propulsion Systems	3	S
MAE 5580	Aircraft Design	3	S
MAE 5600	Process Plan/SQC	3	F
MAE 5610	Hydraulics & Pneumatics	3	S
MAE 5620	Manufacturing Automation	3	F
MAE 5630	Machining Theory	3	S
MAE 5640	Design for Manufacturing	3	F
MAE 5650	Non-Trad Mfg Proc	3	S
MAE 5660	Tran Phenom Mfg Proc	3	S
MAE 5670	Fracture Mechanics	3	F
MAE 5680	Mfg Plnng & Smltn	3	S
MAE 5900	Cooperative Practice	3	F/S/SU
MAE 5930	Special Problems	1-3	F/S/SU
MAE 5930	Kinnematics	3	F

Mechanical & Aerospace Engineering
MAE 5020
Finite Element Methods in Solid Mechanics I

Syllabus

Course Description:

MAE 5020 - Finite Element Methods in Solid Mechanics I. Introduction to finite element methods and their application to the analysis and design of mechanical engineering systems. 3 credits, F.

Prerequisites: MAE 3040

Textbooks: The text is **Concepts and Applications of Finite Element Analysis**, 4th Edition, by Robert D. Cook, et al.

Course Objectives:

Students use mathematics to formulate and solve solid mechanics problems using the finite element method. Both the theoretical approach and the application of a commercial finite element program to solving problems is covered.

Topics Covered:

- Stress/strain/displacement relations
- Direct formulation of element stiffness matrices
- Assembly of element stiffness matrices and forces
- Stress computation
- Classical Rayleigh-Ritz formulation
- Finite element form of Rayleigh-Ritz
- Shape functions for C^0 and C^1 elements
- Consistent nodal loads and convergence requirements
- Triangle elements
- Isoparametric Elements
- Coordinate Transformations and rigid links
- Condensation, substructuring, and structural symmetry
- Solids of revolutions
- Plates and Shells
- Normal modes solution

Class Schedule: Three 50 minute classes, M-W-F

Contribution of course to meeting the professional component:

This course adds to the engineering science component of their program. A major design problem was assigned which required some synthesis for solution. This contributes toward the 1.5 year engineering topic requirement.

Relationship of course to program objectives:

This course makes extensive use of linear algebra and calculus to derive solutions. It also requires proficiency in computer-based engineering software. Communication skills are improved in writing a report summarizing their design project. This course adds to the needed understanding of basic engineering sciences necessary to succeed in graduate school or in the work force.

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Mechanical and Aerospace Engineering
MAE 5060
Mechanics of Composite Materials I

Syllabus

Course Description:

MAE 5060 – Stress-strain relations for nonisotropic composites, such as fiber-reinforced laminates, properties and their uses, strength and life determination, and methods for design using composite materials. 3 credits, Sp

Prerequisites: MAE 3040 or CEE 3010

Textbooks: The text is **Stress Analysis of Fiber-Reinforced Composite Materials**, by Michael W. Hyer. Several handouts are also given throughout the semester.

Course Objectives: The purpose of the course is to help the student obtain a fundamental understanding of the mechanical behavior of laminated composite materials and develop skills in designing and analyzing composite structures.

Topics Covered:

- Fiber-Reinforced Composite Materials
- Micromechanics
- 3D Lamina Constitutive Relationships
- Plane-Stress Lamina Constitutive Relationships
- Classical Lamination Theory
- Failure Theory
- Thermally Induced Stresses
- Interlaminar Stresses
- Governing Equations of Composite Plates

Class Schedule:

Three 50 minute classes, M-W-F

Contribution of course to meeting the professional component:

In this course the fundamental principles of the mechanics of composite materials are covered. Topics covered include; stress-strain relations for non-isotropic composites, such as fiber-reinforced plastic laminates, properties and their use, strength and life determination, and methods for design using composite materials

Relationship of course to program objectives:

Students not only gain a knowledge of the fundamental principles needed to analyze and design composite structures but also gain a better understanding of solid mechanics.

MAE Graduate Course		Credits	Offered
MAE 6010	Finite Element II	3	S
MAE 6040	Cont Mech & Elastic	3	F
MAE 6070	Mech Comp Mtrls II	3	F
MAE 6080	Boundary Element Method	3	S
MAE 6090	Plates & Shells	3	F
MAE 6180	Dynamics & Vibration	3	S
MAE 6340	Space Craft Attitude Control	3	S
MAE 6410	Fluid Dynamics	3	F
MAE 6420	Exp Fluid Mechanics	3	S
MAE 6430	BL Theory/Convect	3	S
MAE 6440	Adv CFD	3	S
MAE 6450	Thermodynamics	3	F
MAE 6460**	Conduction HT	3	S
MAE 6480	Radiation Heat Trans	3	F
MAE 6490	Turbulence	3	S
MAE 6500	Potential Flow	3	F
MAE 6510	Aircraft Dyn & Flt Sim	3	F
MAE 6540	Astrodynamics	3	F
MAE 6550	Advanced Structural Analysis	3	S
MAE 6560	Spacecraft Navigation	3	S
MAE 6900	Seminar	0.5	F/S
MAE 6930	Special Problems	1-3	F/S/SU
MAE 7040	Elasticity	3	S
MAE 7050**	Plasticity	3	S
MAE 7080**	Adv Plates & Shell	3	F
MAE7330**	Nonlinear Adaptive Control	3	S
MAE 7380**	Adv Dynam & Vibrtns	3	F
MAE 7580**	Finite Elements	3	S
MAE 7930	Special Problems	1-3	F/S/SU

** Note: These courses have not been offered during the previous three years.

Mechanical and Aerospace Engineering
MAE 6010
Finite Element Methods in Solid Mechanics II

Syllabus

Course Description:

MAE 6010 – Advanced theory and applications of finite element methods to both static and dynamic solid mechanics problems. 3 credits, Sp.

Prerequisites: MAE 5020

Textbooks: The text is **Concepts and Applications of Finite Element Analysis**, 4th Edition, Robert D. Cook, et al. Reading assignments should be completed before coming to class. Late homework will not be accepted. Each homework assignment will have equal points. The one lowest homework score will be dropped. Some homework will require programming in FORTRAN and/or using I-DEAS software to obtain solutions.

Topics Covered:

- Frame Program
- Reaction Forces
- Inclined Supports
- Triangle Elements
- Q4 Elements
- QM6 Elements
- Q8 Elements
- RBar Elements
- Complete Program

Class Schedule:

Three 50 minutes classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6040
Continuum Mechanics and Elasticity

Syllabus

Course Description:

MAE 6040 - Fundamentals needed to model our engineering and natural system as continuous body will be covered, including the concepts of stress, strain, constitutive relations, and field equations. This course provides a uniform treatment and holistic view for the mathematical fundamentals for thermodynamics, fluid mechanics, and solid mechanics. 3 credits, F.

Prerequisites: MAE 3040 or CEE 3010

Textbooks: The text is **A First Course in Continuum Mechanics**, by Y. C. Fung. We will closely follow the textbook and cover most of the content in chapters 1-12.

Course Objectives:

Fundamentals needed to model our engineering and natural system as continuous body will be covered, including the concepts of stress, strain, constitutive relations, and field equations. This course provides a uniform treatment and holistic view for the mathematical fundamentals for thermodynamics, fluid mechanics, and solid mechanics.

Topics Covered:

- Introduction to Continuum Mechanics
- Vectors and Tensors
- Concept of Stress
- Concept of Strain
- Constitutive Relations
- Derivation of Field Equations
- Special Applications: Fluid Mechanics, Elasticity, and Micromechanics

Class Schedule:

Three 50 minute classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6070
Mechanics of Composite Materials II

Syllabus

Course Description:

MAE 6070 – Second course in composite materials. Stress-strain states of laminated composite structures, including interlaminar stresses, failure criteria, and hygrothermal stresses. 3 credits, F.

Prerequisites: MAE/CEE 5060

Textbooks: The text is **Mechanics of Fibrous Composites**, by Carl T. Herakovich. Homework must be submitted on an 8 ½ x 11 sheet and is due approximately every week. Homework is collected at the beginning of the period it is due. In addition, the reading assignments are to be read before the class in which they are discussed. Many of the homework assignments must be completed on the computer using a working CLT program. Students are expected to have written a CLT program, have a working copy, and be able to edit the program.

Course Objectives:

This is the second course in mechanics of composite materials. Topics include: fabrication, shear-deformation theory, plate theory, interlaminar stresses, failure theories, and numerical methods for solving the equations of motion.

Topics Covered:

- Fabrication
- Shear-Deformation Theory
- Plate Theory
- Interlaminar Stresses
- Failure Theories
- Numerical Methods for Solving Equations of Motion

Class Schedule:

Three 50 minute classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6080
Boundary Element Method

Syllabus

Course Description:

MAE 6080 - The fundamentals of the boundary element method is studied. Emphasis is on solving engineering problems including potential problems and elastostatics problems using the boundary element method. 3 credits, Sp.

Prerequisites: MAE 3040, 5020, FORTRAN programming skills.

Textbooks: There is no required text for the course. Daily reading assignments are given and will be discussed in the class period following the date it is assigned.

References:

Boundary Element Method, Fundamentals & Applications, Frederico Paris and Jose Canas.
Handouts and class notes are also given throughout the semester.

Class Schedule:

Three 50 minutes classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6180
Dynamics and Vibrations

Syllabus

Course Description:

MAE 6180 – Fundamentals of two-dimensional and three-dimensional rigid body dynamics, including Newtonian, Lagrangian, and Leavit Energy Methods. Equations of motion, mode shapes, and natural frequencies for continuous media and multi degree-of-freedom systems. 3 credits, Sp.

Prerequisites: MAE 5300 or CEE /MAE 6130

Textbooks: The text is **Fundamentals of Structural Dynamics**, 2nd Edition, by Roy R. Craig, Jr. and Andrew J. Kurdila. Reading assignments should be completed before coming to class. An assignment requiring programming in FORTRAN may be assigned.

Class Schedule:

Three 50 minutes classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6340
Spacecraft Attitude Control

Syllabus

Course Description:

MAE 6340 – Spacecraft attitude dynamics and controls. Spin stabilized three axis, and dual spin modes. Attitude determination techniques. 3 credits, Sp.

Prerequisites: ECE4310 or MAE 5310

Textbooks: The text is **Spacecraft Dynamics and Control**, by Marcel J. Sidi. Class grading will be based on projects. No collaboration on the programming will be permitted.

References:

Space Vehicle Dynamics and Control, Bong Wie, AIAA Education Series, 1998.

Quaternions and Rotation Sequences: A Primer with Applications to Orbits, Aerospace and Virtual Reality by J. B. Kuipers.

Spacecraft Attitude Dynamics, Peter C. Hughes.

Spacecraft Attitude Determination and Control, James R. Wertz.

Optimal Estimation of Dynamic Systems, by Crassidis and Junkins.

Topics Covered:

- Rotational Kinematics
- Pointing Control
- Nonlinear vs. Linear Dynamic Models
- Gravity Gradient Spacecraft Design
- Spin Stabilized Spacecraft Design
- Zero Momentum Spacecraft Design
- Momentum Bias Spacecraft Design
- Thruster Based Three Axis Attitude Control
- Control in the Presence of Structural Modes
- Kalman Filter Attitude Determination

Class Schedule:

Three 50 minute classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6410
Fluid Dynamics

Syllabus

Course Description:

MAE 6410 – Tensor notation, kinematics, development of the Navier-Stokes equations, vorticity dynamics, boundary-layer approximations, laminar flow exact solutions, numerical solutions, an introduction to turbulent flows. 3 credits, F.

Prerequisites: MAE 3420 or CEE 3500

Textbooks: The text is **Viscous Fluid Flow**, 3rd Edition, by Frank White. Homework will be assigned but not collected. Solutions will be either handed out, or available outside my office. It is your responsibility to do your homework.

Class Schedule:

Three 50 minute classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6420
Experimental Methods in Fluid Mechanics

Syllabus

Course Description:

MAE 6420 – Explores process and techniques involved in acquisition, analysis, and presentation of experimental data. 3 credits, Sp.

Prerequisites: MAE 3420

Textbooks: The text is **Data Reduction and Error Analysis for the Physical Sciences**, 3rd Edition, by Philip R. Bevington and D. Keith Robinson. Homework and projects may require coding in FORTRAN or other low-level languages.

References:

Numerical Recipes by William H. Press, Brian P. Flannery, Saul A. Teukolsky, William T. Vetterling.

Random Data by Bendat and Piersol

Course Objectives:

This class will require the ability to work independently. It is assumed that you have a strong interest in learning measurement techniques. Unfortunately, this knowledge is often learned from painful experience, so clear your calendar. We will spend the first part of the semester covering the text. In the latter part, you will work on a project of your choosing.

Topics Covered:

- Digital Signal Processing
- Statistics
- Uncertainty Analysis

Class Schedule:

Three 50 minute classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6430
Boundary Layer Theory and Convection Heat Transfer

Syllabus

Course Description:

MAE 6430 – Derivation of the boundary layer equations. Exact, approximate, and numerical solution techniques. Boundary layers in compressible flow. Separation. Unsteady boundary layers. Stability and transition. Turbulent boundary layers. Integral, differential, and numerical methods for solving problems associated with transfer of heat in a viscous fluid. 3 credits, Sp.

Prerequisites: MAE 3440, 6410

Textbooks: The text is **Convective Heat and Mass Transfer**, 4th Edition, by Kays and Crawford. This will be a challenging course. Please plan accordingly. It is also a fundamental and theoretical course. The emphasis will be on understanding the material at a first-principles level.

References:

Viscous Flow by White

Boundary Layer by Schlichting

Class Schedule:

Three 50 minutes classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6440
Advanced Computational Fluid Dynamics

Syllabus

Course Description:

MAE 6440 – Advanced topics in computational fluid dynamics using the finite-volume method, compressible flow algorithms including body-fitted nonorthogonal grids, linear solvers, turbulence modeling, and parallel computing. Includes extensive code development. 3 credits, Sp.

Textbooks: This course does not have a textbook, but will use numerous online materials, including journal articles.

References:

C. Hirsch, Numerical Computation of Internal and External Flows, Volume ½, Computational Methods for Inviscid and Viscous Flows, John Wiley & Sons

K. Hoffmann and S. Chiang, Computational Dynamics Volume II

E.F. Toro, Riemann Solvers and Numerical Methods for Fluid Dynamics: A Practical Introduction, Second Edition, Springer

Tannehill, Anderson, and Pletcher, Computational Fluid Mechanics and Heat Transfer, Second Edition, Hemisphere Publishing Corp., 1997.

Course Objectives:

This course provides mechanical engineering graduate students with a background in computational fluid dynamics for hyperbolic equations, e.g. compressible flow or shallow water equations. Students completing the course should have the ability to discretize the governing equations of mass, momentum, and energy conservation.

Topics Covered:

- Finite Difference and Finite Volume Techniques
- Numerical Instability
- Verification of Results
- Computational Modes
- Implementation of Efficient Algorithms for Solving Hyperbolic Equations

Class Schedule:

Three 50 minutes classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6450
Thermodynamics

Syllabus

Course Description:

MAE 6450 – Topics in classical and statistical thermodynamics, including distribution functions, free molecular flow, electron and photon gas modeling, derived properties of solids, and thermodynamic applications in areas of current research interest. 3 credits, F.

Prerequisites: MAE 3400

Textbooks: The text is **Introduction to Thermodynamics – Classical and Statistical**, third edition, by Sonntag and Van Wylen. Reading assignments should be completed before class on the day assigned.

Course Objectives:

Students develop a technical knowledge base and problem solving ability in statistical thermodynamics theory and application. Professor provides facilitation, validation and certification of student achievement.

Topics Covered:

- Classical Concepts and Relations
- 1st and 2nd Laws
- Enthalpy of Formation
- Chemical Equilibrium
- Ideas from Quantum Mechanics, Wave Equations, Translational States
- Electronic, Rotational, and Vibrational States
- Pauli Exclusion
- Probability, Permutations, Combinations, Distribution Functions
- Molecular Models, Fermi-Dirac, Bose-Einstein, Boltzmann Statistics
- Statistical Mechanics, Boltzmann Distribution, 1st Law, Entropy
- 2nd Law, Partition Function and Thermodynamic Properties
- Electronic and Translational Contributions to Properties
- Maxwell-Boltzmann Velocity
- Free Molecular Flow
- Properties of the Diatomic Gas
- The Electron and Photon Gas
- Chemical Equilibrium
- Stefan-Boltzmann Law from Photon Gas Model
- Einstein and Debye Solid
- Entropy and Information Theory

Class Schedule:

Three 50 minutes classes, M-W-F.

**Mechanical and Aerospace Engineering
MAE 6480
Radiation Heat Transfer**

Syllabus

Course Description:

MAE 6480 - Introduction to the physics and applications of thermal radiation heat transfer. Particular emphasis will be in providing the student with sufficient physical and mathematical background to critically evaluate current literature. This course will cover black body radiation, nonblack surfaces, radiative properties, configuration factors, radiation exchange between surfaces, numerical techniques, conduction and combined mode heat transfer. 3 credits, F.

Prerequisites: MAE 3440

Textbooks: The text is **Thermal Radiation Heat Transfer**, 4th Edition, by Robert Siegel.

Course Objectives:

- 1) To develop an understanding of radiation heat transfer phenomenon and its relationships with other modes of heat transfer.
- 2) To develop an understanding of the spectral nature of radiative properties of materials.
- 3) To learn how to predict radiation heat transfer between surfaces and in enclosures.
- 4) To learn how to predict radiation heat transfer in participating media.
- 5) To learn about the fundamentals of solar radiation.
- 6) To learn how to predict heat transfer with combined conduction, convection and radiation.
- 7) To enhance literature research and oral presentation skills.

Topics Covered:

- Fundamentals of radiation heat transfer phenomenon
- Radiation heat transfer between surfaces and in enclosures.
- Radiation heat transfer in participating media.
- Radiative properties of materials.
- Fundamentals of solar radiation.
- Combined conduction, convection and radiation.

Class Schedule: Two 75 min classes T and TR

Mechanical and Aerospace Engineering
MAE 6490
Turbulence

Syllabus

Course Description:

MAE 6490 - Solution of Reynolds-Averaged Navier-Stokes (RANS) equations using the finite-volume method. Emphasis on turbulence modeling for incompressible flows. Extensive computer programming required. 3 credits, Sp.

Prerequisites: MAE 6410 or instructor's consent.

Textbooks: The text is **An Introduction to Turbulent Flow**, By Jean Mathieu and Julian Scott.

References:

<http://www.cfd-online.com>

<http://www.fluent.com>

http://www.fluent.com/software/university/usc_student_form.htm

<http://www.fluent.com/software/university/curriculumexc/index.htm>

Course Objectives:

- 1) Understand the basic technique for discretizing the incompressible Reynolds-Averaged Navier-Stokes equations, including pressure-velocity coupling via the SIMPLE algorithm, in cartesian coordinates.
- 2) Develop a finite-volume RANS solver that will act as a "test bed" for turbulence models.
- 3) Develop an understanding of turbulence modeling and the ability to successfully implement algebraic and two-equation turbulence models into a RANS code.
- 4) Utilize the knowledge gained in the objectives listed above to demonstrate intelligent use of turbulence models within a commercial CFD solver (i.e., which models perform best for a given situation).

Topics Covered:

- Add code NS solver to accept turbulence models.
- Code algebraic models into your NS solver.
- Implement Wilcox solvers
- Continue algebraic model coding;
- Programming 2-equation models into your NS solver.
- FLUENT turbulence models for "well established" cases/geometries
- Programming 2 equation models

Class Schedule: Two 75 minute classes, T-R

MAE 6500
Potential Flow

Syllabus

Course Description:

MAE 6500 – Inviscid, irrotational fluid flow with emphasis on aircraft analysis and design. Exact solutions with complex variables and conformal mapping, perturbation methods, singularity elements and influence coefficients, lifting-line method, numerical vortex lattice method, numerical panel methods, software design and development. 3 credits, F.

Prerequisites: MAE 5500

Textbooks: The texts are **Principles of Ideal-Fluid Aerodynamics** by Karamcheti, **Vortex Dynamics** by Saffman, **Low-Speed Aerodynamics** by Katz and Plotkin and **Aerodynamics** by Phillips.

Course Objectives:

This course is designed to give graduate students in Mechanical and Aerospace Engineering an in-depth understanding of inviscid, irrotational fluid flow. The emphasis is on application of potential flow theory to topics in aerodynamics, including flow over airfoils, finite wings, and complete aircraft.

Topics Covered:

- Review of Vector Calculus, Irrotational Flow and Velocity Potential
- Review of Elementary Potential Flows
- The General Equations of Motion an Ideal Fluid
- Circulation and Lift, the General 3-D Vortex Lifting Law
- Two-Dimensional Solutions Using Complex Variables
- Review of Three-Dimensional Lifting-Line Theory
- The Three-Dimensional Numerical Vortex Lattice Method
- Three-Dimensional Numerical Vortex Panel Methods

Class Schedule:

Three 50 minute classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6510
Aircraft Dynamics and Flight Simulation

Syllabus

Course Description:

MAE 6510 – Aircraft control and maneuverability, control response and transfer functions, non-linear dynamics with gyroscopic and aerodynamic coupling, Euler angle formulations, direction cosine formulation, quaternion formulation, numerical integration methods, software design and development. 3 credits, Sp.

Prerequisites: MAE 5510

Textbooks: The text is **Mechanics of Flight**, by W. F. Phillips

Course Objectives:

This course is designed to give graduate students in Mechanical and Aerospace Engineering an in-depth understanding of flight dynamics for fixed wing aircraft. Emphasis is on the application of fundamental principles to the formulation and numerical solution of dynamics problems associated with an aircraft in flight, including non-linear gyroscopic and aerodynamic coupling and the non-linear dynamics of stalls, turns, and spins.

Topics Covered:

- Review of Aircraft Equations of Motion
- Six DOF Equations of Motion, Alternate Methods of Formulation
- The Euler-Rodrigues Quaternion Formulation
- Quaternion Algebra
- Numerical Integration of the Quaternion Formulation
- Response to Control Inputs
- Nonlinear Effects, Inertial and Gyroscopic Coupling
- Airplane Spin and Post Stall Maneuvers

Class Schedule:

Three 50 minutes classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6540
Astrodynamics

Syllabus

Course Description:

MAE 6540 – Fundamentals: n-body problem, two body-problems, Kepler's problem, and Lambert's problem. 3 credits, F.

Prerequisites: MAE 5520

Textbooks: The text is **Orbital Mechanics for Engineering Students**, by Howard D. Curtis.

References:

An Introduction to the Mathematical Methods of Astrodynamics by Richard H. Battin

Fundamentals of Astrodynamics by Bate, Mueller and White

Fundamentals of Astrodynamics and Applications by David A. Vallado

Course Objectives:

At the conclusion of this course the student should be able to: 1) Demonstrate an understanding of astrodynamics fundamentals such as the 2-body problem, Kepler's problem, and Lambert's problem; 2) demonstrate an understanding of several advanced space mission planning techniques; and 3) Demonstrate an ability to solve astrodynamics problems using numerical techniques.

Topics Covered:

- Universal variables
- Perturbation techniques
- Methods of orbit determination
- The restricted three-body problem
- Space mission planning techniques including relative motion for orbital rendezvous and interplanetary trajectory design

Class Schedule:

Three 50 minute classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6550
Advanced Structural Analysis

Syllabus

Course Description:

MAE 6550 – A treatment of various important topics structure engineers need to know about modern civil, mechanical, and aerospace structures. This course assumes an introductory background in the mechanics of solids while explaining subjects typically spread in various more advanced courses. 3 credits, Sp.

Prerequisites: MAE 6040

Textbooks: There is no textbook required. Lecture notes will be provided.

Course Objectives:

This course emphasizes concepts of mechanics through formulating and solving typical problems of engineering structures, and helps foster an in-depth understanding of the subject. Students not only gain a knowledge of the fundamental principles needed to analyze and design structures but also gain an integrated and consistent understanding of solid and structure mechanics based on linear elasticity.

Topics Covered:

- Review of vectors and tensors in Cartesian Coordinate Systems
- Introduction of Basic Mechanics Concepts: Traction/stress/equilibrium, deformation/strain/compatibility, and constitutive laws
- Variational and energy principles: calculus of variations, energy principles of mechanics
- Common structural components – beams: beam models, classical solutions for beams
- Common structural components – plates: plate models, classical solutions for plates
- Introduction to structural analysis codes including ANSYS, VABS, VAPAS, and DYMORE

Class Schedule:

Three 50 minute classes, M-W-F

Mechanical and Aerospace Engineering
MAE 6560/ECE 6930
Spacecraft Navigation

Syllabus

Course Description:

MAE 6560 – Principles of spacecraft navigation systems; probability theory and the fundamentals of stochastic processes; least-squares techniques and Kalman filtering for optimal state estimation; techniques in inertial, celestial, and satellite navigation; emphasis on applications of Kalman filters for spacecraft navigation problems. 3 credits, Sp.

Prerequisites: MAE 5310 or ECE 5310 or equivalent

Textbooks: The text is **Optimal Estimation of Dynamic Systems** by John L. Crassidis and John L. Junkins.

Course Objectives:

This course is designed to give graduate students in Mechanical, Aerospace, and Electrical Engineering an in-depth understanding of the principles of spacecraft navigation. Emphasis will be placed on applications of Kalman filters to solve realistic problems in celestial, inertial, and satellite navigation.

Topics Covered:

- Review of Mathematical Concepts, Probability Theory, Coordinate Transformations
- Least-Squares Estimation and Kalman Filtering
- Celestial Navigation, the Navigation Fix, Planet/Sun/Moon Angular Measurements
- Inertial Navigation, Strap-Down Systems, Inertial Platforms, Gyros, Accelerometers
- Satellite Navigation, GPS, Doppler data, Pseudorange Measurements

Class Schedule:

Three 50 minutes classes, M-W-F