# Appendix B
# Mechanical Engineering Course Syllabi

**ENGR 2010 - Thermodynamics I**

Catalog Data: ENGR 2010 Thermodynamics I (3). Lec. 3. Pr., CHEM 1030 or CHEM 1110, MATH 1620 or MATH1720. Coreq., PHYS 1600. Principles and applications of thermodynamics to engineering problems. Laboratory includes multi-disciplinary team projects on thermodynamics applications and fundamentals of engineering thermodynamics.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week

Textbook: *Fundamentals of Thermodynamics*, by R. Sonntag, C. Borgnakke, and G. van Wylen, 6th Edition, John Wiley and Sons, 2002.

Reference: None

Course Coordinator: Daniel Mackowski, Associate Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes

*This course will present and demonstrate to the students the following:*

1. Evaluation and manipulation of thermodynamic property information for various substances (water, air, refrigerants) commonly encountered in engineering applications. (Program Outcomes 1, 2, 7)
2. Application of the first and second law of thermodynamics to basic systems and components encountered in engineering applications. (P. O. 1, 2, 7, 11, 12)
3. Fundamental physical and engineering principles involved in ideal power and refrigeration cycles. (P. O. 1, 2, 7, 11, 12)

Course Outcomes and Linkage to Course Objectives

*Upon completion of this course, the student will be able to:*

1. Understand the terminology of thermodynamics and the relevance of thermodynamics to societal issues. (Course Objectives 1, 2, 3)
2. Evaluate the thermodynamic properties of a simple substance including the use of ideal gas laws and thermodynamic tables. (C. Ob. 1)
3. Apply the first law of thermodynamics to closed and open systems to analyze heat and work transfer during processes. (C. Ob. 2)
4. Identify the thermal efficiency and coefficient of performance of ideal power and refrigeration cycles. (C. Ob. 1, 2, 3)
5. Calculate the ideal performance of engineering components used in power and refrigeration cycles. (C. Ob. 1, 2, 3)
6. Apply the principles of availability to simple systems and components. (C. Ob. 1, 2, 3)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)

1. Background and Motivation [3 Lectures]
2. Basic Concepts, Unit Systems [3 Lectures]
3. Properties of a Pure Substance, Equations of State [4 Lectures]
4. Transfer of Energy: The Concepts of Work And Heat [6 Lectures]

5. The First Law of Thermodynamics and Conservation Of Energy, Applications to Closed and Open Systems [10 Lectures]
6. The Second Law of Thermodynamics: The Heat Engine, Reversible And Irreversible Processes [3 Lectures]
7. Entropy [6 Lectures]
8. Second Law Analysis for an Open System [5 Lectures]
9. The Concept of Availability [5 Lectures]
10. Exams and Quizzes [3 Lectures]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science 3 Hours

Prepared by: Daniel Mackowski, March 16, 2004

**MECH 2110 - Statics and Dynamics**

Catalog Data: MECH 2110 Statics and Dynamics (4). Lec. 3, Lab 3. Pr., MATH 1620, PHYS 1600. Vectors, forces, moments and free body diagrams. Systems in mechanical equilibrium. Particles in motion.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week
One 3-Hour Laboratory per Week

Textbook: *Engineering Mechanics, Volume 1 - Statics*, by J. L. Meriam and L. G. Kraige, Fifth Edition, John Wiley and Sons, 2002.
*Engineering Mechanics, Volume 2 - Dynamics*, by J. L. Meriam and L. G. Kraige, Fifth Edition, John Wiley and Sons, 2002.

Laboratory Manual: None

Reference: None

Course Coordinator: Malcolm J. Crocker, Professor of Mechanical Engineering

Course Outcomes and Linkage to Course Objectives

*Upon completion of this course, the student will be able to:*

1. Construct free body diagrams (Course Objectives 1, 2, 3, 4, 5, 6, 7)
2. Calculate reaction forces and moments for practical structures in static equilibrium such as trusses, frames, and simple machines (C. Ob. 1, 2, 7)
3. Construct and solve equations relating the applied forces to the resulting motion of a body modeled as a particle, including projectiles, vehicles, pulley elements, and vibrations of a mass-spring-damper system, etc. (C. Ob. 3, 4, 5, 6, 7)
4. Solve practical dynamics problems using impulse-momentum and work-energy concepts including collisions, vehicle motion, and spring-mass systems. (C. Ob. 3, 4, 5, 6, 7)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)

1. Vectors and Vector Operations [1 Lecture]
2. Forces, Couples, and Resultants [2 Lectures]
3. Mechanical Systems and Free Body Diagrams [3 Lectures]
4. Equilibrium [2 Lectures]
5. Trusses [2 Lectures]
6. Frames and Machines [4 Lectures]
7. Friction [3 Lectures]
8. Distributed Properties - Centroids and Moments of Inertia [5 Lectures]
9. Rectilinear Motion of a Particle [3 Lectures]
10. Two-Dimensional Motion of a Particle [3 Lectures]
11. Three-Dimensional Motion of a Particle [1 Lecture]
12. Particle Dynamics Using Direct Application of Newton’s Law [5 Lectures]
13. Work-Energy Methods [3 Lectures]

14. Impulse-Momentum Methods [2 Lectures]
15. Vibrations with One Degree of Freedom [3 Lectures]
16. Exams and Quizzes [3 Lectures]

Representative Laboratory Topics and Coverage (3 Hour Laboratory Periods)

1. Concurrent Force Systems - Force Table [2 Lab Periods]
2. Non-concurrent Force System - Pulleys [2 Lab Periods]
3. Non-concurrent Force Systems - Suspended [1 Lab Period]
4. Friction - Impends Sliding Rigid Bodies [1 Lab Period]
5. Mass Centers - Suspended Shapes [1 Lab Period]
6. One Dimensional Motion - Gravity Drop [1 Lab Period]
7. Two Dimensional Motion - Marble Cannon [1 Lab Period]
8. Projectile Motion - Working Model Analysis [3 Lab Periods]
9. Kinetic Friction - Sliding [1 Lab Period]
10. Vibrations - Air Track [1 Lab Period]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science 4 Hours

Prepared by: Malcolm J. Crocker, March 16, 2004

**MECH 2120 - Kinematics and Dynamics of Machines**

Catalog Data: MECH 2120 Kinematics and Dynamics of Machines (4). Lec. 3, Lab 3. Pr., MATH 2630, MECH 2110. Kinematics and kinetics of rigid bodies. Kinematics and dynamics of mechanisms, cams, and gears.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week
One 3-Hour Laboratory per Week

Textbook: *Design of Machinery*, by R. L. Norton, Third Edition, McGraw-Hill, 2003.

Reference: None

Course Coordinator: George T. Flowers, Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes

*This course will present and demonstrate to the students the following:*

1. Characterization and description of the motion of a rigid body or a machine. (Program Outcomes 1, 2, 3)
2. The relationships between applied forces and the resulting motion of rigid bodies. (P. O. 1, 2, 3)
3. Use of computer software as a tool for synthesis and design of mechanisms. (P. O. 7)
4. Development and application of the kinematic and kinetic relations necessary for the analysis and design of machine and mechanisms. (P. O. 2, 3, 4)

Course Outcomes and Linkage to Course Objectives

*Upon completion of this course, the student will be able to:*

1. Construct free body diagrams of rigid bodies in motion. (Course Objectives 1, 2)
2. Construct equations relating the motion of the bodies to the forces acting on rigid bodies. (C. O. 1, 2)
3. Solve the differential equations modeling a dynamic system. (C. O. 2)
4. Design cams for specific displacement as well as acceleration profiles. (C. O. 4)
5. Design gears to avoid interference and excessive dynamic loads. (C. O. 4)
6. Use software to simulate and design mechanical linkages, cams, and gears. (C. O. 3)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)

1. Rigid Body Kinematics [8 Lectures]
2. Rigid Body Dynamics [8 Lectures]
3. Basic Concepts of Machines and Mechanisms [3 Lectures]
4. Motion Analysis [6 Lectures]
5. Linkage Analysis [6 Lectures]
6. Cam Design [3 Lectures]
7. Gear Trains [3 Lectures]
8. Dynamic Force Analysis [3 Lectures]
9. Balancing [2 Lectures]
10. Exams and Quizzes [3 Lectures]

Representative Laboratory Topics and Coverage (3 Hour Laboratory Periods)
1. Design of a Complex Mechanism with Five Links: DOF, Kinematic Analysis, Kinetostatic Analysis, Simulations, and Synthesis [6 Lab Periods]
2. Design of a Planetary System: DOF, Kinematic Analysis, Kinetostatic Analysis, Simulations, and Synthesis
   [6 Lab Periods]
3. Design of a Set of Cams to Satisfy a Set of Given Specifications [3 Lab Periods]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science and Design 4 Hours

Prepared by: George T. Flowers, March 23, 2004

**MECH 2210 - Concepts in Design and Manufacturing**

Catalog Data: MECH 2210 Concepts in Design and Manufacturing (3). LEC 3. Pr., ENGR 1110. Design philosophy, ethics, safety, manufacturing, and statistics in design and manufacturing.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week

Textbook: *The Mechanical Design Process*, by D. G. Ullman, Third Edition, McGraw-Hill, 2003.
*Introduction to Manufacturing Processes*, by J. A. Schey, Third Edition, McGraw-Hill, 2000.

Reference: None

Course Coordinator: Peter D. Jones, Associate Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. Techniques for designing a simple mechanical product using a formal process of problem definition, establishing specifications, concept generation and evaluation, and product development. (Program Outcomes 1, 4, 5, 7)
2. Preparation of a manufacturing plan for a simple mechanical product. (P.O. 1, 4, 7)
3. Communication of the design and production process for a simple mechanical product. (P.O. 6, 8)
4. Representative manufacturing techniques in shop and lab settings. (P.O. 4, 7, 10)

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Exercise an appropriate formal design process for a simple mechanical product comprised of several parts (Course Objectives 1, 2, 3, 4)
2. Choose an appropriate manufacturing process for simple mechanical parts and systems. (C. Ob. 2, 4)
3. Work in a group to complete a design and manufacturing plan for a simple mechanical device. (C. Ob. 1, 2, 3, 4)
4. Produce and present design project status reports and a final design project summary report. (C. Ob. 2, 3)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Introduction to Manufacturing [2 Lectures]
2. Solidification and Casting Including Demonstration [4 Lectures]
3. Deformation, Sheet Metalworking [3 Lectures]
4. Blanking Including Hands On Experience [1 Lectures]
5. Plastics And Composites Including Demonstration [3 Lectures]
6. Machining Including Demonstration [4 Lectures]
7. Joining Including Welding Demonstration [4 Lectures]

8. Geometric and Material Properties [2 Lectures]
9. Rapid Prototyping Demonstration [1 Lecture]
10. Computer Numerical Control (CNC) Machining Demonstration [1 Lecture]
11. Design Teams and Processes [2 Lectures]
12. Project Definition and Specification [3 Lectures]
13. Concept Generation, Evaluation [2 Lectures]
14. Product Design, Generation [3 Lectures]
15. Robust Design [2 Lectures]
16. Design for Cost; Manufacture/Assembly, Reliability/Safety, Test and Maintenance, and Environment [3 Lectures]
17. Group Design Presentations [2 Lectures]
18. Examination Exams and Quizzes [3 Lectures]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science and Design 3 Hours

Prepared by: Peter D. Jones, April 9, 2004

**MECH 3020 - Thermodynamics II**

Catalog Data: MECH 3020 Thermodynamics II (3). Lec. 3. Pr., ENGR 2010. Gas and vapor power cycles, refrigeration cycles, gas and gas-vapor mixtures, chemical reactions, chemical and phase equilibrium, thermodynamic property relations.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week

Textbook: *Fundamentals of Thermodynamics*, by R. Sonntag, C. Borgnakke, and G. van Wylen, Sixth Edition, John Wiley and Sons, 2002.

Reference: None

Course Coordinator: Roy W. Knight, Assistant Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes

*This course will present and demonstrate to the students the following:*

1. Applications of the first and second laws of thermodynamics to analyze systems, such as vapor and gas power and refrigeration cycles, and devices, including pumps, compressors, boilers, turbines, heat exchangers, nozzles, diffusers, etc.
   (Program Outcomes 1, 2, 4, 7, 11, 12)
2. The techniques used to analyze gas and gas vapor mixtures, including psychrometry.
   (P. O. 1, 2, 4, 7)
3. The first and second law of thermodynamics as applied to systems involving chemical reactions. (P. O. 1, 2, 3, 7, 11, 12)
4. Analytical techniques used when determining chemical and phase equilibrium.
   (P. O. 1, 2, 3, 7)
5. The basics of thermodynamic property relations, including Maxwell's relations.
   (P. O. 1, 2, 3, 7).

Course Outcomes and Linkage to Course Objectives

*Upon completion of this course, the student will be able to:*

1. Apply first and second law analyses to solve problems involving simple open system devices, particularly steady state, steady flow devices and systems (Course Objective 1).
2. Design and select components for a typical thermal system. (C. Ob. 1, 2, 3, 4)
3. Apply first and second law analyses to solve problems involving simple unsteady state, unsteady flow devices (C. Ob. 1).
4. Apply first law analyses to solve problems involving gas mixtures and gas vapor mixtures, particularly air water vapor mixtures (C. Ob. 2).
5. Apply first and second law analyses to solve simple chemical reaction problems, particularly hydrocarbon combustion problems (C. Ob. 3).
6. Use the chemical equilibrium relations to solve problems involving combustion (C. Ob. 4).
7. Solve simple problems involving thermodynamic property relations, for example problems involving the Clapeyron equation (C. Ob. 5).

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Gas Power Cycles [6 Lectures]
2. Vapor and Combined Power Cycles [6 Lectures]
3. Refrigeration Cycles [6 Lectures]
4. Gas Mixtures [6 Lectures]
5. Gas-Vapor Mixtures and Air Conditioning [5 Lectures]
6. Chemical Reactions [5 Lectures]
7. Chemical and Phase Equilibrium [5 Lectures]
8. Thermodynamic Property Relations [3 Lectures]
9. Exams and Quizzes [3 Lectures]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science and Design 4 Hours

Prepared by: Roy W. Knight, March 16, 2004

**MECH 3030 - Fluid Mechanics**

Catalog Data: MECH 3030 Fluid Mechanics (3). Lec. 3. Pr., MECH 2110, ENGR 2010, MATH 2650. Coreq., 3130. Fluid properties; fluid statics; mass conservation; momentum balance; external and internal flows; Euler and Bernoulli equations; dimensional analysis; viscous flows; boundary layers; compressible flow.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week

Textbook: *Introduction to Fluid Mechanics*, by R. W. Fox, A. T. McDonald, and P. J. Pritchard, 6th Edition, John Wiley and Sons Publishing Company, 2004.

Reference: None

Course Coordinator: Jay Khodadadi, Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. A mathematical and physical understanding of the concepts of stress and strain rate in fluids. (Program Outcomes 1, 2).
2. The concepts of conservation of mass, momentum equations, and conservation of energy in both integral and differential formulations. (P. O. 1, 2).
3. The role of experimental tools in analysis of a wide range of complex fluid problems. (P. O. 1, 2, 5, 7).
4. An introduction to the analysis of ideal and viscous flows. (P. O. 1, 2, 7).

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Model and solve practical fluid flow problems by applying the process of problem definition, application of reasonable assumptions and obtaining limiting ideal solutions (e.g application to fluid forces acting on immersed objects, piping networks, etc.). (Course Objectives. 1, 2, 3, 4)
2. Evaluate a given fluid flow problem and determine the proper use of dimensional analysis leading to an appropriate design of experiments. (C. Ob. 3)
3. Apply theoretical tools needed to solve viscous fluid flow problems and/or determine the need for a more sophisticated computational fluid dynamics approach. (C. Ob. 1, 2, 4)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Introduction [1 Lecture]
2. Fundamental Concepts [1 Lecture]
3. Fluid Statics [6 Lectures]
4. Basic Equations in Integral Form [9 Lectures]
5. Differential Analysis of Fluid Flow [4 Lectures]
6. Incompressible Inviscid Flow [5 Lectures]
7. Dimensional Analysis and Similitude [4 Lectures]
8. Internal Viscous Flows [4 Lectures]

9. External Viscous Flows [4 Lectures]
10. Introduction To Compressible Flow [4 Lectures]
11. Exams and Quizzes [3 Lectures]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science 3 Hours

Prepared by: Jay Khodadadi, March 9, 2004

**MECH 3040 - Heat Transfer**

Catalog Data: MECH 3040 Heat Transfer (3). Lec. 3. Pr., MECH 3020, MECH 3030. Fundamentals of heat transfer by conduction, convection and radiation. Introduction to heat exchangers.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week

Textbook: *Fundamentals of Heat and Mass Transfer*, by F. P. Incropera and D. P. Dewitt, Fifth Edition, John Wiley and Sons, 2002.

Reference: None

Course Coordinator: Sushil Bhavnani, Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. Identification and description of heat transfer problems. (Program Outcome 1)
2. Characterization and description of the mechanisms of heat transfer. (P. O. 1, 2)
3. The relationships between temperature and heat transfer. (P. O. 1)
4. Construction of equations for conduction, convection, and radiation. (P. O. 1, 11, 12)
5. Demonstration of the design of heat exchange hardware. (P. O. 1, 4)
6. Application of mathematical fundamentals to the analysis of heat transfer. (P. O. 2).
7. Systematic approaches to problem solving in the field of heat transfer. (P. O. 7)

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Discuss basic heat transfer terminology (Course Objectives 1, 2, 3, 4)
2. Analyze basic heat transfer situations (C. Ob. 1, 2, 3, 4)
3. Solve basic heat transfer problems (C. Ob. 4, 5, 6, 7)
4. Design heat exchange hardware (C. Ob. 5, 6, 7)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Introduction [3 Lectures]
2. Steady-State, One-Dimensional Conduction [8 Lectures]
3. Steady-State, Two-Dimensional Conduction, Numerical Methods [4 Lectures]
4. Transient Conduction [3 Lectures]
5. Introduction to Convection [2 Lectures]
6. External Flow [5 Lectures]
7. Internal Flow [4 Lectures]
8. Natural Convection [3 Lectures]
9. Fundamentals of Radiation [2 Lectures]
10. Radiation Exchange Between Surfaces [3 Lectures]
11. Heat Exchangers [4 Lectures]
12. Exams and Quizzes [4 Lectures]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science and Design 3 Hours

Prepared by: Sushil Bhavnani, March 16, 2004

**MECH 3050 - Measurement and Instrumentation**

Catalog Data: MECH 3050 Measurement and Instrumentation (3). Lec. 2, Lab 3. Pr., MECH 3030, ELEC 3810. Coreq., MECH 3040. Theory and practice of modern sensors and computer-based data acquisition techniques, uncertainty analysis, results reporting, filtering and signal processing.

Class Schedule: Two 50-Minute Lectures per Week
One 3-Hour Laboratory per Week

Textbook: *Theory and Design for Mechanical Measurements*, by R. S. Figiliola and D. E. Beasley, Third Edition, John Wiley and Sons, 2000.
*Learning With LabView*, by R. H. Bishop, Addison-Wesley Publishing, 1999.

Laboratory Manual: *MECH 3050 Laboratory Manual*, Auburn University.

Reference: None

Course Coordinator: Daniel K. Harris, Associate Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. The operating principles behind measurement sensors used in engineering. (Program Outcomes 5, 7)
2. Statistical background of the methods and limitations of measurement techniques. (P. O. 3, 5)
3. Introduction to modern data acquisition and processing technology. (P. O. 7)
4. Calculation procedures for precision and bias errors estimates. (P. O. 2, 5)
5. Procedures for thorough uncertainty analysis using computed precision and bias errors. (P. O. 4)
6. Implications of the uncertainty analysis on the reduced measurement. (P. O. 5)
7. Concepts in design of experiments. (P. O. 5)
8. Basics of technical report writing. (P. O. 8)

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Select appropriate measurement sensors and data collection techniques to make mechanical engineering measurements. (Course Objectives 1, 2, 3)
2. Design a measurement approach to accurately describe the behavior or response of a system to external stimuli. (C. Ob. 1, 2, 7)
3. Build rudimentary electronic circuits to condition signals. (C. Ob. 4, 5, 6)
4. Apply signal-conditioning software to measured data (C. Ob. 3, 7)
5. Analyze and present measurement results in a thorough and understandable format. (C. Ob. 8)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)

1. Measurement Techniques and Statistical Uncertainty [3 Lectures]
2. General Uncertainty Analysis, Data Rejection, Reporting [3 Lectures]
3. LabView® Software Basics [2 Lectures]
4. Computer Based DAQ and Filtering Theory [4 Lectures]
5. Signal Analysis, A/D Converters, Fourier Transforms [4 Lectures]
6. Displacement, Strain, Force, and Acceleration Sensors [4 Lectures]
7. Piezoelectric Sensors and Vibration Sensors [2 Lectures]
8. Temperature Sensors [2 Lectures]
9. Fluid Velocity and Flow Sensors [2 Lectures]
10. PID Controllers [2 Lectures]
11. Exams and Quizzes [2 Lectures]

Representative Laboratory Topics and Coverage (3 Hour Laboratory Periods)

1. Lab Tour and Introduction [1 Lab Period]
2. LabView I [1 Lab Period]
3. LabView II [1 Lab Period]
4. Gravity Measurement [1 Lab Period]
5. Orifice Discharge [1 Lab Period]
6. Viscosity [1 Lab Period]
7. Pressure and Gas Velocity [1 Lab Period]
8. Volumetric Flow Rate [1 Lab Period]
9. Temperature [1 Lab Period]
10. Flat Plate Heat Transfer Measurement [1 Lab Period]
11. Wind Tunnel Lift/Drag Measurements [1 Lab Period]
12. Heat Exchanger Efficiency [1 Lab Period]
13. Measurement System Design Project [2 Lab Periods]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science and Design 3 Hours

Prepared by: Daniel K. Harris, March 16, 2004

**MECH 3130 - Mechanics of Materials**

Catalog Data: MECH 3130 Mechanics of Materials (4). Lec. 3, Lab 3. Pr., MECH 2110, MATL 2100, MATH 2650, MATH 2660. Coreq., MECH 3220. Stress and strain concepts, stress-strain relationships, applications, uniaxially loaded members, torsion, normal and shear stresses in beams, beam deflections, buckling, stress concentration, combined loading, failure theories, strain energy, impact loading, cyclic loading.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week
One 3-Hour Laboratory per Week

Textbook: *Mechanics of Materials*, by R. C. Hibbeler, 5th Edition, Prentice Hall, 2003.

Laboratory Manual: *MECH 3130 Laboratory Manual*, Auburn University.

Reference: None

Course Coordinator: Hareesh V. Tippur, Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes

*This course will present and demonstrate to the students the following:*

1. A mathematical and physical understanding of the concepts of stresses, strains, and deformations. (Program Outcomes 1, 2).
2. Concepts and applications of stress, strain, and deformation analysis of mechanical members subjected to pure axial loading, torsion, flexure, and combined loading of these situations. (P. O. 1, 2)
3. Applications of stress analysis concepts to mechanical design under static loading situations. (P. O. 1, 4)
4. Hands-on experience in instrumentation, measurements and computer simulations related to stress analysis of mechanical members. (P. O. 5, 7, 8)

Course Outcomes and Linkage to Course Objectives

*Upon completion of this course, the student will be able to:*

1. Solve engineering problems involving mechanical stress, strain and deformations. (Course Objectives 1, 2)
2. Solve mechanical engineering problems related to axial, torsional, flexural, buckling and combined loading configurations through stress, strain and deformation analyses. (C. Ob. 1, 2)
3. Design simple axial, torsional, flexural and buckling members capable of tolerating prescribed limits of stress and deflection. (C. Ob. 3)
4. Perform experiments for measuring stress, strain and deflections, analyze experimental data and report observations in written and graphical forms. (C. Ob. 4)
5. Analyze simple mechanical members using ALGOR/ANSYS finite element software package and comparatively study the results relative to analytical and experimental approaches. (C. Ob. 4)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Stress [3 Lectures]
2. Strain [3 Lectures]
3. Stress-Strain Relations [2 Lectures]
4. Axial Loading, Temperature Effects, Stress Concentration [5 Lectures]
5. Torsion of Circular Sections [4 Lectures]
6. Bending Stresses in Beams [4 Lectures]
7. Shear Stresses in Beams [2 Lectures]
8. Deflection of Beams Including Discontinuity Functions [4 Lectures]
9. Combined Loading and Pressure Vessels [3 Lectures]
10. Stress and Strain Transformations, Mohr's Circle [5 Lectures]
11. Failure Theories and Simple Design Applications [3 Lectures]
12. Buckling of Columns [2 Lectures]
13. Strain Energy [2 Lectures]
14. Exams and Quizzes [3 Lectures]

Representative Laboratory Topics and Coverage (3 Hour Laboratory Periods)
1. Centroids and Moments of Inertia [1 Lab Period]
2. Strain Gage Mounting and Measurements [1 Lab Period]
3. Uniaxial Testing and Material Properties [1 Lab Period]
4. Torsion Testing, Shear Modulus [1 Lab Period]
5. Stresses and Strains in Beams [1 Lab Period]
6. Photoelastic Analysis of Stresses in Beams [1 Lab Period]
7. Beam Deflection Measurements [1 Lab Period]
8. Introduction to Finite Element Analysis [1 Lab Period]
9. Finite Element Analysis of Trusses [1 Lab Period]
10. Finite Element Analysis of Beams [2 Lab Periods]
11. Finite Element Analysis 2D Components and Calculations of Stress Concentrations [2 Lab Periods]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science and Design 4 Hours

Prepared by: Hareesh V. Tippur, March 9, 2004

**MECH 3140 - System Dynamics and Controls**

Catalog Data: MECH 3140 System Dynamics and Controls (3). Lec. 3. Pr., MECH 2120, MATH 2650. System dynamics and automatic control theory.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week

Textbook: *System Dynamics*, by K. Ogata, Fourth Edition, Prentice-Hall Publishing, 2004.

Reference: None

Course Coordinator: David M. Bevly, Assistant Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. Development of models for mechanical, electrical, and fluid systems. (Program Outcomes 1, 2, 3).
2. Analysis of the stability and dynamic characteristics of dynamical systems. (P. O. 1, 2).
3. Design of control systems in the time and frequency domain. (P. O. 1, 4)
4. Application of software to simulate dynamical systems and control systems. (P. O. 7)
5. Development of tools to design and analyze control systems in the time and frequency domain. (P. O. 7).
6. Understanding of practical issues related to controller implementation. (P. O. 1, 2, 3, 4)

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Develop the governing differential equations for mechanical, electrical, and fluid systems. (Course Objective 1)
2. Represent systems of differential equations using block diagrams. (C. O. 1)
3. Analyze and solve the differential equations of dynamical systems. (C. O. 2, 6)
4. Construct root locus and frequency response diagrams. (C. O. 3, 5, 6)
5. Use computer software (such as MATLAB) as a tool for the analysis of dynamical systems and the analysis and design of feedback control systems. (C. O. 4)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Modeling Mechanical Systems [6 Lectures]
2. Modeling Electrical Systems [3 Lectures]
3. Modeling Other Systems [3 Lectures]
4. Linearization [3 Lectures]
5. First Order Time Response [3 Lectures]
6. Second Order Time Response [3 Lectures]
7. First Order Frequency Response [3 Lectures]
8. Second Order Frequency Response [3 Lectures]
9. Responses of Higher Order Systems [3 Lectures]
10. Laplace Transform and Transfer Functions [3 Lectures]
11. Block Diagrams and PID Control [4 Lectures]

12. Control Design Rules [2 Lectures]
13. Integral Control and Root Locus [6 Lectures]
14. Exams and Quizzes [3 Lectures]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science 3 Hours

Prepared by: David M. Bevly, March 23, 2004

**MECH 3220 - Computer Aided Engineering**

Catalog Data: MECH 3220 Computer Aided Engineering (3). Lec. 2, Lab. 3. Pr., ENGR 1110, COMP 1200, MATH 2650. The computer as a tool in mechanical engineering

Class Schedule: Two 50-Minute Lectures per Week
One 3-Hour Laboratory per Week

Textbook: *Engineering Problem Solving with MATLAB*, by Delores M Etter, Second Edition, Prentice-Hall, 1996.
*Solid Edge Fundamentals*, Volumes 1 and 2, Unigraphics Solutions, 2001.

Reference: None

Course Coordinator: Peter D. Jones, Associate Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. Construction of engineering drawings and solid models of parts and assemblies using modern software tools. (Program Outcomes 1, 2, 4, 7, 8).
2. Use of software packages (e.g. Matlab) to solve engineering problems. (P. O. 1, 2, 4, 7)
3. Numerical methods for finding approximate solutions to complicated mathematical equations (algebraic/differential) resulting in practical engineering applications. (P. O. 1, 2, 4, 7)

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Use a CAD package (e.g. Solid Edge) to produce engineering drawings and renderings of solid models. (Course Objective 1)
2. Apply a variety of numerical methods (e.g. least squares curve fitting, numerical integration, Gaussian elimination, and Newton's method) to solve engineering problems. (C. Ob. 2, 3)
3. Use commercial software packages (e.g. Matlab and Excel) and write computer programs to implement numerical methods for solving engineering problems. (C. Ob. 2, 3)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Engineering Drawings [4 Lectures]
2. Solid Modeling [6 Lectures]
3. Software Packages [6 Lectures]
4. Numerical Methods [8 Lectures]
5. Computer Programming [4 Lectures]
6. Exams and Quizzes [2 Lectures]

Representative Laboratory Topics and Coverage (3 Hour Laboratory Periods)
1. Engineering Drawing and Solid Modeling Using Solid Edge [5 Lab Periods]
2. Modeling of a Real Assembly [2 Lab Period]
3. Root Finding, Newton Raphson Technique [1 Lab Period]

4. Numerical Methods and Programming with MATLAB Including Solution of Linear Equations and Ordinary Differential Equations [5 Lab Periods]
5. Symbolic Manipulation [1 Lab Period]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Science and Design 3 Hours

Prepared by: Peter D. Jones, March 26, 2004

**MECH 3230 - Machine Design**

Catalog Data: MECH 3230 Machine Design (3). Lec. 3. Pr., MECH 3130, MECH 3220, MECH 2210. Design of systems containing a variety of mechanical elements.

Class Schedule: Three 50-Minute Lectures per Week or Two 75-Minute Lectures per Week

Textbook: *Mechanical Engineering Design*, by J. E. Shigley and C. R. Mischke, Fifth Classic Edition, McGraw-Hill, 2001

Reference: None

Course Coordinator: Pradeep Lall, Associate Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. A variety of mechanical components and their implementation in system design. (Program Outcomes 1, 4)
2. Dissection of a complex mechanical system and application of engineering skills for analysis and design. (P. O. 1, 2, 4)
3. Solution of multi-objective design problems. (P. O. 1, 2, 4, 7)
4. Iterative nature of design. (P. O. 1, 2, 4, 7, 9)

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Design simple machine elements such as screws, shafts, gears, bearings, springs, belts, clutches, and brakes. (Course Objectives 1, 2, 3, 4)
2. Incorporate fatigue including non-zero mean stress, and utilize constant life and S-N diagrams. (C. Ob. 2, 3)
3. Select and apply the appropriate failure criteria for material overstress. (C. Ob. 2, 3)
4. Judiciously select safety factors for various applications while understanding implications on the final implementation of the concept. (C. Ob 3, 4)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Mechanical Engineering Design [3 Lectures]
2. Load Analysis and Materials [3 Lectures]
3. Static Body Stresses and Failure Theories [3 Lectures]
4. Fatigue [3 Lectures]
5. Surface Damage [3 Lectures]
6. Threaded Fasteners and Power Screws [3 Lectures]
7. Rivets, Welding and Bonding [1 Lecture]
8. Springs [3 Lectures]
9. Lubrication and Slide Bearings [3 Lectures]
10. Rolling Element Bearings [2 Lectures]
11. Spur Gears [4 Lectures]
12. Helical, Bevel and Worm Gears [4 Lectures]

13. Shaft Design [2 Lectures]
14. Clutches and Brakes [3 Lectures]
15. Miscellaneous Power Transmission Components [2 Lectures]
16. Exams and Quizzes [3 Lectures]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Design 4 Hours

Prepared by: Pradeep Lall, March 26, 2004

**MECH 4240 - Comprehensive Design I**

Catalog Data: MECH 4240 Comprehensive Design I (2). Lec. 1, Lab. 3. Pr. MECH 2@@0, MECH 3@@0, MECH 3230. Coreq., MECH 3040, MECH 3050, MECH 3140, INSY 3600. Capstone engineering design course based on a design project similar to those encountered by the engineer in industry involving thermal and mechanical design.

Class Schedule: One 50-Minute Lecture per Week
One 3-Hour Laboratory per Week

Textbook: None

Reference: None

Course Coordinator: David Beale, Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. Methodology of the design of a mechanical system. (Program Outcomes 1, 4, 6, 7)
2. Skills necessary to work effectively as a member of a design team. (P. O. 6, 8, 9)
3. Integration of technical knowledge from coursework into practical design applications. (P. O. 1, 2, 3, 4, 5, 7, 8)
4. Role of the engineer in industrial settings. (P. O. 4, 6, 7, 8, 9, 12)

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Design an industrially-relevant complex and integrated mechanical and/or thermal system and individual components (Course Objectives 1, 2, 3, 4)
2. Apply the engineering design process in a rigorous manner, step-by-step from need to final design, working in a design team with individual functional responsibilities. (C. Ob. 2, 3, 4)
3. Effectively communicate the design and production process in a professional setting and using modern engineering design tools. (C. Ob. 2)
4. Consider many important design issues including safety, cost, manufacturability, environmental, and ethical concerns (C. Ob. 3, 4)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Design Methodology [5 Lectures]
2. Review of Engineering Fundamentals [5 Lectures]
3. Engineering Drawing and Presentations [5 Lectures]

Representative Laboratory Topics and Coverage (3 Hour Laboratory Periods)
1. Design Methodology [5 Lab Periods]
2. Review of Engineering Fundamentals [5 Lab Periods]
3. Engineering Drawing and Presentations [5 Lab Periods]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Design 2 Hours

Prepared by: David Beale, March 26, 2004

**MECH 4250 - Comprehensive Design II**

Catalog Data: MECH 4250 Comprehensive Design II (2). Lec. 1, Lab. 3. Pr., MECH 3040, MECH 3050, MECH 3140, MECH 4240, INSY 3600. Continuation of MECH 4240. Detailed design, fabrication, communication, and presentation of a prototype machine for an industrial sponsor including final report..

Class Schedule: One 50-Minute Lecture per Week
One 3-Hour Laboratory per Week

Textbook: None

Reference: None

Course Coordinator: David Beale, Professor of Mechanical Engineering

Course Objectives and Linkage to Program Outcomes
*This course will present and demonstrate to the students the following:*
1. Methodology of the design of a mechanical system. (Program Outcomes 1, 4, 6,7)
2. Skills necessary to work effectively as a member of a design team. (P. O. 6, 8, 9)
3. Integration of technical knowledge from coursework into practical design applications. (P. O. 1, 2, 3, 4, 5, 7, 8)
4. Role of the engineer in industrial settings. (P. O. 4, 6, 7, 8, 9, 12)

Course Outcomes and Linkage to Course Objectives
*Upon completion of this course, the student will be able to:*
1. Design an industrially-relevant complex and integrated mechanical system and individual components (Course Objectives 1, 2, 3, 4)
2. Apply the engineering design process in a rigorous manner, step-by-step from need to final design, working in a design team with individual functional responsibilities. (C. Ob. 2, 3, 4)
3. Effectively communicate the design and production process in a professional setting and using modern engineering design tools. (C. Ob. 2)
4. Consider many important design issues including safety, cost, manufacturability, environmental, and ethical concerns (C. Ob. 3, 4)
5. Identify need, develop design constraints and specifications for a real world, industry sponsored engineering project. (C. Ob. 4)
6. Innovate, develop and communicate design concepts, and select the most promising for a design. (C. Ob. 3, 4)
7. Use techniques, skills and modern engineering tools to communicate a detailed design for manufacture. (C. Ob. 2)
8. Prepare and present a complete design including analysis, dimensioned drawings, consideration of safety and manufacturability, parts list, and cost analysis. (C. Ob. 3, 4)
9. Work in groups, and produce and present final project reports. (C. Ob. 2)
10. Construct, assemble, and test a working prototype in accordance with engineering design drawings. (C. Ob. 3, 4)
11. Update drawings and iterate on design as necessary to improve functionality. (C. Ob. 3, 4)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)
1. Course Requirements and Expectations. [1 Lecture]
2. Discussion with Industrial Sponsor [1 Lecture]
3. Scheduling and Division of Tasks [1 Lecture]
4. Plant Safety and Safety Engineering [1 Lecture]
5. Project Management Techniques and Gantt Charting [1 Lecture]
6. Computer Control Of Machines [1 Lecture]
7. Critical Review of Prototype and Progress by Instructor, Presentation of Prototype Progress to Industrial Sponsor, and Review of Sponsor's Comments and Concerns [3 Lectures]
8. Principles Of Patenting [1 Lecture]
9. Statistics in Testing and Reliability [1 Lecture]
10. Critical Review of Final Prototype by Instructor, Presentation of Prototype to Industrial Sponsor. [4 Lectures]

Representative Laboratory Topics and Coverage (3 Hour Laboratory Periods)
1. Plant Visit [1 Lab Period]
2. Hands on Demonstration of Shop Machine Operation and Safety [1 Lab Period]
3. Hands on Production of Machined Parts [6 Lab Periods]
4. Assembly of Machine Parts and Prototype [3 Lab Periods]
5. Testing of Prototype and Final Project [3 Lab Periods]

Contribution to ME Curriculum: Required Course

Professional Component Contribution: Engineering Design 2 Hours

Prepared by: David Beale, March 26, 2004