**COURSE SYLLABI**

**MECHANICAL & AEROSPACE ENGINEERING**

**UTAH STATE UNIVERSITY**

| MAE Required Courses | | Credits | Offered | Course Coordinator |
|---|---|---|---|---|
| CHEM 1210 | Principals of Chemistry I | 4 | F/S | Adams |
| CHEM 1215 | Principals of Chemistry Lab I | 1 | F/S | Adams |
| MATH 1210 | Calculus I | 4 | F/S/Su | Adams |
| MATH 1220 | Calculus II | 4 | F/S/Su | Adams |
| MATH 2210 | Multivariable Calculus | 3 | F/S/Su | Adams |
| MATH 2250 | Linear Algebra and Diff. Eq. | 4 | F/S/Su | Adams |
| PHYS 2200 | Elements of Mechanics | 2 | F/S/Su | Adams |
| PHYS 2225 | Elements of Mechanics Lab | 1 | F/S/Su | Adams |
| PHYS 2220 | Gen. Phys. Science & Engr. II | 4 | F/S/Su | Adams |
| ENGR 2010 | Engineering Mechanics Statics | 3 | F/S | Adams |
| ENGR 2030 | Engr. Mech. Dynamics | 3 | F/S/Su | Adams |
| ENGR 2140 | Strength of Materials | 3 | F/S/Su | Adams |
| ETE 2210 | Fundamental Electronics for Engineers | 3 | F/S/Su | Adams |
| MAE 1200 | Engineering Graphics | 2 | F/S | Villanueva |
| MAE 2160 | Material Science | 3 | S | Roberts |
| MAE 2165 | Material Science Laboratory | 1 | S | Roberts |
| MAE 2300 | Thermodynamics I | 3 | S/Sum | Hailey |
| MAE 3040 | Mechanics of Solids | 3 | F | Folkman |
| MAE 3200 | Engineering Numerical Methods I | 3 | F | Spall |
| MAE 3210 | Numerical Methods II | 3 | S | Katz |
| MAE 3320 | Advanced Dynamics | 3 | F | Geller |
| MAE 3340 | Instr. & Measurements | 3 | S | Whitmore |
| MAE 3400 | Thermodynamics II | 3 | F | Quinn |
| MAE 3420 | Fluid Mechanics | 3 | F | Spall |

| | | | | |
|---|---|---|---|---|
| MAE 3440 | Heat & Mass Transfer | 3 | S | Ban |
| MAE 3600 | Professionalism & Ethics | 1 | F | Fullmer |
| MAE 4300 | Machine Design | 3 | S | Folkman |
| MAE 4400 | Fluids/Thermal Lab | 2 | F | Smith |
| MAE 4800 | Capstone Design I | 3 | F/S | Fullmer |
| MAE 4810 | Capstone Design II | 3 | F/S | Fullmer |
| MAE 5300 | Vibrations | 3 | F | Fronk |

**CHEM 1210 – Principles of Chemistry I**

**Required**

Credits and Contact Hours: 4 credits, 3.3 contact hours per week.

Course Coordinator: Alvan Hengge, Department Head, Chemistry

Textbook: "Chemistry: The Central Science" 12th Edition, Brown, Lemay, Bursten, Murphy & Woodward. Pearson Education.

Catalog Description: First of a two-semester sequence, covering fundamentals of chemistry. Designed for science and engineering students. 4 credits, Traditionally offered: Fall, Spring

Prerequisite/Restriction: Math ACT score of at least 25, or MATH 1050 or higher; or co-requisite of MATH 1050. High school chemistry recommended.

**Course Goals and Topics Covered:**

- Students will gain a fundamental understanding of the principles of fundamental chemistry. Specifically, students will be able to:
- Describe units of measurement for mass, length, velocity, time
- Use the metric system of units and perform conversions mathematically
- Perform calculations utilizing correct significant figures
- Identify and describe the different particles inside an atom and describe the structure of an atom
- Describe the Periodic Table as it relates to atomic number, atomic mass, valence electron count
- Be able to name simple atoms and general ionic and molecular compounds
- Balance chemical equations
- Differentiate between a chemical formula and an empirical formula
- Define units of solution concentration
- Define an acid, a base, a salt, and electrolyte
- Calculate formula weights and perform stoichiometric calculations
- Determine theoretical yields and experimental yields
- Utilize the First Law of thermodynamics and the Law of Hess; predict enthalpies for chemical processes
- Describe the nature of electromagnetic radiation
- Describe the origin of line spectra and how it relates to the development of quantum numbers
- Describe the forces that favor the formation of the H2 molecule over two isolated H atoms
- Describe Bohr orbitals and the structure of a many-electron atom
- Describe and draw the shapes of the Hydrogenic Obitals (s, p, d, f)
- Utilize the Periodic Table to predict atomic trends in size, ionization energies, electron attachment

- Draw Lewis diagrams for atoms and polyatomic species
- Describe the Octet Rule and draw resonance structures
- Predict molecular shapes using the Valence Shell Electron Repulsion Model
- Predict molecular polarity
- Differentiate single, double, and triple bonds and estimate bond relative bond energies
- Describe the notion of hybrid orbitals and when this approximation works
- Describe the properties of gases and utilize the gas laws of Boyle, Charles, and Avogadro
- Perform calculations using the Ideal Gas Law and understand the associated pitfalls
- Describe and differentiate between the solid, liquid, and gas phases
- Draw and use a phase diagram to describe temperature and pressure relationships
- Define the term colligative property
- Show how vapor pressure of a solvent is affected by solute concentration

**Relationship of Course to Student Outcomes:**

| | Student Outcomes | Course * Outcomes |
|---|---|---|
| a) | an ability to apply knowledge of mathematics, science, and engineering, | ✓ |
| b) | an ability to design and conduct experiments, as well as to analyze and interpret data, | |
| c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| d) | an ability to function on multi-disciplinary teams, | |
| e) | an ability to identify, formulate, and solve engineering problems, | |
| f) | an understanding of professional and ethical responsibility | |
| g) | an ability to communicate effectively | |
| h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| i) | a recognition of the need for, and an ability to engage in life-long learning | |
| j) | a knowledge of contemporary issues, | |
| k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |

| | | |
|---|---|---|
| l) | an ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems. | |
| *An ✓ indicates that this course helps the students to achieve the Student Outcomes. | | |

Last Updated: July 31, 2013

## CHEM 1215 – Chemical Principles Laboratory I

**Required**

Credits and Contact Hours: 1 credits, 3 contact hours per week.

Course Coordinator: Alvan Hengge, Department Head, Chemistry

Textbook: "Chemistry: The Central Science" 12th Edition, Brown, Lemay, Bursten, Murphy & Woodward, Pearson Education.

Catalog Description: Laboratory course designed to be taken concurrently with CHEM 1210. The laboratory class offers hands-on experience related to the topics taught in the lecture sequence.

Prerequisite: CHEM 1210 (may be taken concurrently).

**Course Goals and Topics Covered:**

- Students will engage in laboratory experiences that are designed to complement the CHEM 1210 lecture course. Specifically, students will be able to:
- apply basic chemistry laboratory techniques
- assess data
- synthesize compounds
- determine chemical composition and characteristics
- conduct chemical separations
- characterize reactions
- Topics Covered:
- Basic lab techniques
- Separation of the components of a mixture
- Chemical reactions – a "greener" approach
- Chemical formulas
- Chemical reactions of Cu and % yield
- Gravimetric analysis of a chloride salt
- Paper chromatography
- Heats of neutralization
- Atomic spectra
- Behavior of gases

**Relationship of Course to Student Outcomes:**

| | Student Outcomes | Course *<br>Outcomes |
|---|---|---|

| | | |
|---|---|---|
| a) | an ability to apply knowledge of mathematics, science, and engineering, | ✓ |
| b) | an ability to design and conduct experiments, as well as to analyze and interpret data, | ✓ |
| c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| d) | an ability to function on multi-disciplinary teams, | |
| e) | an ability to identify, formulate, and solve engineering problems, | |
| f) | an understanding of professional and ethical responsibility | |
| g) | an ability to communicate effectively | |
| h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| i) | a recognition of the need for, and an ability to engage in life-long learning | |
| j) | a knowledge of contemporary issues, | |
| k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |
| *An ✓ indicates that this course helps the students to achieve the Student Outcomes. | | |

Last Updated: July 31, 2013

**MATH 1210, Section 001 – Calculus I**
**Required**

Credits and Contact Hours: 4 credits, 3 contact hours per week

Course Instructor: Michael Snyder

Textbook: University Calculus by Hass, Weir, and Thomas.

Catalog Description: Analytic geometry, differential and integral calculus, transcendental functions, and applications. Graphing calculator required.

Prerequisites/Co-requisites: Prerequisite/Restriction: One of the following within the last year or three consecutive semesters (including summer); ACT Math score of at least 27; SAT Math score of at least 620; AP Calculus AB score of at least 3; Grade of C- or better in MATH 1050 and MATH 1060; or satisfactory score on the Math Placement Exam.

**Course Goals:**

Math 1210 is an introduction to analytic geometry, differential and integral calculus, transcendental functions, and applications in scientific disciplines.

**Topics Covered:**

- Limits and Continuity
- Differentiation
- Applications of Derivatives
- Integration
- Applications of Definite Integrals

**Relationship of Course to Student Outcomes:**

| | Student Outcomes | Course * Outcomes |
|---|---|---|
| a) | an ability to apply knowledge of mathematics, science, and engineering, | ✓ |
| b) | an ability to design and conduct experiments, as well as to analyze and interpret data, | |
| c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| d) | an ability to function on multi-disciplinary teams, | |
| e) | an ability to identify, formulate, and solve engineering problems, | |
| f) | an understanding of professional and ethical responsibility | |

| | | |
|---|---|---|
| g) | an ability to communicate effectively | |
| h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| i) | a recognition of the need for, and an ability to engage in life-long learning | |
| j) | a knowledge of contemporary issues, | |
| k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |
| l) | an ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems. | |
| *An ✓ indicates that this course helps the students to achieve the Student Outcomes. | | |

**MATH 1220, Section 001 – Calculus II**
**Required**

Credits and Contact Hours: 4 credits, 3 contact hours per week

Course Instructor: Ju Yi

Textbook: "University Calculus", by Hass, Weir, & Thomas

Catalog Description: Integration, infinite series, introduction to vectors, and applications. Graphing calculator required.

Prerequisites/Co-requisites: C- or better in MATH 1210, or AP score of at least 4 on Calculus AB exam or at least 3 on Calculus BC exam.

**Course Goals:**

Integration, infinite series, introduction to vectors, and applications, covering section 6.4 through chapter 11 of the text. Emphasis will be placed upon gaining an understanding of the core concepts of calculus, becoming fluent in the language of mathematics, acquiring computational skill, and acquiring the ability to use calculus for solving problems. Your homework and exams will reflect all of these objectives.

**Topics Covered:**

- Applications of Definite Integrals
- Techniques of Integration
- Infinite Sequences and Series
- Polar Coordinates and Conics
- Vectors and the Geometry of Space
- Vector-Valued Functions and Motion in Space

**Relationship of Course to Student Outcomes:**

| | Student Outcomes | Course * Outcomes |
|---|---|---|
| a) | an ability to apply knowledge of mathematics, science, and engineering, | ✓ |
| b) | an ability to design and conduct experiments, as well as to analyze and interpret data, | |
| c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| d) | an ability to function on multi-disciplinary teams, | |
| e) | an ability to identify, formulate, and solve engineering problems, | |

| | | |
|---|---|---|
| f) | an understanding of professional and ethical responsibility | |
| g) | an ability to communicate effectively | |
| h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| i) | a recognition of the need for, and an ability to engage in life-long learning | |
| j) | a knowledge of contemporary issues, | |
| k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |
| l) | an ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems. | |
| *An ✓ indicates that this course helps the students to achieve the Student Outcomes. | | |

**MATH 2250 – Linear Algebra and Differential Equations**
**Required**

Credits and Contact Hours: 4 credits, 3 contact hours per week

Course Instructor: Claire Watson

Textbook: Differential Equations and Linear Algebra: by C. Henry Edwards, David E. Penney and David Calvis, Third Edition.

Catalog Description: Linear systems, abstract vector spaces, matrices through eigenvalues and eigenvectors, solution of ode's, Laplace transforms, first order systems.

Prerequisites/Co-requisites: C- or better in Math 1220; or AP Calculus score of 5 on BC exam and C- or better in MATH 2210.

**Coarse Goals and Topics Covered:**

- First order equations
- Mathematical Modeling
- Numberical Methods
- Linear Systems and matrices
- Vector Spaces
- Eigenvectors and Eigenvalues
- Linear Algebra Concepts
- Solution of Linear Ordinary Differential Equations
- Laplace Transforms and First Order Symptoms

**Relationship of Course to Student Outcomes:**

| | Student Outcomes | Course * Outcomes |
|---|---|---|
| a) | an ability to apply knowledge of mathematics, science, and engineering, | ✓ |
| b) | an ability to design and conduct experiments, as well as to analyze and interpret data, | |
| c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| d) | an ability to function on multi-disciplinary teams, | |
| e) | an ability to identify, formulate, and solve engineering problems, | |
| f) | an understanding of professional and ethical responsibility | |

| | | |
|---|---|---|
| g) | an ability to communicate effectively | |
| h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| i) | a recognition of the need for, and an ability to engage in life-long learning | |
| j) | a knowledge of contemporary issues, | |
| k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |
| l) | an ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems. | |
| *An ✓ indicates that this course helps the students to achieve the Student Outcomes. | | |

**PHYS 2200 – Elements of Mechanics**

**Required**

Credits and Contact Hours: 2 credits, 3.3 contact hours per week for half a semester.

Course Coordinator: Jan Sojka, Department Head, Physics

Textbook: "Essential University Physics," Second Edition, 2011, Richard Wolfson, Addison Wesley

Catalog Description: Calculus-based introduction to particle mechanics. Kinematics, Newton's laws of motion, momentum, work and energy, and angular momentum. Required recitation and lab.

Prerequisite: MATH 1210.

**Course Goals and Topics Covered:**

This is a basic physics course that covers fundamental concepts in motion, forces, energy, momentum, and rotational motion. Students will understand the following concepts:

- Units and Solving Physics Problems
- 1D Motion
- 2D and 3D Motion
- Newton's Laws
- Forces and Motion
- Work and Energy
- Energy Conservation
- Gravity
- Systems of Particles
- Rotation
- Angular Momentum

**Relationship of Course to Student Outcomes:**

| | Student Outcomes | Course * Outcomes |
|---|---|---|
| a) | an ability to apply knowledge of mathematics, science, and engineering, | ✓ |
| b) | an ability to design and conduct experiments, as well as to analyze and interpret data, | |
| c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| d) | an ability to function on multi-disciplinary teams, | |

| | | |
|---|---|---|
| e) | an ability to identify, formulate, and solve engineering problems, | |
| f) | an understanding of professional and ethical responsibility | |
| g) | an ability to communicate effectively | |
| h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| i) | a recognition of the need for, and an ability to engage in life-long learning | |
| j) | a knowledge of contemporary issues, | |
| k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |
| *An ✓ indicates that this course helps the students to achieve the Student Outcomes. | | |

Last Updated: August 29, 2013

**PHYS 2220 - General Physics–Science and Engineering II**

**Required**

Credits and Contact Hours: 4 credits, 3.3 contact hours per week.

Course Coordinator: Jan Sojka, Department Head, Physics

Textbook: "Essential University Physics," Second Edition, 2011, Richard Wolfson, Addison Wesley.

Catalog Description: The study of waves, electricity and magnetism, optics, and quantum phenomena. Topics include electric and magnetic forces and fields, electric potential, Maxwell's equations, DC and AC circuits, geometrical optics, wave nature of light, special relativity, and atomic, molecular, nuclear phenomena. Lecture and required recitation.

Prerequisite/Restriction: MATH 1210; PHYS 2200 or PHYS 2210, or a minimum score of 4 or higher on the AP Physics B exam, or a minimum score of 3 on the AP Physics C (Mechanics) exam.

**Course Goals and Topics Covered:**

- Students will understand the following concepts:
- Electric charge, force and field
- Gauss' law
- Electrical potential
- Electrical energy and capacitors
- Electric current
- Electric circuits
- Magnetism: force and field
- Electromagnetic induction
- AC circuits
- Maxwell's relations
- Reflection, refractions, lenses
- Relativity
- Particles and waves
- Quantum mechanics

**Relationship of Course to Student Outcomes:**

| | Student Outcomes | Course * Outcomes |
|---|---|---|
| a) | an ability to apply knowledge of mathematics, science, and engineering, | ✓ |

| | | |
|---|---|---|
| b) | an ability to design and conduct experiments, as well as to analyze and interpret data, | |
| c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| d) | an ability to function on multi-disciplinary teams, | |
| e) | an ability to identify, formulate, and solve engineering problems, | |
| f) | an understanding of professional and ethical responsibility | |
| g) | an ability to communicate effectively | |
| h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| i) | a recognition of the need for, and an ability to engage in life-long learning | |
| j) | a knowledge of contemporary issues, | |
| k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |
| *An ✓ indicates that this course helps the students to achieve the Student Outcomes. | | |

Last Updated: August 6, 2013

**PHYS 2225 – Physics for Scientists and Engineers - Lab II**

**Required**

Credits and Contact Hours: 1 credit, 3 contact hours per week.

Course Coordinator: Jan Sojka, Department Head, Physics

Textbook: "Essential University Physics," 2nd Edition, Richard Wolfson, Addison Wesley.

Catalog Description: Computer assisted laboratory investigations of wave, electricity and magnetism, optics and quantum physics principles taught in PHYS 2220.

Prerequisite/Restriction PHYS 2220 (may be taken concurrently)

**Course Goals and Topics Covered:**

Students will be able to:

- make physical measurements using instrumentation
- develop basic skills in error analysis
- prepare laboratory reports
- Topics Covered:
- Basic lab techniques
- Error analysis
- Refraction and thin lenses
- Interference
- Electric fields and potentials
- Simple resistive circuits
- RC Circuits
- Resonance in a driven LCR circuit
- Build RC circuits
- Optical spectroscopy
- Inverse photoelectric effect and Planck's constant

**Relationship of Course to Student Outcomes:**

| | Student Outcomes | Course * Outcomes |
|---|---|---|
| a) | an ability to apply knowledge of mathematics, science, and engineering, | ✓ |
| b) | an ability to design and conduct experiments, as well as to analyze and interpret data, | ✓ |

| | | |
|---|---|---|
| c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| d) | an ability to function on multi-disciplinary teams, | |
| e) | an ability to identify, formulate, and solve engineering problems, | |
| f) | an understanding of professional and ethical responsibility | |
| g) | an ability to communicate effectively | |
| h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| i) | a recognition of the need for, and an ability to engage in life-long learning | |
| j) | a knowledge of contemporary issues, | |
| k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |
| *An ✓ indicates that this course helps the students to achieve the Student Outcomes. | | |

Last Updated: August 6, 2013

**Engr 2010 Engineering Mechanics – Statics**

**Required**

Credits and contact hours: 3 credits, 3 contact hours per week from lecture 1 hour per week recitation

Instructor: Wade Goodridge, William Rahmeyer

Textbook: Engineering Mechanics-Statics and Dynamics, 13th edition, by Hibbeler, Prentice Hall, 2013

Catalog Description: Introductory mechanics course focusing on force and position vectors; equilibrium of particles; rigid bodies; equivalent system of forces; equilibrium; free body diagrams; static analysis of trusses, frames, and machines; centroids and centers of gravity; friction; and moments of inertia.

Prerequisites: PHYS 2210 (Physics for scientists and engineers I), Math 1210 (Calculus I), Math 1220 (Calculus II); Co-requisites: none

**Coarse Goals:**

Gaining factual knowledge (terminology, classifications, methods, trends) by conducting assigned reading and attending lecture were content will be delivered and interacting with instructor and other students discussing and demonstrating procedures and terminology.

Learning fundamental principles, generalizations, or theories by attending lecture to learn correct methods of problem solving, practicing and demonstrating techniques and procedures for analysis with homework problems and quizzes, and attending recitation and help sessions to refine knowledge gathered in lecture and readings.

Learning to apply course material (to improve thinking, problem solving, and decisions) with

techniques and procedures by following proper given and find homework style forcing problem understanding prior to starting the solving process and developing proper free body diagrams in homework clearly eliciting known and desired unknowns.

**Topics Covered:**

- Force and Cartesian vectors
- Equilibrium of a particle and Free Body diagrams
- Moments, moments about an axis, moment couples
- Equivalent force systems
- Distributed loading
- 2D equilibrium and 2 force members
- 3D equilibrium and rigid body constraints
- Trusses-method of joint and method of sections
- Frames and Machines
- Shear and moment equations

- Shear and moment diagrams
- Friction
- Center of gravity, center of mass, centroids
- Composite bodies
- Fluid pressure
- Moment of Inertia
- Product of Inertia for an area

**Relationship of Course to Student Outcomes:**

a. an ability to apply knowledge of mathematics, science and engineering

e. an ability to identify, formulate, and solve engineering problems

k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**ENGR 2030 Dynamics**

**Required**

Credits and contact hours: 3 credits. The class meets three times each week: Monday, Wednesday, and Friday. Each lecture is 50 minutes.

Course Coordinator: Dr. Ning Fang

Text book: "Engineering Mechanics: Dynamics," 13th edition, R. C. Hibbler, 2012.

Catalog Description: The course covers Newtonian mechanics, including equations of motion, kinetics of particles, kinetics of rigid bodies, work and energy, impulse and momentum, three-dimensional kinematics, and vibrations.

Prerequisite: ENGR 2010 Statics

**Coarse Goals:**

The goals of the course are to help students learn fundamental principles, generalizations, and theories, and apply course materials to improve thinking and problem solving. In particular, students will develop abilities to solve kinematics and dynamics problems for a particle (point mass) and for a planar rigid body by using

**Topics Covered:**

- Chapter 12 Kinematics of a Particle: Rectilinear Kinematics: Continuous Motion and Erratic Motion; Curvilinear Motion: Rectangular Components, Normal and Tangential Components, and Cylindrical Components; Motion of a Projectile; Absolute Dependent Motion Analysis of Two Particles; Relative-Motion of Two Particles Using Translating Axes
- Chapter 13 Kinetics of a Particle: Force and Acceleration: Newton's Second Law of Motion; The Equation of Motion; Equation of Motion for a System of Particles; Equations of Motion: Rectangular Coordinates, Normal and Tangential Coordinates, Cylindrical Coordinates
- Chapter 14 Kinetics of a Particle: Work and Energy: The Work of a Force; Principle of Work and Energy; Principle of Work and Energy for a System of Particles; Power and Efficiency; Conservative Forces and Potential Energy; Conservation of Energy
- Chapter 15 Kinetics of a Particle: Impulse and Momentum: Principle of Linear Impulse and Momentum; Principle of Linear Impulse and Momentum for a System of Particles; Conservation of Linear Momentum for a System of Particles; Impact; Angular Momentum; Relation Between Moment of a Force and Angular Momentum; Principle of Angular Impulse and Momentum
- Chapter 16 Planar Kinematics of a Rigid Body: Planar Rigid-Body Motion; Translation; Rotation about a Fixed Axis; Absolute Motion Analysis; Relative-Motion Analysis: Velocity; Instantaneous Center of Zero Velocity; Relative-Motion Analysis: Acceleration
- Chapter 17 Planar Kinetics of a Rigid Body: Force and Acceleration: Moment of Inertia; Planar Kinetic Equations of Motion; Equations of Motion: Translation, Rotation about a Fixed Axis, General Plane Motion

- Chapter 18 Planar Kinetics of a Rigid Body: Work and Energy: Kinetic Energy; The Work of a Force; The Work of a Couple; Principle of Work and Energy; Conservation of Energy
- Chapter 19 Planar Kinetics of a Rigid Body: Impulse and Momentum: Linear and Angular Momentum; Principle of Impulse and Momentum; Conservation of Momentum; Eccentric Impact
- Chapter 22 Vibration: Undamped Free Vibration; Undamped Forced Vibration

**Relationship of Course to Student Outcomes**

3a) an ability to apply knowledge of mathematics, science and engineering

Updated: October 2013

## ENGR 2140 Strength of Materials

**Required**

Credits and contact hours: 3 credits, 2.5 contact hours per week

Instructors: Joseph A. Caliendo (Fall), James Bay (Spring)

Textbook: Mechanics of Materials, 8th Edition, Geere & Goodno, Cengage, 2009.

Catalog description: Stress, strain, and deflection due to axial loads; moment and torsion; shear and moment diagrams; and equations of equilibrium and compatibility.

Prerequisites: ENGR 2010 Statics

### Course Goals:

To develop an understanding of the relationship between loads applied to a deformable body and the internal stress, strain, and deformations induced in the body. In addition, analytical and problem-solving skills are developed.

### Topics Covered:

- normal stress and shear stress & strain
- indeterminate structures
- thermal effects
- stresses on inclined sections
- transmission of power
- indeterminate torsion
- shear and bending moment diagrams
- bending stresses
- Mohr’s Circle
- combined stresses

### Relationship of Course to Student Outcomes:

3a) an ability to apply knowledge of mathematics, science and engineering

3h)

Updated: August, 2013

**ENGR-2210 – Fundamental Electronics for Engineers**

**Required**

Credits and contact hours: 3 credits, three 50-minutes classes (during fall semester) or two 75 minutes classes (during spring semester) per week

Course Coordinator: Oenardi Lawanto (Engineering Education)

Textbook: Pearson Custom Electronics Technology, ENGR 2210, Volume I, Utah State, Pearson Learning Solutions, 2011.

Pearson Custom Electronics Technology, ENGR 2210, Volume II, Utah State, Pearson Learning Solutions, 2011.

Catalog Description: A study and application of DC/AC and digital concepts which includes circuit fundamentals, theorems, laws, analysis, components, digital design fundamentals, and combinational circuits design, equipment and measuring devices. The laboratory will include circuit design, construction, and analysis of DC/AC circuits, and the use of measuring instruments, power supplies and signal generators.

Prerequisites: MATH-1210 and MATH-1220

**Course Goals and Topics Covered:**

- Students will apply theorems to analyze circuits in series, parallel, and compound.
- Students will design and analyze simple combinational digital logic circuits.
- Students will build and analyze simple analog circuits on a bread board.
- Students will use an oscilloscope, digital multi meter, power supply, and frequency generator.
- Brief list of topics to be covered:
- DC voltage, current, and resistance
- Ohms' law, power, energy, and efficiency
- Kirchhoff Voltage and Current Law
- Mesh and nodal analysis of DC resistive circuits
- Superposition Theorem
- Thevenin and Norton Theorem
- Capacitor in series and parallel
- R-C transients
- Inductor in series and parallel
- R-L transients
- Response of basic R, L and C elements to a sinusoidal voltage/current
- Series and parallel AC circuits
- Digital and number systems

- Logic gates and Boolean operation
- Combinational logic circuit

**Relationship of Course to Student Outcomes**

| Program outcomes | | Course* outcomes |
|---|---|---|
| **a)** | An ability to apply knowledge of mathematics, science, and engineering | X |
| **b)** | An ability to design and conduct experiments, as well as to analyze and interpret data | X |
| **c)** | An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| **d)** | An ability to function on multi-disciplinary teams | |
| **e)** | An ability to identify, formulate, and solve engineering problems | X |
| **f)** | An understanding of professional and ethical responsibility | |
| **g)** | An ability to communicate effectively | |
| **h)** | The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| **i)** | A recognition of the need for, and an ability to engage in life-long learning | |
| **j)** | A knowledge of contemporary issues | |
| **k)** | An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | X |
| **l)** | An ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems | |
| **[*] An X indicates that this course helps the students to achieve the Program outcomes** | | |

**MAE 1200 – Engineering Graphics**

**Required**

Credits and Contact Hours: 2 credits, 4 contact hours per week

Course Coordinator: Idalis Villanueva

Textbook: Artistic Engineering – An Introduction to Mechanical Design, John Devitry

Catalog Description: 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, Fall, Sp.

Prerequisites: MATH 1060 or Math ACT score of 27 or higher or AP Calculus score of 3 or higher.

**Course Goals:**

The objective of the course is to teach the fundamental principles of engineering design using engineering graphics as the baseline. In essence, a student should be able to do the following by the end of the semester:

Understand in basic form the role of SolidEdge on developing design ideas based on mechanical assemblies and functional systems

Apply knowledge of SolidEdge software application in generating complete and accurate set of drawings

Design a creative and engineering-based project idea through sketching, sectional and multi-view drawings, auxiliary views, and assemblies using SolidEdge

Demonstrate creative thinking, problem-solving, critical thinking, and cooperative teamwork through engineering design projects

**Topics Covered:**

- Cartesian Coordinate System and Planar Views
- Extrusion, Protrusions, Revolutions
- Sweep and Loft
- Relate Commands
- Introduction to Dimensioning
- Sheet Metal
- Rounding, thin wall and lip
- Mass and Physical Properties
- Assemblies and Motion
- Engineering Design Principles
- 3-D Modeling and Simulation
- Geometric Dimensioning and Tolerancing

**Relationship of Course to Student Outcomes:**

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

3l) An ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems.

3l1: Students design a mechanical system, component, or process.

Last Updated: January 24, 2014

Approved by MAE Faculty: October 2013

**Official Syllabus**

**MAE 2160 – Material Science**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Nick Roberts

Textbook: Material Science and Engineering – An Introduction, Interactive Software Set, 8th Edition, William Callister, Jr., John Wiley.

Catalog Description: Study of atomic and microscopic structures of metals, polymers, ceramics, and composite materials, and how these structures affect material properties. 3 credits, Sp.

Prerequisites: CHEM 1210 and ENGR 2140 (both may be taken concurrently).

**Course Goals:**

- The objective of the course is to teach the fundamental principles of materials science so that the student can:
- Explain material behavior based on microstructure,
- Solve problems which relate material structure and properties to behavior,
- Select appropriate materials for a given application,
- Understand the failure of materials, and
- Understand why different materials require different processing conditions for their manufacture and use.

**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 Materials & Behavior
- Composite Materials

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering,

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2013

**MAE 2165 – Material Science**

**Required**

Credits and Contact Hours: 1 credit, 2 contact hours per week

Course Coordinator: Nick Roberts

Textbook: Material Science and Engineering – An Introduction, Interactive Software Set, 8th Edition, William Callister, Jr., John Wiley.

Catalog Description: Laboratory sessions held weekly where the mechanical and thermal properties of metals, polymers, ceramics, and composite materials are studied. 1 credit, Sp.

Prerequisites: MAE 2160 (prerequisite or corequisite).

**Course Goals:**

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

**Topics Covered:**

- Tensile Testing
- Glass Fracture
- Phase Diagrams / Thermal Analysis of Materials Behavior
- Age-hardening of aluminum alloys
- 
- Hardenability of Steels
- Metallography and microstructure
- Mechanical Properties of Polymeric Materials
- Melt Flow Indexing of a Polymer
- Composites

**Relationship of Course to Student Outcomes:**

3b) An ability to design and conduct experiments, as well as to analyze and interpret data,

3b2: Students perform experiments and operate instrumentation in a manner appropriate for the required accuracy.

3b3: Uses appropriate tools to analyze data and verifies and validates experimental results including the use of statistics to account for possible experimental error.

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Last Updated: August 6, 2013

Approved by MAE Faculty: October 2013

**MAE 2300 – Thermodynamics I**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week.

Course Coordinator: Christine Hailey

Textbook: Thermodynamics - An Engineering Approach, 7th Edition, Cengel and Boles, McGraw-Hill.

Catalog Description: First and second laws of thermodynamics; analysis of open and closed systems; equations of state; power and refrigeration cycles; problem solving methodology. 3 credits, F, Sp, Su.

Prerequisites: MATH 1220; MATH 2210 (may be taken concurrently)

**Course Goals:**

- Students will gain a fundamental understanding of the principles of classical thermodynamics. Specifically, students will be able to:
- Describe the thermodynamic properties of a pure substance using tabular data and equations of state.
- Apply the 1st Law of Thermodynamics to analyze idealized closed and open systems
- Apply the 2nd Law of Thermodynamics in order to analyze idealized closed and open system
- Apply ideal cycle analysis to simple power and refrigeration cycles.

**Topics Covered:**

- Thermodynamics concepts including system, state, state postulate, equilibrium, process and cycle
- Heat, work, first law of thermodynamics, energy balances, energy transfers to and from a system
- Properties of a pure substance
- Energy balances for an idealized closed systems
- Energy and mass balances for idealized control volumes
- Second law of thermodynamics, Carnot cycles, thermal efficiencies
- Entropy, isentropic processes, isentropic efficiencies
- Idealized power cycles: Otto, Diesel, Rankine
- Idealized refrigeration cycles: vapor compression cycle

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering,

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3e) An ability to identify, formulate, and solve engineering problems,

3e1: Students apply scientific and engineering principles to formulate a complete mathematical model appropriate for the engineering problem.

3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model.

3e3: Students understand the accuracy associated with the analytical, numerical, or experimental method being used.

Last Updated: August 6, 2013

Approved by MAE Faculty: October 2013

**MAE 3040 – Mechanics of Solids**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week.

Course Coordinator: Steven Folkman

Textbook: Advanced Mechanics of Materials, 6th Edition, A. P. Boresi, R. J. Schmidt John Wiley.

Catalog Description: Stress, strain, and deflection due to flexure and shear. Combined stresses, instability, nonsymmetric bending, torsion, and energy methods. 3 credits, F.

Prerequisites: ENGR 2140.

**Course Goals:**

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

**Topics Covered:**

- Three dimensional stress, strain, and displacement relationship
- Hooke's 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

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering,

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability,

3c2: Students identify the realistic constraints on a design problem.

3c3: Students develop criteria for acceptability and desirability of solutions.

3c4: Students apply appropriate scientific and engineering principles to design a system, component, or process that meets desired needs.

3e) An ability to identify, formulate, and solve engineering problems,

3e1: Students apply scientific and engineering principles to formulate a complete mathematical model appropriate for the engineering problem.

3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model.

3e3: Students understand the accuracy associated with the analytical, numerical, or experimental method being used.

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Last Updated: August 6, 2013

Approved by MAE Faculty: October 2013

## MAE 3200 – Engineering Numerical Methods I

**Required**

Credits and Contact Hours: 3 credits, 100 contact min and one 75 min lab per week

Course Coordinator: Bob Spall

Textbook: Fortran 95/2003 for Scientists and Engineers, 3rd Edition, Stephen J. Chapman, McGraw-Hill.

Catalog Description: Introduction to computational methods, emphasizing software development using FORTRAN 95 (2 credits) and MATLAB (1 credit). 3 credits, F.

**Course Goals:**

To develop programming skills in Foran90/95 and Matlab, 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 Fortran 90
- Control structures
- I/O concepts
- Arrays
- MATLAB fundamentals
- MATLAB graphics
- Procedures and structured programming
- Additional data types
- Programming applications
- In general, Chapters 1-9 in textbook.
- MATLAB programming
- MATLAB M-Files

**Relationship of Course to Student Outcomes:**

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Last Updated: August 6, 2013

Approved by MAE Faculty: October 2013

**MAE 3210 – Engineering Numerical Methods II**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Aaron Katz

Textbook: Numerical Methods for Engineers with Software and Programming Applications, 6th Ed., Chapra and Canale, McGraw-Hill.

Catalog Description: Explores basic tools of numerical analysis, solution to ordinary and partial differential equations, software development using FORTRAN 95, and applications using computer algebra packages. 3 credits, Sp.

Prerequisites: MAE 3200; MATH 2210, MATH 2250 (may be taken concurrently).

**Course Goals:**

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 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

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering,

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3b) An ability to design and conduct experiments, as well as to analyze and interpret data.

3b2) Students design and perform experiments and operate instrumentation in a manner appropriate for the required accuracy.

3e) An ability to identify, formulate, and solve engineering problems, 3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model.

3e3: Students understand the accuracy associated with the analytical, numerical, or experimental method being used.

3g) An ability to communicate effectively

3g2: Students use appropriate graphical standards in written and oral communications.

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Last Updated: August 6, 2013

Approved by MAE Faculty: October 2013

**MAE 3320 – Advanced Dynamics**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week.

Course Coordinator: David Geller

Textbook: Principles of Dynamics, Donald Greenwood, Prentice Hall, 1988

Catalog Description: 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 3200 (may be taken concurrently).

**Course Goals:**

At the conclusion of this course the student should be able to:

- Demonstrate ability to formulate and solve kinematics and dynamics problems for systems of particles in general 3-dimensional motion.
- Demonstrate ability to formulate and solve dynamics problems for rigid bodies in general 3-dimensional motion.
- Demonstrate an understanding of analytical dynamics and an ability to obtain equations of motion using Lagrangian approach.
- Demonstrate an understanding and an ability to solve simple spring-mass-damper systems.
-

**Topics Covered:**

- 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

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3e) An ability to identify, formulate, and solve engineering problems

3e1: Students apply scientific and engineering principles to formulate a complete mathematical model appropriate for the engineering problem.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2013

**MAE 3340 – Instrumentation and Measurements**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours and 2 hours lab per week

Course Coordinator: Stephen A. Whitmore

Textbook: Theory and Design for Mechanical Measurements, Figliola, Richard, and Beasley Donald E., Wiley, 2011 ISBN: ISBN 978-0-470-54741-0.

Also available as e-book: ISBN: 978-0-470-91208-9

Catalog Description: 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, ENGR 2210, MAE 3420

**Course Goals:**

- Provide mechanical engineering graduates with sufficient skill to design experiments, assembly measurement apparatus, acquire and process data, and evaluate accuracy of experimental results. At the completion of this course students will have the ability to
- Acquire the common mechanical measurement signals in the laboratory using computer based data acquisition systems,
- Design measurement systems including transducer and sensing element selection, signal conditioning, sampling, and data logging,
- Understand the characteristics of measurement signals; effects of data sampling, Nyquist frequency, aliasing, bandwidth, frequency resolution,
- Understand the response of measurement systems and instruments, frequency response analysis, Fourier analysis, spectral decomposition using fast Fourier transform (FFT),
- Analyze and classify measurement data using the basic theory of error, probability theory and statistics. Apply sample mean, variance, normal and student-T probability distributions to assess measurement error, predict confidence intervals.
- Perform basic curve fitting of measurement data, and assess goodness of fit using Chi-square analysis.

**Topics Covered:**

- Types of measurement methods and measurement standards
- Strain gauges
- Wheatstone bridge
- Static error propagation, uncertainty analysis, and random effects in data
- Normal and Student-t distribution, confidence intervals
- Sensor calibration, curve-fits and error models

- Pressure, temperature, strain, acceleration, and vibration measurements
- Time response of sensors and the effects on data, 1st, 2nd-order systems
- Frequency response, Fourier modeling of time-varying signals, Fast Fourier Transform (FFT)
- Sampling of time-varying signals, analog to digital signal conversion
- Operational Amplifiers and active signal conditioning, including filtering
- Programmable Logic Circuits (PLCs)

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3b) An ability to design and conduct experiments, as well as to analyze and interpret data

3b1: Determines data that are appropriate to collect and selects appropriate equipment, protocols, etc. for measuring the appropriate variables to get accurate test results

3b2: Students perform experiments and operate instrumentation in a manner appropriate for the required accuracy.

3b3: Uses appropriate tools to analyze data and verifies and validates experimental results including the use of statistics to account for possible experimental error.

3e) An ability to identify, formulate, and solve engineering problems

3e3: Students understand the accuracy associated with the analytical, numerical, or experimental method being used.

3g) An ability to communicate effectively

3g1: Students apply the correct technical style and format appropriate for the audience.

3g2: Students use appropriate graphical standards in written and oral communications.

3g3: Students apply the rules of grammar and composition appropriately in written communication.

Last Updated: August 6, 2013

Approved by MAE Faculty: October 2013

**MAE 3400 – Thermodynamics II**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Barton Smith III

Textbooks: Thermodynamics, An Engineering Approach, 7th Edition, Y.A. Cengal and M.A. Boles, McGraw Hill, (first 2/3 of course)

Fundamentals of Heat and Mass Transfer, 6th Ed., F.P. Incropera, D.P. DeWitt, T.L. Bergman and A.S. Lavine, Wiley, (last 1/3 of course)

Catalog Description: Second law analysis, power and refrigeration cycles, property relations, gas mixtures, psychrometrics, chemical reactions, introduction to heat transfer, steady state and transient conduction. 3 credits, F.

Prerequisites:  MAE 2300; MAE 3200 (may be taken concurrently).

**Course Goals:**

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
- Review Second Law
- Review Power Cycles
- Refrigeration
- Ideal Gas Mixtures
- Psychrometrics
- Meteorological Thermodynamics
- Basics of Heat Transfer
- Conduction
- 1-dimensional Conduction Problems
- 2-dimensional Conduction

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3e) An ability to identify, formulate, and solve engineering problems

3e1: Students apply scientific and engineering principles to formulate a complete mathematical model appropriate for the engineering problem.

3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model.

3g) An ability to communicate effectively

3g1: Students apply the correct technical style and format appropriate for the audience.

3g3: Students apply the rules of grammar and composition appropriately in written communication.

3h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

3h1: Students evaluate case studied with conflicting/competing social values to make informed decisions about an engineering solution.

3h2: Students evaluate and analyzes the economics of an engineering solution.

3j) A knowledge of contemporary issues

3j1: Students identify current critical issues confronting mechanical engineers.

3j2: Students evaluate case studied that present alternative engineering solutions or scenarios taking into consideration current issues.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2013

**MAE 3420 – Fluid Mechanics**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Robert Spall

Textbook: Fluid Mechanics – Fundamentals and Applications, 3rd Edition, Yunus A. Cengel and John M. Cimbala, McGraw-Hill.

Catalog Description: Application of fluid dynamic theory to inviscid and viscous, incompressible and compressible, and external and internal fluid flows, with emphasis on laminar and turbulent boundary layers. 3 credits, F.

Prerequisites: ENGR 2030, MAE 3200, MAE 2300 (MAE 3200 may be taken concurrently).

**Course Goals:**

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

**Topics Covered:**

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

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3e) An ability to identify, formulate, and solve engineering problems

3e1: Students apply scientific and engineering principles to formulate a complete mathematical model appropriate for the engineering problem.

3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model.

Last Updated: August 6, 2013

Approved by MAE Faculty: October 2013

**MAE 3440 – Heat and Mass Transfer (DI)**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Heng Ban

Textbook: Fundamentals of Heat and Mass Transfer plus Interactive Heat Transfer Version 2.0 with User Manual, 6th Edition, Incropera and DeWitt, John Wiley.

Catalog Description: 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 3210 (may be taken concurrently).

**Course Goals:**

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 conduction
- Transient Conduction
- Finite Difference Methods
- Convection, Boundary Layers
- Similarity, Analogies
- Turbulence
- External Flows, Plates
- Cylinders & Spheres
- Jets, Multiple Obstacles
- Internal Flow, Balances
- Internal Flow, Correlations & Enhancement
- Free Convection Fundamentals
- Empirical Correlations
- Spheres, Vertical, Enclosures, Free plus Forced
- Boiling and Condensation
- Heat Exchangers, Overall HTC, LMTD
- Effectiveness – NTU
- Design Project
- 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

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

3c1: Students produce a clear and unambiguous needs statement for a design project.

3c2: Students identify the realistic constraints on a design problem.

3c3: Students develop criteria for acceptability and desirability of solutions.

3c4: Students apply appropriate scientific and engineering principles to design a system, component, or process that meets desired needs.

3d) An ability to function on multi-disciplinary teams

3d1: Students participate in a team setting and fulfill appropriate roles to assure team success.

3d2: Students integrate input from all team members and make decisions in relation to the team objectives.

3e) An ability to identify, formulate, and solve engineering problems

3e1: Students apply scientific and engineering principles to formulate a complete mathematical model appropriate for the engineering problem.

3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model.

3e3: Students understand the accuracy associated with the analytical, numerical, or experimental method being used.

3g) An ability to communicate effectively

3g1: Students apply the correct technical style and format appropriate for the audience.

3g2: Students use appropriate graphical standards in written and oral communications.

3g3: Students apply the rules of grammar and composition appropriately in written communication.

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

3l) An ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems.

3l2: Students design a thermal system, component, or process.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2013

**MAE 3600 – Engineering Professionalism**

**Required**

Credits and Contact Hours: 1 credit, 50 contact min per week

Course Coordinator: Rees Fullmer

Textbook: None

Catalog Description: Seminar course introducing engineering students to the professional skills required in engineering practice. Topics address professional issues in ethics, legal responsibilities, economics, business, management, safety, environmental and societal impacts, contemporary issues, and lifelong learning. 1 credit, F.

Prerequisites: Admitted into the MEEN Professional Program

**Course Goals:**

At the completion of this course students will:

- Understand the American Society of Mechanical Engineer's Code of Ethics and its implications in the profession
- Identify and evaluate engineering conflicts (technical, personal, ethical)
- Understand intellectual property: how to identify it, when to protect it, and how to protect it.
- Be aware of contemporary engineering issue in the local, national, and international communities.

**Topics Covered:**

- Engineering Professionalism
- Engineering Ethics
- Intellectual Property
- Contemporary Issues

**Relationship of Course to Student Outcomes:**

3d) An ability to function on multi-disciplinary teams

3d1: Students participate in a team setting and fulfill appropriate roles to assure team success.

3d2: Students integrate input from all team members and make decisions in relation to the team objectives.

3f) An understanding of professional and ethical responsibility

3f1: Students understand the ASME Code of Ethics of Engineers.

3f2: Students apply the ASME Code of Ethics to a case study to evaluate the ethical dimensions of an engineering problem solution.

3g) An ability to communicate effectively

3g1: Students apply the correct technical style and format appropriate for the audience.

3g2: Students use appropriate graphical standards in written and oral communications.

3g3: Students apply the rules of grammar and composition appropriately in written communication.

3g4: Students prepare and give oral presentations on technical topics.

3h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

3h1: Students evaluate case studied with conflicting/competing social values to make informed decisions about an engineering solution.

3h2: Students evaluate and analyzes the economics of an engineering solution.

3i) A recognition of the need for, and an ability to engage in life-long learning

3i1: Students find external information relevant to an engineering problem without guidance.

3i2: Students explain the need for lifelong learning.

3j) A knowledge of contemporary issues,

3j1: Students identify current critical issues confronting mechanical engineers.

3j2: Students evaluate case studied that present alternative engineering solutions or scenarios taking into consideration current issues.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2014

**MAE 4300 – Machine Design (DI)**

**Required**

Credits and Contact Hours:  3 credits, 2.5 contact hours per week

Course Coordinator:  Steven Folkman

Textbook:  Shigley's Mechanical Engineering Design, 9th Edition, R. Budynas and J. Nisbett, McGraw Hill

Catalog Description: 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.

**Course Goals:**

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:**

- Load and Stress Analysis
- Failures Resulting from Static Loading
- Failure Resulting from Variable Loading and Fatigue
- Shafts and Shaft Components
- Screws, Fasteners, and the Design of Nonpermanent Joints
- Welding, Brazing, Bonding, and the Design of Permanent Joints
- Mechanical Springs
- Rolling-Contact Bearings
- Lubrication and Journal Bearings
- Gearing – General
- Spur and Helical Gears
- Bevel and Worm Gears

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

3c2: Students identify the realistic constraints on a design problem.

3c3: Students develop criteria for acceptability and desirability of solutions.

3c4: Students apply appropriate scientific and engineering principles to design a system, component, or process that meets desired needs.

3e) An ability to identify, formulate, and solve engineering problems

3e1: Students apply scientific and engineering principles to formulate a complete mathematical model appropriate for the engineering problem.

3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model.

3e3: Students understand the accuracy associated with the analytical, numerical, or experimental method being used.

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

3l) An ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems.

3l1: Students design a mechanical system, component, or process.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2014

**MAE 4400 – Fluids/Thermal Laboratory (CI)**

**Required**

Credits and Contact Hours: 2 credits, 1.25 contact hours per week and 90 minute lab every second week.

Course Coordinator: Barton Smith

Textbooks: Recent texts for MAE 3400, 3420, 3440.

Catalog Description: Laboratory experiences in observation and measurement of fundamental fluid and thermal phenomena. 2 credits, F.

Prerequisites: MAE 3340, MAE 3440.

**Course Goals:**

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

**Topics Covered: (typically several of the following)**

- Temperature measurement
- Differential and Absolute Pressure measurement
- Volume Flow measurement
- Minor and Major Losses
- Free and forced convection heat transfer
- Conduction heat transfer
- Particle Image Velocimetry measurements
- Computing forces from velocity measurements
- Measurement Uncertainty

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3b) An ability to design and conduct experiments, as well as to analyze and interpret data

3b1: Determines data that are appropriate to collect and selects appropriate equipment, protocols, etc. for measuring the appropriate variables to get accurate test results

3b2: Students perform experiments and operate instrumentation in a manner appropriate for the required accuracy.

3b3: Uses appropriate tools to analyze data and verifies and validates experimental results including the use of statistics to account for possible experimental error.

3e) An ability to identify, formulate, and solve engineering problems

3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model

3e3: Students understand the accuracy associated with the analytical, numerical, or experimental method being used.

3g) An ability to communicate effectively

3g1: Students apply the correct technical style and format appropriate for the audience.

3g2: Students use appropriate graphical standards in written and oral communications.

3g3: Students apply the rules of grammar and composition appropriately in written communication.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2014

**MAE 4800 – Capstone Design I (CI)**

**Required**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week plus group study under faculty advisement

Course Coordinator: Rees Fullmer

Textbook: Customized Text from McGraw Hill

Catalog Description: First course in the senior design sequence. Includes design process, teaming skills, engineering economics, project selection and management, proposal writing, technical writing, and technical presentations. 3 credits, F, Sp.

Prerequisites: MAE 3440, MAE 4300 (both of which may be taken concurrently).

**Course Goals:**

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

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

**Topics Covered:**

- Engineering Design Process
- Engineering Drawings for Fabrication
- Design Requirements
- Project Management
- Business Skills
- Interdisciplinary Team Skills
- Engineering Communication

**Relationship of Course to Student Outcomes:**

3b) An ability to design and conduct experiments, as well as to analyze and interpret data

3b1: Determines data that are appropriate to collect and selects appropriate equipment, protocols, etc. for measuring the appropriate variables to get accurate test results

3b2: Students perform experiments and operate instrumentation in a manner appropriate for the required accuracy.

3b3: Uses appropriate tools to analyze data and verifies and validates experimental results including the use of statistics to account for possible experimental error.

3c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

3c1:  Students produce a clear and unambiguous needs statement for a design project.

3c2: Students identify the realistic constraints on a design problem.

3c3: Students develop criteria for acceptability and desirability of solutions.

3c4: Students apply appropriate scientific and engineering principles to design a system, component, or process that meets desired needs.

3d) An ability to function on multi-disciplinary teams

3d1: Students participate in a team setting and fulfill appropriate roles to assure team success.

3d2: Students integrate input from all team members and make decisions in relation to the team objectives.

3f) An understanding of professional and ethical responsibility

3f1: Students understand the ASME Code of Ethics of Engineers.

3f2: Students apply the ASME Code of Ethics to a case study to evaluate the ethical dimensions of an engineering problem solution.

3g) An ability to communicate effectively

3g1: Students apply the correct technical style and format appropriate for the audience.

3g2: Students use appropriate graphical standards in written and oral communications.

3g3: Students apply the rules of grammar and composition appropriately in written communication.

3g4: Students prepare and give oral presentations on technical topics.

3h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

3h1: Students evaluate case studied with conflicting/competing social values to make informed decisions about an engineering solution.

3h2: Students evaluate and analyzes the economics of an engineering solution.

3i) A recognition of the need for, and an ability to engage in life-long learning

3i1: Students find external information relevant to an engineering problem without guidance.

3j) A knowledge of contemporary issues

3j1: Students identify current critical issues confronting mechanical engineers.

3j2: Students evaluate case studied that present alternative engineering solutions or scenarios taking into consideration current issues.

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

3l) An ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems.

3l1: 3l3: Students design a mechanical system, component, or process.

3l2: Students design a thermal system, component, or process.

3l3: Students realize a physical system, component, or process.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2014

## MAE 4810 – Capstone Design II

**Required**

Credits and Contact Hours: 3 credits, 45 contact min per week and weekly team meeting with instructor(s) as well as team activities focused on the fabrication, testing and evaluation of the design prototype.

Course Coordinator: Rees Fullmer

Textbook: Customized Text from McGraw Hill

Catalog Description: Second course in the senior design sequence. Includes design reviews, technical reporting, and design realization. 3 credits, F, Sp.

Prerequisites: MAE 4800.

**Course Goals:**

The objective of the senior capstone design project is to utilize engineering fundamentals to complete a design project. The emphasis in Capstone Design II is on team and work organization, prototype design fabrication, and testing/evaluation of prototype.

**Topics Covered:**

- Engineering Specifications
- Design Requirements
- Drawing package
- Project Scheduling
- Documentation
- Effective Presentations – written and oral

**Relationship of Course to Student Outcomes:**

3b) An ability to design and conduct experiments, as well as to analyze and interpret data

3b1: Determines data that are appropriate to collect and selects appropriate equipment, protocols, etc. for measuring the appropriate variables to get accurate test results

3b2: Students perform experiments and operate instrumentation in a manner appropriate for the required accuracy.

3b3: Uses appropriate tools to analyze data and verifies and validates experimental results including the use of statistics to account for possible experimental error.

3c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

3c1: Students produce a clear and unambiguous needs statement for a design project.

3c2: Students identify the realistic constraints on a design problem.

3c3: Students develop criteria for acceptability and desirability of solutions.

3c4: Students apply appropriate scientific and engineering principles to design a system, component, or process that meets desired needs.

3d) An ability to function on multi-disciplinary teams

3d1: Students participate in a team setting and fulfill appropriate roles to assure team success.

3d2: Students integrate input from all team members and make decisions in relation to the team objectives.

3f) An understanding of professional and ethical responsibility

3f1: Students understand the ASME Code of Ethics of Engineers.

3f2: Students apply the ASME Code of Ethics to a case study to evaluate the ethical dimensions of an engineering problem solution.

3g) An ability to communicate effectively

3g1: Students apply the correct technical style and format appropriate for the audience.

3g2: Students use appropriate graphical standards in written and oral communications.

3g3: Students apply the rules of grammar and composition appropriately in written communication.

3g4: Students prepare and give oral presentations on technical topics.

3h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

3h1: Students evaluate case studied with conflicting/competing social values to make informed decisions about an engineering solution.

3h2: Students evaluate and analyzes the economics of an engineering solution.

3i) A recognition of the need for, and an ability to engage in life-long learning

3i1: Students find external information relevant to an engineering problem without guidance.

3j) A knowledge of contemporary issues

3j1:  Students identify current critical issues confronting mechanical engineers.

3j2: Students evaluate case studied that present alternative engineering solutions or scenarios taking into consideration current issues.

3k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

3k1: Students demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

3l) An ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems

3l1: Students design a mechanical system, component, or process.

3l2: Students design a thermal system, component, or process.

3l3: Students realize a physical system, component, or process.

Last Updated: August 7, 2013

Approved by MAE Faculty: October 2014

**MAE 5300 – Vibrations**

**Required**

Credits and Contact Hours: 3 credits, 2.5 hours contact hours per week

Course Coordinator: T.H. Fronk

Textbook: Mechanical Vibrations, Singiresu S. Rao, 5th Edition, Prentice Hall

Catalog Description: 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, ENGR 2140

Course Goals: 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
- Torsional Vibration
- Pendulums
- Energy Methods
- Lumped Systems
- Forced Vibrations
- Trans. Vibrations
- Convolution
- Damping
- Hysteretic Damping
- Coulomb Damping
- Damped-Forced
- 2 DOF
- Rayleigh's Principle
- Continuous Systems

**Relationship of Course to Student Outcomes:**

3a) An ability to apply knowledge of mathematics, science, and engineering

3a1: Students apply scientific and engineering principles to formulate a mathematical model of a system or process, which is appropriate for the required accuracy.

3a2: Students apply mathematical principles to obtain an analytical or numerical solution to model equations.

3a3: Students understand alternate approaches to solving engineering problems, in order to help choose an effective approach.

3e) An ability to identify, formulate, and solve engineering problems

3e1: Students apply scientific and engineering principles to formulate a complete mathematical model appropriate for the engineering problem.

3e2: Students apply mathematical principles to obtain an analytical or numerical solution to the complete mathematical model.

Last Updated: August 6, 2013

Approved by MAE Faculty: October 2014

**MAE ELECTIVE COURSES SYLLABI**

| Course Number | Course Name | Credits | ME | Responsible Faculty |
|---|---|---|---|---|
| MAE 5020 | Finite Elem Meth in Solid Mechanics I | 3 | F | Folkman |
| MAE 5060 | Mech of Comp Mtls I | 3 | S | Fronk |
| MAE 5310 | Dynamic Sys & Cntrls | 3 | F | Fullmer |
| MAE 5320 | Mechatronics | 3 | S | Fullmer |
| MAE 5350 | Kinematics | 3 | F | Lui |
| MAE 5410 | Des & Optim of Thermal Sys | 3 | F | Ban |
| MAE 5420 | Compress Fluid Flow | 3 | S | Whitmore |
| MAE 5440 | CFD | 3 | S | Spall |
| MAE 5450 | Renewable Energy | 3 | | Quinn |
| MAE 5500 | Aerodynamics | 3 | F | Phillips |
| MAE 5510 | Dynamics of Atmospheric Flight | 3 | F | Phillips |
| MAE 5520 | Elements of Space Flight | 3 | F | Fullmer |
| MAE 5540 | Propulsion | 3 | | Whitmore |
| MAE 5560 | Dynamics of Space Flight | 3 | F | Fullmer |
| MAE 5580 | Dynamics of Atmospheric Flight | 3 | F | Phillips |
| MAE 5670 | Fracture Mechanics | 3 | F | Lui |
| MAE 5900 | Cooperative Practice | 3 | F/S/Su | Fronk |

**MAE 5020 – Finite Element Methods in Solid Mechanics I**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Steven Folkman

Textbook: Concepts and Applications of Finite Element Analysis, 4th Edition by Robert D. Cook, et. al., John Wiley.

Catalog Description: Introduction to finite element methods and their application to the analysis and design of mechanical engineering systems. 3 credits, F.

Prerequisites: MAE 3040.

**Course Goals:**

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 are 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 C0 and C1 elements
- Consistent nodal loads and convergence requirements
- Triangle elements
- Isoparametric Elements
- Coordinate Transformations and rigid links
- Structural symmetry
- Solids of revolutions
- Plates and Shells

Last Updated: August 1, 2013

Approved by MAE Faculty: October 2013

## MAE 5060 – Mechanics of Composite Materials I

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Thomas Fronk

Textbook: Stress Analysis of Fiber-Reinforced Composite Materials, Michael W. Hyer, McGraw-Hill. Several handouts are also given throughout the semester.

Catalog Description: Stress-strain relations for nonisotropic composites, such as fiber-reinforced plastic 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

**Course Goals:**

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
- Governing Equations of Laminated Plates

Last Updated: August 1, 2013

Approved by MAE Faculty: October 2013

**MAE 5310 – Dynamic Systems & Controls**

**Elective**

Credits and Contact Hours: 3 credits; 2.5 contact hours per week

Course Coordinator: Rees Fullmer

Textbook: Modern Control Systems, 11th Edition, Dorf and Bishop, Prentice Hall.

Catalog Description: Study of continuous-time systems, classical and modern systems design methods, transfer function models, state space, dynamics of linear systems, and frequency domain analysis and design techniques. Introduction to controllability and observability, and full-state pole placement controller design. Laboratory work required. 3 credits, F.

Prerequisites: MAE 3340.

**Course Goals:**

The objective of this course is for students to learn how to carry out a complete control system development, including system modeling, analysis, and controller design.

**Topics Covered:**

- Modeling
- Introduction to feedback control systems and design methodology.
- Laplace transforms, transfer functions and modeling of physical systems.
- State-space modeling.
- Analysis
- Stability.
- System responses, performance characteristics, and transient response analysis.
- Controllability/observability.
- Routh-Hurwitz and root locus techniques.
- Frequency-domain analysis (Bode and Nyquist plots, gain and phase margins, Nichols charts).
- Design
- PID control.
- Phase compensation.
- Alternate controller configurations and design methodology.
- State feedback design (full-order).

Approved by MAE Faculty: October 2013

**MAE 5320 – Mechatronics**

**Elective**

Credits and Contact Hours: 3 credits; 2.5 contact hours per week

Course Coordinator: Rees Fullmer

Textbook: De Silva, Clarence W. Mechatronics: An Integrated Approach. Boca Raton, FL: CRC Press, 2004.

Course Description: Principles, modeling, interfacing, and signal conditioning of motion sensors and actuators. Hardware-in-the-loop simulation and rapid prototyping of real-time closed-loop computer control of electromechanical systems. Modeling, analysis, and identification of discrete-time or sampled-data dynamic systems. Commonly used digital controller design methods. Introduction of nonlinear effects and their compensation in mechatronic systems. Laboratory work and/or design project required. Three lectures and one lab.

Prerequisites: MAE 5310

**Course Goals:**

- Knowledge of sensors and transducers (thermocouple, strain guage piezoelectric sensors, accelerometer, tachometer, potentiometer, optical encoder).
- Knowledge of actuators (DC motor, stepper motor, hydraulic motor, piezoelectric actuator).
- Interfacing (op-amps, signal conditioning, AD/DA, power amplifiers, Matlab serial communications, LCD modules).
- Sampled data systems modeling and analysis (sampling process, signal reconstruction, linear discrete time models, z-transform, discrete transfer function, discrete system stability).
- Hardware-in-the-loop experimentation and rapid prototyping via Matlab RTW/Quanswer real-time toolbox.
- Basic offline systems identification techniques (Matlab systems identification toolbox).
- Digital controller design (approximate continuous design at-sample digital design, internal model principle for digital control, repetitive control, PID relay, autotuning).
- Capable of applying a systematic control system design methodology to a laboratory mechatronic system.

**Topics Covered:**

- Overview of Mechatronics and Sample Mechatronic Systems
- Sensors
- Actuators
- Interfacing
- Hardware-in-the-loop experimentation and rapid prototyping
- Digital Control Systems Analysis

- Discrete-time System Identification
- Digital Controller Design
- Miscellaneous

**MAE 5350 – Kinematics**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Ling Liu

Textbook: Design of Machinery, 5 ed. R. Norton, McGraw Hill, 2011. ISBN: 007742171X

Catalog Description: The study of the motion of rigid bodies and systems of rigid bodies. This includes the kinematic analysis of linkages, cams and gear trains. 3 credits, Spring.

Prerequisites: MAE 3320.

**Course Goals:**

After this course, the student is expected to have general mathematical and computer skills to perform kinematic, kinetic, dynamic analyses within the context of general machine design.

**Topics Covered:**

This class provides an overview of the kinematics, kinetics, and dynamics of machine elements including linkages, cams, and gear trains. These topics are discussed in the following chapters: graphical linkage, position analysis, analytic synthesis, velocity analysis, acceleration analysis, cam design, dynamic forces, balancing, engine dynamics, multi-cylinder, and cam dynamics.

Last Updated: August 1, 2013

Approved by MAE Faculty: October 2013

**MAE 5410 – Design & Optimization of Thermal Systems**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Heng Ban

Textbook: Design of Fluid Thermal Systems, third edition, William Janna, Cengage Learning

Catalog Description: Discussion of the basic considerations that occur in the design of thermal systems, including problem formulation, appropriate modeling and solution methodologies, optimization techniques, and economic analysis.

Prerequisites: MAE 3440.

**Course Objectives:**

Upon completion of this course, students should be able to:

- Demonstrate the ability to solve practical pipe flow problems: given a piping system, find the pressure drop.
- Demonstrate the ability to solve practical pipe flow problems. That is, given minimal piping system information, determine the pipe diameter that will minimize the initial and operating costs for an installation.
- Demonstrate the ability to size a pump for a given piping system and to select an operating configuration to avoid pump cavitation.
- Demonstrate the ability to analyze a heat exchanger. In particular, given two flow streams, calculate expected outlet temperatures.
- Demonstrate the ability to function as a member of a design team. This is evaluated by performance as part of a group while solving the semester long design project.

Topics Covered:

- Air conditioning systems
- Moist air properties and conditioning processes
- Indoor air quality
- Heat transmission in building structures
- Solar radiation
- Space heat loading
- Cooling load
- Energy calculations
- Flow, pumps, and piping design
- Space air diffusion
- Fans and building air distribution
- Applications of computational fluid dynamics to problems in HVAC

Last Updated: August 1, 2013; Approved by MAE Faculty : October 2013

## MAE 5420 – Compressible Fluid Flow

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Stephen A. Whitmore

Textbook: Modern Compressible Flow with Historical Perspectives, 3rd Edition, John D. Anderson, Jr., McGraw-Hill.

Catalog Description: Application of conservation of mass, momentum and energy to the design and analysis of compressible fluid systems. 3 credits, F.

Prerequisites: MAE 3400, MAE 3420.

**Course Goals:**

To establish the necessary physical and thermodynamic background and then develop the fundamental concepts that will allow the student to solve practical compressible flow problems.

**Topics Covered:**

- Thermodynamics review
- Integral forms of conservation equations for inviscid flow
- One-dimensional flow
- Normal shock relations
- Quasi-one-dimensional flow
- Oblique shocks and Prandtl-Meyer expansion
- Supersonic flow over flat plate
- 2-D Supersonic airfoil, Wave Drag
- Introduction to turbulent boundary layers in high-speed flows
- Skin friction models
- 
- Effects of skin friction on supersonic lift-to-drag ratio
- Detached shockwaves
- Supersonic drag on blunt leading edge
- Flow through multiple shock systems
- Application to supersonic inlet design
- Method of characteristics as applied to nozzle design
- Introduction to differential form of conservation equations
- Supersonic conical flow
- Taylor-Maccoll solution
- Hypersonic flow
- Non-adiabatic shockwaves

Last Updated: August 1, 2013; Approved by MAE Faculty: October 2013

**MAE 5440 – Computational Fluid Dynamics**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Robert Spall

Textbook: An Introduction to Computational Fluid Dynamics, 2nd Ed., Versteeg & Malalasekera, Longman.

Catalog Description: Introduction to computational fluid dynamics and heat transfer using the finite-volume method. Extensive code development. Application of a commercial CFD solver to a problem of interest. 3 credits, Sp.

Prerequisites: MAE 3420 and MAE 3440.

**Course Goals:**

To provide the student with sufficient background to write their own basic Navier-Stokes solver, and to intelligently use the commercial solvers available in industry.

**Topics Covered:**

- Conservation laws and boundary conditions
- Finite volume method for diffusion problems
- Implementation of boundary conditions
- Solution of discretized equations
- Finite volume method for convection diffusion problems
- First order upwinding, central differencing, second-order upwind, QUICK schemes
- SIMPLE Solution algorithms for pressure-velocity coupling
- Turbulence and its modeling
- Finite volume method for unsteady flows
- Grid generation
- Commercial solvers

Last Updated: August 1, 2013

Approved by MAE Faculty: October 2013

**MAE 5450 – Renewable Energy**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Jason Quinn

Textbook: Renewable Energy Resources. 2nd edition, John Twidell & Tony Weir

Catalog Description: Fundamentals of thermodynamics, fluid mechanics, and systems analysis applied to alternative energy systems; analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance, and environmental impact. 3 credits, F.

Prerequisites: MAE 3440

**Course Goals:**

- Provide students an appreciation for the need and promise of simultaneously renewable, alternative, and "clean" energy technologies
- Teach the prevalent types and applications of renewable energy systems
- Teach students the basic principles of operation of renewable energy converters
- Train students to apply thermal science fundamentals to the design/analysis of renewable energy system components
- Expose students to the diversity of beneficial applications currently utilizing renewable energy (e.g., "solar cell roofs") and future implementations of such technologies
- Introduce students to societal catalysts and challenges regarding renewable energy implementation ("clean energy" incentives, energy security, codes and regulatory needs, etc.)

**Topics Covered:**

- Renewable Energy technologies including: hydro, thermal solar, photovoltaic, wind, subsurface thermal, and biofuels
- Principles, overview and importance of renewable energy
- Review of thermal sciences (i.e., pertinent thermodynamics/transport phenomena)
- Solar-based heating and power generation
- Fluidic power generation (aerial and waterway)
- Biomass and biofuels
- "Subsurface" thermal energy utilization (OTEC and geothermal)
- Energy systems, storage and transmission
- Nuclear Fission and Fusion Energy (non-renewable technically)
- Opportunities for, and challenges to, societal implementation

Last Updated: August 1, 2013

Approved by MAE Faculty: October 2013

**MAE 5500 – Aerodynamics**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Warren Phillips

Textbook: Mechanics of Flight, 2nd Edition, Warren F. Phillips, 2010, Wiley.

Aerodynamics of Flight, Warren F. Phillips, Wiley (Manuscript in preparation, handouts).

Catalog Description: Fundamentals of incompressible, inviscid flow; aerodynamic forces and moments; airfoil characteristics; incompressible flow around two-dimensional airfoils and finite wings; three-dimensional incompressible flow; and introduction to aircraft performance. 3 credits, F.

Prerequisites: MAE 3420.

**Course Goals:**

This course is designed to give Engineering students a basic understanding of the methods used to solve practical problems in aerodynamics using analytical tools, numerical methods, and simplified flow equations. Specific course objectives include:

- Students will be able to draw useful free-body diagrams showing the traditionally defined aerodynamic forces, moments, and angles; and from these diagrams be able to transform the force and moment components to any given coordinate system.
- Students will be able to analyze 2-dimensional flow over airfoils and predict the resulting forces and moments, using both thin airfoil theory and numerical panel methods.
- Students will be able to analyze 3-dimensional flow over finite wings and predict the resulting forces and moments, using both the infinite series solution and a numerical solution to Prandtl's lifting-line theory.
- Students will be able to predict traditional aircraft performance parameters from aircraft geometry, weight, aerodynamic coefficients, altitude, and engine parameters.

**Topics Covered:**

- Fundamentals of Fluid Dynamics.
- Inviscid, Incompressible Flow.
- Flow over Airfoils, Numerical Methods.
- Flow over Airfoils, Thin Airfoil Theory.
- Flow over Finite Wings, Prandtl's Lifting-line Theory.
- Flow over Finite Wings, Numerical Methods.
- Aircraft Performance and Design.

Last Updated: August 1, 2013

Approved by MAE Faculty: October 2013

**MAE 5510 – Dynamics of Atmospheric Flight**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Warren Phillips

Textbook: Mechanics of Flight, 2nd Edition, Warren F. Phillips, 2010, Wiley.

Catalog Description: Aircraft equations of motion; aerodynamic forces and moments; aircraft stability and control in roll, pitch, and yaw; aircraft motion with six degrees of freedom; aircraft performance and design; and design project.

Prerequisites: MAE 5500

**Course Goals:**

- This course is designed to give senior level and graduate students in Mechanical and Aerospace Engineering a basic understanding of the characteristics of atmospheric flight and the methods used for aircraft flight analysis and design. Specific course objectives include:
- Students will be able to predict traditional longitudinal and lateral static stability and trim parameters from aircraft geometry, weight, aerodynamic coefficients, altitude, and propulsion parameters.
- Students will understand and be able apply the traditional Euler angle formulation of the rigid-body 6-DOF equations of aircraft motion.
- Students will be able to predict traditional longitudinal and lateral dynamic modes from aircraft geometry, weight, aerodynamic coefficients, altitude, and propulsion parameters.

**Topics Covered:**

- Review of Aircraft Performance
- Propellers and Propulsion
- Static Stability and Control
- Six Degree-of-Freedom Equations of Motion
- Longitudinal Motion
- Lateral Motion
- Unsteady Aerodynamic Response

Last Updated: August 1, 2013

Approved by MAE Faculty: October 2013

**MAE 5520 - Elements of Space Flight**

**Elective**

Credits and Contact Hours: 3 credits; 2.5 contact hours per week

Course Coordinator: David Geller

Textbook: Spacecraft Systems Engineering, 3rd Edition, Peter Fortescue, John Stark, Graham Swinerd, John Wiley.

Catalog Description: Introduction to astrodynamics and orbital design. Spacecraft systems engineering including spacecraft sybsystems (e.g., attitude control, communications, power, structures). Introduction to propulsion and launch vehicles.

Prerequisites: MAE 3320 or PHYS 3550; or both ECE 2290 and ECE 2700.

**Course Goals:**

The students should acquire a sound background in orbital mechanics, and attitude motion and control.

**Topics Covered:**

- 2-Body Problem
- Orbital Motion
- Orbital Geometry/Dynamics
- Coordinate Systems
- Orbit Determination
- Basic Orbital Maneuvers
- Out of Plane Orbit Changes
- Rendezvous
- Earth Oblateness Effects
- Rocket Performance
- Rocket Flight Dynamics
- Multiple/Single stage(s)
- Lunar Trajectories
- Lunar and Interplanetary Patched Conics Rigid Body Dynamics
- Euler Equations and Euler Angles
- Torque Free Motion
- Quasi-Rigid Spacecraft
- Gyroscopic Motion
- Spinning Spacecraft
- 3-Axis Stabilization
- Gravity Gradient Stabilization
- Dual Spinning Spacecraft
- Mass Movement Techniques
- Bias Momentum Systems
- Attitude Determination

**MAE 5540 – Propulsion Systems**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Stephen A. Whitmore

Textbook: "Introduction to Rocket Science and Engineering," Taylor, Travis S., Taylor-Francis CRC Press, 2009, ISBN-10: 1420075284

Catalog Description: Fundamentals of rocket and air breathing propulsion, including space flight dynamics, nozzle theory, combustion processes, and flight performance. Rocket propulsion systems, including solid, liquid, hybrid, and combined cycles. Air breathing propulsion systems, including ramjet, scramjet, turbojet, and turbofan engine concepts. 3 credits, Spring.

Prerequisites: MAE 5420 or consent of instructor.

**Course Goals:**

- This course covers fundamentals of turbine and rocket propulsion, including nozzle theory and thermodynamic relations, combustion processes and flight performance.
- This course will establish the necessary physical and thermodynamic background and then develop the fundamental concepts that will allow the student to design rocket-based and air-breathing propulsions systems.
- Students should gain a broad knowledge of propulsion technology and concepts, as well as the ability to dig deeper for in formation on advanced concepts
- Students should be able to intelligently interpret this and other information on the subject and relate it to other areas of study.
- Students should be able to apply the material to solve problems provided

**Topics Covered:**

- Rocket Propulsion Systems
- Thrust Equation, Rocket Equation, Specific Impulse
- Space flight dynamics
- Ideal and Non-ideal Nozzle Theory
- Solid, liquid, hybrid, and combined rocket propulsion systems
- Airbreathing Propulsion Systems
- Ramjet, ScramJet, Turbojet, and Turbofan Engines
- Airbreathing Combustion Cycle Analysis
- Rocket and Turbine-Based Combined Cycle Systems, Liquid Air Collection Systems

Last Updated: August 1, 2013; Approved by MAE Faculty: October 2013

**MAE 5560 – Dynamics of Space Flight**

**Elective**

Credits and Contact Hours: 3 credits; 2.5 contact hours per week

Course Coordinator: David Geller

Textbook: Orbital Mechanics for Engineering Students, 2nd Ed., Howard Curtis, Elsevier Academic Press.

Catalog Description: Fundamentals of spacecraft dynamics, including Keplerian orbits, orbital position as a function of time, three-dimensional orbits, orbital determination, orbital maneuvers, satellite attitude dynamics, and rocket vehicle dynamics. 3 credits, F.

Prerequisites: MAE 3320 or permission of instructor.

## Course Goals:

Develop a fundamental understanding of orbital dynamics for spacecraft for Aerospace engineers.

## Topics Covered:

- Gravitational forces
- Analytic solutions to the two-body problem
- Elliptic, parabolic and hyperbolic orbits.
- Orbits in 3 dimensions
- J2 Orbital perturbation effects
- Orbit determination
- Orbit transfers in 3 dimensions
- Basic interplanetary trajectories
- Introduction to launch dynamics
- Numerical solutions to orbital dynamics
- Commercial software exposure to Satellite Tool Kit.

**MAE 5580 – Dynamics of Atmospheric Flight**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Warren Phillips

Textbook: Mechanics of Flight, 2nd Edition, Warren F. Phillips, 2010, Wiley.

Catalog Description: Design and optimization of aircraft systems. Students work in teams to design and optimize an aircraft to satisfy a specific set of mission requirements, including mission effectiveness, cost, and scheduling. Class is linked to national design competitions and/or current USU aircraft design projects.

Prerequisites: MAE 5500 and MAE 5510

**Course Goals:**

This course is designed to give senior level undergraduate and graduate students in Mechanical and Aerospace Engineering an understanding of and experience with the aircraft design process. Emphasis is on conceptual design and the optimization process.

**Topics Covered:**

- Overview of Engineering Requirements and the Aircraft Design Process.
- Analysis and Performance of DC Electric Motors.
- Matching a DC Motor-Propeller Combination to Optimize Mission Effectiveness.
- Matching Airframe and Propulsion Systems to Optimize Mission Effectiveness.
- Airframe Structural Analysis and Design.
- Static and Dynamic Stability Constraints.
- Minimizing Aircraft Weight with Combined Structural and Stability Constraints.
- Engineering Design Documentation.

Last Updated: August 1, 2013

Approved by MAE Faculty: October 2013

**MAE 5670 – Fracture Mechanics**

**Elective**

Credits and Contact Hours: 3 credits, 2.5 contact hours per week

Course Coordinator: Ling Liu

Textbook: Orbital Mechanics for Engineering Students, 2nd Ed., Howard Curtis, Elsevier Academic Press.

Catalog Description: Covers linear elastic and elastic-plastic fracture mechanics; micro-mechanisms of fracture in metals, polymers, ceramics, composites, and concrete; and failure analysis of engineering. Enrollment limited to students accepted into College of Engineering. 3 credits, F.

Prerequisites: Grade of C- or better in MAE 2160 and grade of D or better in MAE 3040.

**Course Goals:**

- Students completing this course should have studied the theory and techniques on how to apply concepts of solid mechanics and materials science in the context of fracture mechanics to the design and analysis of engineering structures for safe service. Specific course objectives include:
- Demonstrate the ability to understand and apply linear elastic fracture mechanics to engineering problems.
- Demonstrate the ability to understand and apply elastic-plastic fracture mechanics to engineering problems.
- Demonstrate the ability to understand fracture mechanisms for materials and apply to engineering failure analysis.
- Demonstrate the ability to understand fracture toughness testing methods.

**Topics Covered:**

- History and overview; An atomic view of fracture;
- Stress concentration effect of flaws
- The Griffith energy balance
- The energy release rate; Instability and the R curve
- Stress analysis of cracks; Relationship between K and G
- Crack tip plasticity;
- Plane stress versus plane strain; K failure criterion
- Crack tip opening displacement (CTOD)
- The J contour integral
- Relationship between J and CTOD; Crack growth resistance curves
- Dynamic fracture and crack arrest
- Fracture mechanisms in metals

- Fracture mechanisms in nonmetals; Fundamentals of failure analysis
- Fracture toughness testing of metals
- Fracture toughness testing of nonmetals; Fatigue crack propagation
- Term paper presentations

**MAE 5900 – Cooperative Practices**

**Elective**

Credits and Contact Hours: 3 credits, variable contact hours per week

Course Coordinator: Robert Spall, Thomas Fronk

Textbook: None

Catalog Description: Planned work experience in industry. Detailed program must have prior approval. Written report required. (Does not meet requirement as a technical elective.)

Prerequisites: Must be in a professional program.

**Course Objectives:**

The experience must be an extension of the classroom: a learning experience that provides for applying the knowledge gained in the classroom. It must not be simply to advance the operations of the employer or be the work that a regular employee would routinely perform.

The experience has a defined beginning and end, and a job description with desired qualifications.

There are clearly defined learning objectives/goals related to the professional goals of the student's academic coursework.

There is supervision by a professional with expertise and educational and/or professional background in the field of the experience.

There is routine feedback by the experienced supervisor.

There are resources, equipment, and facilities provided by the host employer that support learning objectives/goals.

**Topics Covered:**

Variable, depending on co-op company.