## APPENDIX I

### B. Course Syllabi

#### Core Courses in the Mechanical Engineering Curriculum

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#### Other Required Engineering Courses

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#### Support Courses

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ME 211: INTRODUCTION TO THERMODYNAMICS

CATALOG DATA:
ME 211 - Introduction to Thermodynamics: (3-0) 3 Credits
Prerequisite: MATH 125, PHYS 211. An introduction to the basic concepts of energy conversion, including the first and second laws of thermodynamics, energy and entropy, work and heat, thermodynamic systems analysis, and the concepts of properties and state. Application of these fundamentals to energy conversion systems will be presented.

TEXTBOOK:

INSTRUCTOR:
Dr. Wayne B. Krause, Professor of Mechanical Engineering
Office hours: Open and by appointment

EXPECTATIONS:
Upon entering this course, the students will be considered competent in the following:
1. Application of the basic areas of Physics I (Phys 211),
2. Application of integral calculus (Calculus I and II),
3. Application of the basic concepts in Statics ( EM 214)

COURSE OBJECTIVES:
The objective of this course is to provide students with the working knowledge required to formulate and analyze problems in basic engineering thermodynamics. The course focus is to develop a conceptual and working knowledge of: state and properties, conservation of mass and the first and second laws of thermodynamics. This understanding is further developed by application in other junior and senior level courses, including a second course in engineering thermodynamics. Upon completion of this course, the student will show an aptitude, where required in his/her other junior and senior courses, to be able to:
1. Apply and appreciate the utility of the general problem-solving method.
2. Apply basic thermodynamic concepts and energy-related terminology and units,
3. Apply concepts related to systems, properties and states, including heat, energy and work.
4. Apply concepts of energy conservation (First Law of Thermodynamics).
5. Apply concepts related to entropy and the Second Law of Thermodynamics.
6. Apply the knowledge base to the analysis of thermodynamic systems or thermodynamic cycles.

CLASS SCHEDULE:
Lecture: 3 hours per week, 8:00-8:50 am, MWF.

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: 0.5 credit or 17%

TOPICS:
The course will cover the traditional elements of an introduction to engineering thermodynamics and will be presented in four units.
Unit 1: Basic Concepts of Thermodynamics and Properties of Pure Substances
Thermodynamics and Energy; Dimensions and Units; Systems – Closed & Open
Properties of a System; State and Equilibrium
Processes and Cycles; Forms of Energy
Temperature and the Zeroth Law of Thermodynamics
Pressure and pressure measuring methods
Problem solution methods; Pure substances, phases and phase change processes; Property diagrams for phase change processes
Property tables and introduction to software for properties; Ideal gases, the equation of state, and the compressibility factor
Ideal gases, liquids, solids: Specific heats, internal energy, and enthalpy
Applications of the concepts
Unit 2: Energy transfer by heat, work, and mass. Introduction of the conservation of energy concept for closed, open, and unsteady systems
Closed systems and applications
Steady-flow systems and the control volume with applications; Unsteady flow systems with applications
Unit 3: The second law of thermodynamics and entropy
Introduction, thermal energy reservoirs, heat engines, efficiencies, reversed heat engines, coefficient of performance
Applications: Heat engines, refrigerators, heat pumps; Principles of the Carnot cycle and specific applications
The absolute temperature scale; Reversible and irreversible processes
Unit 4: Applications of engineering thermodynamics to energy conversion systems to include: Rankine cycle, refrigeration cycle, gas turbine cycle, other selected gas power cycles, alternate energy conversion systems, and design based projects.

COMPUTER USAGE:
Application of Microsoft Excel to spreadsheet based problems and the utilization of TEST.
COURSE OUTCOMES:
Upon completion of this course, students will have demonstrated the ability to:
1. Apply the correct terminology (including the proper units) for energy related concepts and energy conversion systems, determine properties of real substances, such as steam and refrigerant 134-a, and ideal gases from either tabular data or equations of state.
   • Use absolute, gage, and vacuum pressures correctly. Calculate gage and vacuum pressures using the manometer equation.
   • Use temperature scales correctly: Kelvin (absolute) and Celsius; Rankine (absolute) and Fahrenheit.
   • Determine property data using the steam and R-134a tables. Sketch P-v, T-v, and P-T plots for steam, R-134a, and ideal gases.
   • Locate data states on P-v, T-v, and P-T plots for steam, R-134a, and ideal gases.
   • Determine the condition of a "state" as a compressed, saturated, or superheated state and determine the thermodynamic properties. t • Demonstrate the use of quality in finding properties of two-phase substances.
   • Apply the concept of the generalized compressibility factor to demonstrate when the ideal gas equation may be used.
   • Apply the ideal gas equation to solve problems involving pressure, temperature, and volume.
   • Determine changes in internal energy and enthalpy for ideal gases.
2. Analyze processes involving ideal gases and real substances as working fluids in both closed systems and open systems or control volumes to determine process diagrams, apply conservation of mass, apply the first law of thermodynamics to perform energy balances, and determine heat and work transfers.
   • Determine the pressure-volume relation for processes and plot the processes on P-v and diagrams.
   • Calculate the boundary work for a variety of processes for closed systems.
   • Determine mass flow rate from its definition and relation to volume flow rate.
   • Apply the first law to closed systems containing ideal gases, steam, or R-134a to determine heat transfer, work, or property changes. • Apply the first law to steady-flow open systems containing ideal gases, steam, and refrigerant-134a to determine heat transfer, work, and property changes during processes.
3. Analyze systems and control volumes through the application of first and second law.
   • Determine the efficiency of heat engines and compare with the Carnot heat engine efficiency.
   • Determine coefficients of performance of refrigerators and heat pumps and compare with the reversed Carnot cycle.
   • Determine entropy changes for both ideal gases and real substances. Plot processes on both P-v and T-s diagrams.
   • Determine the properties of a working fluid at the end of an isentropic process. Determine isentropic efficiency.
   • For both closed and open systems, apply both the first and second laws to determine heat transfer, work, and property changes.
   • Develop an appreciation for primary issues related to energy and the environment.
4. Analyze the basic cycles: vapor compression refrigeration, SI power, CI power, Brayton, and Rankine.

The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

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<td>Program Outcome &gt;</td>
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*For a list of Program Objectives and Program Outcomes, visit http://www.hpcnet.org/assessmenthomepage

LABORATORY: No laboratory component is included in this course.

ASSESSMENT AND EVALUATION:
Course objectives: The course objectives will be evaluated from input supplied from instructors of the following courses: ME 331, ME 390, ME 400/500, ME 311, ME 313, ME 411, ME 412/512, ME 414, ME 416, ME 419, ME 477, and ME 479. Also assessment instruments will be used for evaluating the course objectives: a. The FE Exam; b. An Exit Exam
Course outcomes: The course outcomes will be evaluated from in-class testing and other instruments deemed suitable.

PREPARED BY:
ME 221: DYNAMICS OF MECHANISMS

CATALOG DATA:
ME 221 – Dynamics of Mechanisms: (3-0) 3 Credits

Prerequisite: PHYS 211, EM 214, MATH 125. Brief review of dynamics of a particle. Kinetics and kinematics of two and three-dimensional mechanisms. Emphasis will include free body diagrams, vector methods, and various coordinate systems. Newton’s law and energy methods will both be used.

TEXTBOOK:
Engineering Mechanics – Dynamics by R.C. Hibbeler

INSTRUCTOR:
Dr. Vojislav D. Kalanovic, MWF 10-12 p.m.

EXPECTATIONS:
Upon entering this course, the student will be expected to:
1. Have basing knowledge of mechanics from the stand-point of PHYS 211
2. Be able to form Free Body Diagrams
3. Be able to integrate and differentiate with ease
4. Proficient in vector algebra

COURSE OBJECTIVES:
The objective of this course is to provide the working knowledge required to formulate and analyze engineering problems related to bodies in motion. The course will also provide a series of methodologies enabling the flexibility in the process of solution forming.

CLASS SCHEDULE:
Lecture 3 hours per week 9 – 10 a.m. MWF

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: 0.5 credit or 17%

TOPICS:
The course will cover the traditional elements of kinematics and kinetics and will include the following:

   KINETICS OF PARTICLE: FORCE AND ACCELERATION
   KINETICS OF PARTICLE: WORK AND ENERGY
   KINETICS OF PARTICLE: IMPULSE AND MOMENTUM
   PLANAR KINEMATICS OF A RIGID BODY
   PLANAR KINEMATICS OF A RIGID BODY: FORCE AND ACCELERATION
   PLANAR KINEMATICS OF A RIGID BODY: WORK AND ENERGY

COMPUTER USAGE:
This course does not require specific computer usage.

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to:
1. Form kinetic diagrams
2. Correctly set-up coordinate frames
3. Form differential equations of motion
4. Use principle of Work and Energy
5. Use principle of Impulse and Momentum

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RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:

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* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/assessment)

LABORATORY:
There is no laboratory component for this course. However, students are required to run parametric studies thus being exposed to a virtual laboratory environment.

ASSESSMENT AND EVALUATION:
The course objectives will be evaluated from the input supplied by: FE exam, Exit exam, ME 311, ME 316, ME 331, ME 352, and ME 385. In addition, course outcomes will be evaluated from in-class testing and other instruments deemed suitable.

GRADING
The grade for this course will be formed based on the test and quiz scores

PREPARED BY:
Dr. Vojislav D. Kalanovic, January 2, 2003

Students with special needs or requiring special accommodations should contact the campus ADA coordinator, Jolie McCoy, at 394-1924 at the earliest opportunity.
ME-262: PRODUCT DEVELOPMENT

Catalog Data:
ME-262 – Product Development: (3-1) 4 Credits
Prerequisites: GE 115, GE 117
Course Description:
The course presents in a detailed fashion useful tools and structured methodologies that support the product development practice. Also, it attempts to develop in the students the necessary skills and attitudes required for successful product development in today's competitive marketplace. The cornerstone is a semester-long project in which small teams of students plan, conceive, design, and prototype a simple physical product. Each student brings his/her own background to the team effort, and must learn to synthesize his/her perspective with those of the other students in the group to develop a marketable product. An introduction to manufacturing aspects that must be taken into consideration during product development is provided in the context of a mini-project.

Textbook:

Instructor:
Dr. Vojislav D. Kalanovic.
Associate Professor, Mechanical Engineering Department.
Office: CM-132 ; ph: 394.6704
Office Hours: Open

Expectations
1) The students are expected to enter the class with a good working knowledge of basic Physics and basic Calculus.
2) Basic computer skills, such as the ability to work in the MS Windows environment, are a prerequisite.
3) The students should be able to comfortably work with MS Excel, MS Word, and MS Power Point.
4) The students should be able to adequately use a CAD program (like Solid Works) to create solid models and drawings.

Course Objectives:
After taking this course the student should be able to:
1) Master the terminology and key concepts related to product development.
2) Understand and participate in an active fashion in all the steps involved in a structured product development process.
3) Use a concurrent engineering approach during a structured product development process.
4) Document the process and the results of each stage of a structured product development process.
5) Communicate in an effective fashion the key results of each stage of a structured product development process.
6) Honestly assess the participation of other members of a product development team and self assess his/her own work.

PROFESSIONAL COMPONENT:
Engineering Science: 4.0 credit or 100%

Topics:
- Working in Teams.
- Development Processes and Organizations.
- Product Planning.
- Identifying Customer Needs.
- Establishing Product Specifications.
- Concept Generation.
- Concept Selection.
- Concept Testing.
- Prototyping.

Computer Usage:
All the written reports must be prepared in MS Word.
All the presentations must be prepared in MS PowerPoint.
All the project reports must be submitted both in printed and in electronic form. A floppy or CD-ROM with the corresponding MS Word document(s) must be provided with each report.
All the presentations must be submitted both in printed and in electronic form. A floppy or CD-ROM with the corresponding MS PowerPoint document(s) must be provided before each presentation.

Course Outcomes:
After taking this course, the students should be able to:
1) Develop a set team rules and an assessment strategy to be used during a structured product development process.
2) Identify a product opportunity gap and prepare a mission statement for a product.
3) Apply the basic elements of the Quality Function Deployment (QFD) methodology to identify the customer needs, carry out competitive benchmarking, and set the target specifications for a product.
4) Classify the customer needs according to the Kano Model of customer satisfaction.
5) Decompose a problem into simpler sub-problems using a functional decomposition, a decomposition based on the sequence of user actions, a decomposition based on key customer needs, or a decomposition using a combination of these three alternatives.
6) Carry out an effective external search for product concept ideas using resources such as consulting experts, searching patent databases, analyzing competitive products, etc.
7) Use his/her own creativity to generate original product concept ideas.
8) Apply the basic elements of the TRIZ methodology to generate product concepts.
9) Effectively use concept classification trees and concept combination tables during the concept generation process.
10) Apply decision matrices to select product concepts.
11) Define the architecture for a simple product.
12) Develop and carry out an effective prototyping plan.
13) Create different types of prototypes for a given product concept.
14) Prepare and execute an effective concept testing plan.

**Relation of Course Outcomes to Program Outcomes:**

The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

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**Laboratory:**
Most of the laboratory sessions will be devoted to a "Design for Manufacturing" mini project. This mini project will involve the design and manufacture of a very simple product. The students will work in teams to develop a product concept which will be rapid prototyped. Then, the class will select the best design and a small production run of that design will be made. Through this mini project, the students will be exposed to some of the facilities available in the CAMP Lab.

**Assessment and Evaluation:**

Course objectives:
The course objectives will be evaluated from input supplied from instructors of the courses that have ME-262 as a prerequisite (ME-322 Machine Design I, and ME-385 Mechanics and Materials in Design I). Also, particular attention will be given to the input provided by the instructors of the senior design course sequence (ME-464 Mechanical Engineering Design I, and ME-465 Mechanical Engineering Design II).

Course Outcomes:
Tentatively, the course outcomes will be evaluated through in-class activities, progress reports, final report, product prototypes, peer evaluations, and other instruments deemed suitable.

Tentative grading policy is summarized as follows: a) In class tests 30%, b) mini project 70%.

**Prepared by:**
Dr. Vojislav D. Kalanovic Date: January 2, 2004
ME 312: ENGINEERING THERMODYNAMICS

CATALOG DATA:
ME 312: ENGINEERING THERMODYNAMICS: (3-0) 3 credits.

PREREQUISITES: ME 211, ME 221. A detailed study of applications of thermodynamic principles to practical engineering systems e.g. steam power cycles internal combustion engines, gas turbines refrigeration systems, energy systems, etc. One-dimensional gas dynamics, isentropic compressible flow functions, normal shock functions, thermodynamics of mixtures and reacting systems, psychrometrics, and combustion.

TEXTBOOK:

INSTRUCTOR:
Dr. G. A. Buck
Phone: 394-2346
Office: CM124
Office hrs: Posted or by appointment
E-Mail: gbuck@taz.sdsmt.edu

INCOMING EXPECTATIONS:
Upon entering this course students will be considered fluent in the following areas:
1) Determination of required thermodynamic properties for simple compressible substances (including ideal gases) given sufficient information to define the state, and the ability to sketch process lines on appropriate diagrams
2) Application of the first law of thermodynamics to both closed and open systems
3) Application of the second law of thermodynamics to both closed and open systems and the determination of the entropy production term
4) Knowledge of simple power and refrigeration cycles e.g. Carnot, Rankine, Brayton, Otto, Diesel and vapor compression refrigeration and determination of appropriately defined performance measures (thermal efficiencies) for these basic cycles

COURSE OBJECTIVES:
The objective of this course is to provide students with the skills to:
1) Synthesize practical engineering problems related to thermodynamics and carry an analysis through to completion
2) Apply basic conservation principles of mass and energy (1st law of thermodynamics) to arbitrary processes and cycles that arise in typical engineering thermodynamics
3) Apply the second law of thermodynamics (including the exergy concept) to arbitrary processes and cycles and understand the significance of the results
4) Apply one-dimensional gas-dynamic theory to solve problems arising in the compressible flow of in viscid gases through variable area channels
5) Apply basic psychrometric principles to solve practical engineering problems involving air-water vapor mixtures
6) Apply basic thermodynamic principles to solve problems involving the reacting systems that arise in typical combustion applications

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: 0.5 credit or 17%

CLASS SCHEDULE:
Lecture: 3 hours per week, Sec. 1 12:00-12:50 PM MWF

Topics:
- Review concepts, state relations, ideal gas law
- 1st law of therm, closed sys and control vol.
- 1-D compressible flow, speed of sound, Mach number
- Isentropic flow functions, choked flow, nozzles and diffusers, normal shocks, MIT video
- Review of 2nd law of thermo, Carnot cycle, concept of entropy, TdS relations, Exergy, dead state, reversible work
- 2nd law efficiency, exergy balances, applications
- Gas power systems, air standard analysis, gas turbines, Brayton cycle
- Gas power systems continued, reheat, intercool, regeneration
- Vapor power sys, Rankine cycle, efficiency factors, Reheat, regeneration (open and closed feedwater heating)
- 2nd law analysis of vapor power cycles
- Refrigeration preliminaries, heat pumps, reverse Carnot
- Vapor compression systems, refrigerant selection
- Refrigeration/heat pump applications, absorption refrigeration, open cycle absorption
COMPUTER USAGE:
Students should be proficient in the use of Microsoft Excel for importing data from a file into a spreadsheet for subsequent plotting and processing. They will also be required to use the EES software packaged with the text to create models of various power and refrigeration cycles and conduct parametric studies to determine the significance of important thermodynamic properties that the engineer might wish to control in the design and operation of such systems.

COURSE OUTCOMES:
Upon completion of this course students will have demonstrated the ability to:
1.) Determine required thermodynamic properties and apply the first law of thermodynamics to an arbitrary simple compressible system, either open (control volume) or closed (fixed mass), and determine any desired thermodynamic quantity for that system by appropriately defining the boundaries of the system and all heat and work interactions with the surroundings of the system.
2.) Apply the basic concepts of compressible flow to solve problems involving several regions of isentropic flow separated by normal shocks in a high speed gas flow, i.e. use the concepts of stagnation state, Mach number, isentropic flow functions, and normal shock functions to obtain any desired unknown with sufficient given information.
3.) Recognize and exploit the difference between a point dependent function (property) and a path dependent function such as heat, work and exergy destruction in the solution of thermodynamic problems.
4.) Apply the first and second laws of thermodynamics in combination to determine the amount of exergy destroyed in any energy conversion scheme.
5.) Relate the exergy destroyed in any known process or cycle to the entropy produced for that process or cycle.
6.) Analyze gas power systems (with realistic efficiency and power enhancing devices) and determine any desired unknown thermodynamic quantity.
7.) Analyze vapor power systems (with realistic efficiency and power enhancing devices) and determine any desired unknown thermodynamic quantity.
8.) Analyze vapor compression refrigeration cycles employing the most common industrial and residential refrigerants to determine any desired unknown thermodynamic quantity and understand the basic principles of absorption refrigeration.
9.) Apply the first and second laws of thermodynamics to non-reacting mixtures, in particular air-water vapor mixtures, to solve basic psychrometric problems.
10.) Analyze reacting thermodynamic systems involving combustion of hydrocarbon fuels with air as the source of oxidizer in typical combustion applications.

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:

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* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/assessment)

LABORATORY:
No laboratory credit is associated with the class but students are often given a plant tour of the Black Hills Power Ben French plant to observe real world applications of the concepts discussed in class.

ASSESSMENT AND EVALUATION:
Because this course is typically taken at the senior level, attainment of the course objectives will be evaluated from input supplied by the industrial advisory board and the alumni survey.

PREPARED BY:
ME 313: HEAT TRANSFER

CATALOG DATA:
ME 313 – Heat Transfer: (3-0) 3 Credits

Prerequisite: ME 211 and Math 373 (concurrent). A study of the transfer of heat by conduction, convection, and radiation. Application to thermal systems.

TEXTBOOK:

INSTRUCTOR:
Dr. Michael A. Langerman, Professor of Mechanical Engineering
Office hours: posted or by appointment

EXPECTATIONS:
Upon entering this course, the students will be considered fluent in the following areas:

1) Application of the 1st and 2nd laws of thermodynamics (ME 211),
2) Application of integral calculus (Calculus I and II),
3) Application of ordinary differential equations (Math 321),

and other sophomore and junior level physics and mechanics courses taken in sequence in the ME curriculum.

COURSE OBJECTIVES:
The objective of this course is to provide students with the working knowledge required to formulate and analyze problems in thermal systems and thermal systems design and to take this knowledge on for application in other junior and senior level courses. Upon completion of this course, the student will show an aptitude, where required in his/her other junior and senior courses, to be able to:

1) Differentiate between, recognize the inter-relationships of, and perform fundamental analysis involving the three heat transfer modes: conduction, convection, and radiation,
2) Perform fundamental energy balances.

CLASS SCHEDULE:
Lecture: 3 hours per week, 10:00AM-10:50PM, W,F.

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: 0.5 credit or 17%

TOPICS:
The course will cover the traditional elements of heat transfer in solids, liquids, and gases and will be presented in three units.

Unit 1
- Thermodynamics and Heat Transfer
- Heat Transfer mechanisms
- Heat Conduction Equation
- Solution to partial differential equations
- Boundary Conditions and Solutions
- Resistance methods
- Critical radius
- Extended surfaces (fins)

Unit 2
- Transient heat conduction
- Numerical methods
- Solution to numerical equations
- Numerical stability
- Forced convection
- Boundary layers

Unit 3
- Natural convection
• Combined convection
• Boiling and condensation
• Blackbody radiation
• Radiation properties, Kirchoff’s law
• Radiation view factors
• Radiation shields
• Heat Exchangers

**Computer Usage:**
Students will need to be able to program in their favorite language including spreadsheet applications.

**Course Outcomes:**
Upon completion of this course, students will have demonstrated the ability to:
1. Obtain accurate material properties,
2. Formulate, and solve analytically, basic conduction, convection, and radiation heat transfer problems regarding thermal systems and thermal systems design,
3. Solve simple, second-order, ordinary differential equations describing conduction heat transfer processes,
4. Formulate, and solve numerically, conduction heat transfer problems,
5. Identify the differences between forced and natural convection,
6. Apply the elements of boiling and condensation theory to problem solving,
7. Identify the differences between blackbody, gray body, and real surface radiation,
8. Identify basic heat exchanger types,
9. Apply engineering analysis in the selection of heat exchangers,

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

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* (For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/MechEng](http://www.hpcnet.org/MechEng))

**Laboratory:**
The students will tour the ME integrated laboratory and conduct one experiment for class presentation. The laboratory experience will be performed in groups of four to five students. The experiments will involve equipment that may include the subsonic wind tunnel or modular equipment for specific thermal data acquisition.

**Assessment and Evaluation:**
Course outcomes:
The course outcomes will be evaluated from input supplied from instructors of cohered courses such as: ME 331, ME 390, ME 400/500, ME 411, ME 412/512, ME 414, ME 419, ME 430, ME 477, and ME 479. Also the following assessment instruments will be used for evaluating the course objectives:
1. FE exam
2. Exit exam

Course outcomes:
The course outcomes will also be evaluated from in-class testing and other instruments deemed suitable.

**Prepared By:**
Michael Langerman, Date: January 9, 2004
ME316: SOLID MECHANICS

CATALOG DATA:
Prerequisites: EM 216 and ME 221. Covers stress analysis and failure theories of both brittle and ductile materials and energy methods. Also includes such topics as elastic impact, stability, axi-symmetrically loaded members in flexure and torsion, and an introduction to plastic behavior of solids.

TEXTBOOK

INSTRUCTOR:
Dr. Lidvin Kjerengtroen, Professor of Mechanical Engineering
Office hours: Posted or by appointment

EXPECTATIONS:
Upon entering this course the student should be proficient in the following areas
1. Fundamental mathematical skills including; calculus, trigonometry, and algebra
2. Statics-equilibrium, free body diagrams, reactions, external and internal loads, shear and moment diagrams, beams and statically determinate trusses, and area moment of inertia. (EM214)
3. Stress analysis- Axial, bearing, shear (direct, transverse, and torsion), and bending. (EM 216)
4. Dynamics: Conservation of energy, Newton's second law.

CLASS SCHEDULE & ROOM
Lecture: 3 hours per week, MWF 9-9:50, MI #222

TOPICS
The course will cover the following topics;
1. Section 1.2 - Equilibrium of A Deformable Body (Brief review)
2. Mechanical Properties of Materials: Sections 3.1-3.6 (Brief review)
3. Axial Load: Sections 4.1-4.9 (Brief review)
5. Strain Transformation & Theories of Failure 10.1-10.7
6. Deflections of Beams and Shafts 12.1-12.2 and 12.5-12.6
8. Torsion: 5.1-5.10
9. Bending topics: Sections 6.6-6.11
10. Transverse Shear: sections 7.1-7.6
11. Combined Loads: Sections 8.1-8.2
13. Pressure Vessels – Handout

COURSE OBJECTIVE
1. Objective 1: Apply load, stress, strain, and deformation analysis to the fundamentals of mechanical design and intermediate solid mechanics
2. Objective 2: Apply static, dynamic, and impact loading conditions to predict failure in parts
3. Objective 3: Become comfortable with the use of energy methods
4. Objective 4: Obtain a solid understanding of stress and strain analysis

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: 0.5 credit or 17%

COMPUTER USAGE
Spreadsheets and Mathematics application tools such as Mathcad

COURSE OUTCOMES
1. Ability to use equilibrium, compatibility, and constitutive relationships to solve solid mechanics problems
2. Ability to evaluate bending, shear and axial stresses for mechanical components
3. Ability to determine stress levels and deformations when impact loading occurs.
4. Ability to analyze components to avoid failure.
5. Ability to evaluate stress and strain for various types of combined loading.
6. Ability to determine deformations due to distributed and concentrated loads.
7. Ability to determine when buckling occurs in a column and determine a critical load at which a column will not return to its original straight configuration.
8. Ability to apply pressurization effects on cylinders for both internal and external pressurization.

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
MAP COURSE OUTCOMES TO PROGRAM OUTCOMES AND WEIGHT (1-4) WITH 4 BEING THE HIGHEST

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LABORATORY:
There is no laboratory associated with this class.

ASSESSMENT AND EVALUATION:
Class tests and exams, FE exam, tests of expectations, ME322, senior design, exit exam

PREPARED BY:
Lidvin Kjerengtroen August 29, 2003
ME 322: MACHINE DESIGN I

CATALOG DATA:
ME 322 MACHINE DESIGN I: (3-0) 3 credits.
Prerequisites: ME 316 and ME 262. Applications of the fundamentals of strength of materials, basic elastic theory, material science and how they apply to the design and selection of machine elements. Elements include shafts, gears, fasteners, and drive components such as gears and chains.

TEXTBOOK:

INSTRUCTOR:
Dr. Karim Heinz Muci, Associate Professor of Mechanical Engineering
Office: Civil & Mechanical Engineering Bldg., CM-131
Office hours: Monday, Tuesday, Wednesday, and Thursday, 1:00 pm – 2:30 pm. Friday, 1:00 pm – 2:00 pm (Other times may be possible making and appointment at the end of one of our lecture hours).

EXPECTATIONS:
- The students are expected to enter the class with a good working knowledge of:
  ✓ Developing free-body diagrams (EM-214)
  ✓ Static and dynamic principles (EM-214 and ME-221)
  ✓ Stress analysis and failure criteria (EM-321 and ME-316)
  ✓ Differential and integral calculus (MATH-123 and MATH-125)
  ✓ Ordinary differential equations (MATH-321)
  ✓ The product development process (ME-262)
- Basic computer skills, such as the ability to work in the MS Windows environment, are a prerequisite.
- The students should be able to comfortably work with MS Excel, MS Word, and MS Power Point.
- The students should be able to use the software Mathcad (or another program with similar capabilities) or they should be able to program in their favorite programming language.

COURSE OBJECTIVES:
After taking this course the student should be able to:
- Apply solid mechanics principles and appropriate failure criteria to derive equations that can be used to design a machine component.
- Establish an algorithm that can be used for the design of a particular machine component and use existing software tools to implement it.
- Take into account factors such as cost, service environment, material and manufacturing, during the design of a machine component.
- Prepare technical reports and presentations documenting the relevant information corresponding to the design of a machine component.

CLASS SCHEDULE:
Lecture: 3 hours per week, Monday, Wednesday and Friday, 9:00 am – 9:50 am. Classroom: MEP-254

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: 0.5 credit or 17%

TOPICS:
1. Review of fatigue failure theories.
2. Shafts and axles.
3. Screws and fasteners.
4. Rolling-contact bearings.
5. Spur and helical gears.
6. Helical compression springs.
7. Belts.

COMPUTER USAGE:
- Use of the software Mathcad.
  Important note: You may use another program that has capabilities similar to the ones provided by Mathcad. However, the instructor won’t be able to help you if you run into problems while trying to solve a homework assignment or project with that software. Also, the instructor may grade your homework/project taking only into account your final results.
- Students will be required to use various computer tools, including but not limited to word processing, CAD, spreadsheets, modeling and programming.
- All the students must have and regularly read an e-mail account. During the semester, the instructor may send important information to the students via e-mail.
• Written reports must be prepared in a word processor.
• Some assignments and/or projects may require electronic submission of work.

COURSE OUTCOMES:
After taking this course the student should be able to:
1. Apply high-cycle fatigue considerations for the design of machine components subjected to cyclic loading.
2. Design transmission shafts made of ductile materials.
3. Design and/or select appropriate fasteners for common applications.
4. Design parallel square keys.
5. Select rolling-element bearings based on the information commonly found in catalogs provided by the manufacturers of those components.
6. Understand the terminology used and the considerations that need to be taken into account for the design of spur and helical gears.
8. Understand the terminology used and the considerations that need to be taken into account for the selection of belts.
9. Identify the key requirements and specifications that need to be taken into consideration for the design of common mechanical components.
10. Work in small teams to design basic mechanical components.
11. Use the commercial software Mathcad (or another program with similar capabilities) to implement algorithms that can be used for the design or selection of machine components.
12. Communicate in an effective fashion the process used, the calculations performed, and the results obtained during the design of a mechanical component.

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4, where 4 indicates a strong emphasis):

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*(For a list of Program Objectives and Program Outcomes, please go to [http://www.hpnet.org/assessment](http://www.hpnet.org/assessment))

LABORATORY:
This course does not have a laboratory component.

ASSESSMENT AND EVALUATION:
Course objectives:
In the Mechanical Engineering undergraduate curriculum, Machine Design I (ME-322) corresponds to one of the courses of the second semester of the junior year. Consequently, the course will be mainly evaluated by the Senior Design Project course sequence (ME 477 and ME 479). Also, it will be evaluated by senior elective courses, such as Machine Design II (ME 422), that have ME 322 as a prerequisite.

Course outcomes:
The course outcomes will be evaluated by three in-class exams, homework, and project related material.

PREPARED BY
Karim Heinz Muci, Date: December 26, 2003.
ME 331: THERMO FLUID DYNAMICS

CATALOG DATA:
ME 331-THERMO FLUID DYNAMICS: (3-0) 3 credits.

Prerequisites: ME 211 and ME 221. A study of the nature of fluids, constitutive relations, fluid statics/buoyancy, and the equations governing the motion of ideal (inviscid) and viscous, incompressible fluids, as well as inviscid, compressible fluids (1-dimensional gas dynamics). Internal and external flows, including viscous pipe flow, the Moody diagram, lift, drag and separation. Laminar and turbulent boundary layer theory, and dimensional analysis, modeling, and similitude.

TEXTBOOK:

INSTRUCTOR:
Dr. Michael A. Langerman, Professor of Mechanical Engineering
Office hours: MF 11:00-12:00, Thur 10:00-11:00

EXPECTATIONS:
Upon entering this course, the students will be expected to:

1) Apply the 1st and 2nd laws of thermodynamics (ME 211),
2) Determine thermal properties, either tabular or through application of an equation of state (ME 211, 313, 351),
3) Apply Newton’s second law (EM 221, ME 211),
4) Understand and apply fundamental ordinary differential equations (Math 321),

and have a working knowledge of other sophomore and junior level physics and mechanics courses taken in sequence in the ME curriculum.

COURSE OBJECTIVES:
The objective of this course is to provide students with the working knowledge required to formulate and analyze problems in thermal/fluid systems and thermal/fluid systems design and to take this knowledge on for application in other junior and senior level courses. Upon completion of this course, the student will show an aptitude, where required in his/her other junior and senior courses, to be able to:

1) Apply the general engineering problem solving method (Given, Find, Analysis, etc.)
2) Differentiate between Bernoulli’s equation and the mechanical energy equation.
3) Solve simple external and internal fluid flow problems in engineering design.

CLASS SCHEDULE:
Lecture: 3 hours per week, 10:00-10:50 am, MWF.

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: 0.5 credit or 17%

TOPICS:
The course will cover the traditional elements of heat transfer in solids, liquids, and gases and will be presented in three units.

Unit 1
- Fluid properties
- Conservation laws
- Thermodynamic relationships
- Hydrostatic pressure
- Manometers
- Hydrostatic forces
- Buoyancy and Rigid Body Motion

Unit 2
- Fluid Acceleration
- Bernoulli Equation
- Integral Equations and Reynolds Transport Theorem
- Conservation of mass
- Conservation of Energy
- Conservation of Momentum
Unit 3

Dimensional Analysis
Similitude
Internal flow
Pipe systems
External flow

The course will cover the traditional elements of heat transfer in solids, liquids, and gases and will be presented in three units.

Computer Usage:
Students will need to be able to program in their favorite language including spreadsheet applications.

Course Outcomes:
Upon completion of this course, students will have demonstrated the ability to:
1. Obtain accurate material properties,
2. Be able to work effectively in groups and teams,
3. Appropriately apply simplifying assumptions and solve problems with the aid of computers,
4. Understand the difference between and the interrelationship of the integral and differential formulation of the basic conservation equations in fluid mechanics,
5. Formulate problems using the principles of similitude and use experimental data to obtain a solution,
6. Apply the concepts of viscous internal flow to solve fundamental piping problems in engineering design,
7. Apply the concepts of viscous and non-viscous external flow to solve fundamental immersed flow problems in engineering design,
8. Conduct laboratory experiments and present finding in a professional oral format,
9. Interpret societal issues and identify and act on ethical issues that may arise in fluid mechanics.

Relation of Course Outcomes to Program Outcomes:
The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

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* (For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/MechEngr](http://www.hpcnet.org/MechEngr))

Laboratory:
The students will tour the ME integrated laboratory and conduct one experiment for class presentation. The laboratory experience will be performed in groups of four to five students.

Assessment and Evaluation:
Course objectives: The course objectives will be evaluated in the senior year capstone design course. A Program Outcomes exit exam will be administered at this time.
Course outcomes: The course outcomes will be evaluated from in-class testing and other instruments deemed suitable. Also the course outcomes will be externally evaluated on an ongoing basis from input supplied by instructors of courses cohered to ME 331 including: ME 411, ME 402/502, ME 414, ME 416, ME 419, ME 430, ME 477, and ME 479.

Prepared By:
Michael Langerman, Date: September 3, 2003

110
ME/EE 351/351L: MECHATRONICS AND MEASUREMENT SYSTEMS

CATALOG DATA:
ME/EE351 – Mechatronic and Measurement Systems: (3-1) 4 Credits
Co-requisites: EE 220 (formerly EE211) and CSC 150. This course will encompass general measurement techniques found in Mechanical and Electrical Engineering. These include measurement of force, strain, frequency, pressure, flow rates, and temperatures. Elements of signal conditioning and data acquisition will be introduced. In addition, the course will have a Mechatronics approach reflected in the combined applications of electronic, mechanical, and control systems. EE 351 and ME 351 are cross-listed.

TEXTBOOK AND MATERIALS:
Project Management and Teamwork, Karl A. Smith, 2000
PELA, Experimental Circuit Board, 1 per team, sold in bookstore

INSTRUCTORS:
Dr. Kalanovic: Office: CM 132,
Office Hours: open office policy
Ms. Linde: Office: EP 316
Office Hours: 10:00 – 10:50 MWF, 4:00 – 5:00 MT

EXPECTATIONS:
Upon entering this course, the students will be expected to:
Have a basic knowledge of algorithm development
Have a basic knowledge of a programming syntax
Have a basic knowledge of electrical circuit analysis

PROFESSIONAL COMPONENT:
Engineering Science: 3 credit or 75%; Engineering Design: 1 credit or 25%

TOPICS:
Introduction to Mechatronics:
Measurement Fundamentals:
Electrical Circuits and Components:
Review of Circuit Analysis
Semiconductor Electronics:
Diodes and LED’s
Transistors (Common Emitter BJT circuit)
System Response:
First Order Systems
Second Order Systems
Analog Signal Processing Using Operational Amplifiers
Basic Op-Amp Circuits
Differential Amplifier
Digital Circuits and Systems
Basic Logic Gates
Relationship to Programming and PLC’s
Data Acquisition
Sensors
Actuators

LABORATORY:
Several lab assignments are done to teach the students the basics of a Mechatronic system and interfacing digital and analog inputs and outputs to the PELA. A one credit hour laboratory ME/EE351L accompanies this course. The laboratory meets for three hours every week. The following laboratories are performed:
Analog Inputs
Temperature Sensor
First Order Response
Brainstorming on Free Project and Robot Design
DC Motor Control
Frequency Domain Analysis
Robot Sensor and Switch Implementation
DC Robot Motor Modification and H-bridge Implementation
Sensors
Actuators
Projects and Robot

COMPUTER USAGE:
Student will use PICC to program a PIC microcontroller and Matlab to analyze data.

COURSE OUTCOMES:
Upon completion of this course, students should demonstrate the ability to:
1. Apply the basic methodology of electronic measurements.
2. Apply the basics of signal conditioning.
3. Perform basic computer interfacing for measurements and control.
4. Select a transducer for standard measurements (temperature, flow, pressure, strain, displacement, velocity and acceleration etc.)
5. Select an electronically controlled actuator.
6. Apply the process of design of a mechatronic system.
7) Implement a mechatronic system.
8) Present a project via a creative video.
9. Demonstrate the fundamentals of working in a team.
10. Deal with issues that arise within a team such as conflict resolution, communication, trust development, and mutual accountability.

RELATION OF COURSE TO PROGRAM OUTCOMES:
These course outcomes fulfill the following program outcomes:
An ability to apply knowledge of mathematics, science, and engineering.
An ability to design and conduct experiments, as well as to analyze and interpret data.
An ability to design a system, component, or process to meet desired needs.
An ability to function on multi-disciplinary teams
An ability to identify, formulate, and solve engineering problems.
An understanding of professional and ethical responsibility
An ability to communicate effectively
The broad education necessary to understand the impact of engineering solutions in a global and societal context
A recognition of the need for, and an ability to engage in life-long learning
A knowledge of contemporary issues
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
The following table indicates the relative strengths of each course outcome in addressing the program outcomes listed above (on a scale of 0 to 4 where 4 indicates a strong emphasis)

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* (For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/**assessment](http://www.hpcnet.org/**assessment*)

PREPARED BY:
Elaine Linde and Dr. Vojisav Kalanovic, Date: August 20, 2003

REVISED:
Elaine Linde and Dr. Vojisav Kalanovic, Date: January 5, 2004
ME 352: INTRODUCTION TO DYNAMIC SYSTEMS (Required)

CATALOG DATA:
ME 352: Introduction to Dynamic Systems (3-0) 3 credits
Prerequisites: MATH 321, ME 221. This is an introductory course in the control of dynamic systems. The course presents the methodology for modeling and linearizing of electrical, mechanical, thermal, hydraulic and pneumatic systems. The course also covers control system analysis and synthesis in the time and frequency domains.

TEXTBOOK:

INSTRUCTOR:
Dr. U.A. Korde, CM 132, 355-3731, Fax: 394-2405, Umesh.korde@sdsmt.edu
Office Hours: M 1-3 PM, T 10-11 AM, W3-4 PM, F1-2 PM; and by prior arrangement.

EXPECTATIONS:
Students are expected to have:
1. an ability to apply Newton’s laws and solve dynamic problems including rigid body in plane motion,
2. an ability to solve ordinary differential equations with constant coefficients,
3. familiarity with Laplace transforms.

COURSE OBJECTIVES:
The objective of this course is to provide the basic working knowledge required to analyze and design control systems. The course will provide methods applicable to the analysis and design of control systems. Upon completion of the course, the student will:
1. analyze mechanical systems using linear, Laplace-transform based models,
2. use block diagrams to represent systems,
3. analyze linear systems for their transient and steady-state behavior,
4. examine the stability of linear systems,
5. analyze and design control systems using root-locus methods,
6. become familiar with frequency-response methods (Bode plots, etc.).

CLASS SCHEDULE:
Lecture: 3 hours per week, MWF 8-8:50 AM, EP 255

PROFESSIONAL COMPONENT:
Engineering Science: 2 credit or 66%; Engineering Design: 1 credit or 33%

TOPICS:
Introduction, Overview of Control
Feedback basics, block diagrams, Laplace transforms, simulations
Mechanical systems, transfer functions, Linearization
Intro to 1st, 2nd order systems, poles, zeros
1st, 2nd order transient response, simulations
Controller introduction, simple controllers
Multiple subsystems
Stability considerations
Steady-state behavior, errors
Root locus techniques
Design, controllers using root locus
Frequency Response, Bode Pots

COMPUTER USAGE:
Students will use MATLAB with SIMULINK for homework and project assignments.

COURSE OUTCOMES:
Upon completion of this course, students will have demonstrated the ability to:
1. develop linear mathematical models for mechanical systems,
2. use block diagrams to represent systems,
3. determine the transient response and steady-state errors of linear systems (step-input response, etc.)
4. design controllers for linear systems (e.g. the PID controller),
5. work in groups on design projects and present results.
RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strength of each course outcome in addressing the program outcomes (on a scale of 1 to 4, 4 indicating strong emphasis).

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<th>ME 352 Program Outcome</th>
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* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/MechEngr)

LABORATORY:
There is no specific laboratory component for this course. However, projects may involve laboratory experience.

ASSESSMENT AND EVALUATION:
Course objectives:
The course objectives will be evaluated in the senior year capstone design course. A Program Outcomes exit exam will be administered at this time.
Course outcomes:
The course outcomes will be evaluated from in-class testing and other instruments deemed suitable. Also the course outcomes will be externally evaluated on an ongoing basis from input supplied by instructors of courses cohered to ME 352, e.g. ME 423, ME 453

PREPARED BY:
U.A. Korde, January 5, 2004
ME 477: MECHANICAL ENGINEERING DESIGN I

CATALOG DATA:
ME 477-MECHANICAL ENGINEERING DESIGN I: (0-2) 2 credits.
Prerequisite: Senior standing or graduation within three semesters, ME 322, ME 351 (concurrent). The first semester of a two-course sequence in senior design practice. Integrates concepts from all areas in mechanical engineering into a practical design project. Fundamentals of the design process, specifications, decision-making, and preliminary design will be the focus, with the major part of the course being the project.

TEXTBOOK:
No textbook is required.

INSTRUCTOR:
Dr. Christopher H. M. Jenkins, Professor of Mechanical Engineering
Office hours: posted or by appointment

EXPECTATIONS:
This course focuses on capstone design projects. This means the student is expected to bring together foundational knowledge from the bulk of their undergraduate experience. Specifically, the student is expected to have a good working knowledge of:
1) Principles of modern product and process design
2) Written and oral communication skills
3) Problem solving skills
4) Basic analysis techniques in fluid, solid, and thermal mechanics

COURSE OBJECTIVES:
The objective of this course is to provide a realistic engineering experience through use of a design project. Students will work in teams under the mentorship of a faculty member. Upon completion of this course, the student will demonstrate ability to:

1) Define project requirements
2) Conceptualize various solutions
3) Rationally down select to a candidate design
4) Prepare the foundation to realize and implement the design
5) Effectively communicate the design by oral and written means
6) Work in a team environment

CLASS SCHEDULE:
Lecture: 1 hour per week, 4:00PM-4:50PM Tuesday; weekly project meetings with faculty advisor.

PROFESSIONAL COMPONENT:
Engineering Design: 2.0 credit or 100%

TOPICS:
Capstone design projects

COMPUTER USAGE:
As required by projects

COURSE OUTCOMES:
Upon completion of this course, students will have demonstrated the ability to:
1. Develop a set of project specifications and constraints
2. Research the state of the art of current and competing technology
3. Write a set of task statements
4. Develop a project schedule
5. Conceptualize various preliminary solutions to the project requirements
6. Use decision matrices for down selection to a candidate solution
7. Develop a cost estimate
8. Make oral presentations and deliver written communications effectively
9. Work effectively in a team environment
10. Define the problem in a societal context, including issues such as ethics, safety, environmental impact, etc.
RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:

The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

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<th>Course Outcome</th>
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* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/MechEngr)

LABORATORY:

As required by projects.

ASSESSMENT AND EVALUATION:

Course objectives

The course objectives may be evaluated by one or more of the following methods:
1. FE exam
2. Exit exam
3. Alumni survey

Course outcomes

The course outcomes will be evaluated by the following methods:

1. Professionalism = 22.5%
   - Attendance at required meetings = 5%
   - EIT = 7.5% (documentation required).
   - Exit Exam = 7.5%.
   - Engineering society = 2.5% (documentation required).
2. Design Review = 25% (Average of evaluator's scores)
3. Design Fair = 17.5% (Average of evaluator's scores)
4. Overall project effort/formance = 10% (self assessment).
5. Written reporting = 25% (Course coordinator = 15%; project advisor = 10%).

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<th>ITEM</th>
<th>% COORDINATOR</th>
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<td>Design Review</td>
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PREPARED BY:

C. H. M. Jenkins January 9, 2004
ME 479: MECHANICAL ENGINEERING DESIGN II

CATALOG DATA:
ME 479- MECHANICAL ENGINEERING DESIGN II: (0-2) 2 credits.
Prerequisite: Senior standing or graduation within three semesters, ME 322, ME 351 (concurrent). The second semester continuation of ME 477. Integrates concepts from all areas in mechanical engineering into a practical design project. Detailed design and analysis, manufacturing, and assembly will be the focus.

TEXTBOOK:
No textbook is required.

INSTRUCTOR:
Dr. Christopher H. M. Jenkins, Professor of Mechanical Engineering
Office hours: posted or by appointment

EXPECTATIONS:
This course focuses on capstone design projects. This means the student is expected to bring together foundational knowledge from the bulk of their undergraduate experience. Specifically, the student is expected to have a good working knowledge of:
5) Principles of modern product and process design
6) Written and oral communication skills
7) Problem solving skills
8) Basic analysis techniques in fluid, solid, and thermal mechanics

COURSE OBJECTIVES:
The objective of this course is to provide a realistic engineering experience through use of a design project. Students will work in teams under the mentorship of a faculty member. Upon completion of this course, the student will demonstrate ability to:
1. Perform detailed analysis in support of developing the design concept
2. Carry out a formal experiment in support of developing the design concept
3. Develop detailed manufacturing and assembly plans
4. Effectively communicate the design by oral and written means
5. Work in a team environment

CLASS SCHEDULE:
Lecture: 1 hour per week, 4:00PM-4:50PM Tuesday; weekly project meetings with faculty advisor.

PROFESSIONAL COMPONENT:
Engineering Design: 2.0 credit or 100%

TOPICS:
Capstone design projects

COMPUTER USAGE:
As required by projects

COURSE OUTCOMES:
1. Upon completion of this course, students will have demonstrated the ability to:
2. Apply analytical tools from a variety of their technical courses
3. Develop and implement a formal experiment plan
4. Develop and implement a manufacturing and assembly plan
5. Use a project schedule and other tools to effectively manage a project
6. Produce a set of archival design drawings
7. Make oral presentations and deliver written communications effectively
8. Work effectively in a team environment

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:

The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):
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* (For a list of Program Objectives and Program Outcomes, please go to [http://www.hpecnet.org/MechEngr](http://www.hpecnet.org/MechEngr))

**Laboratory:**
As required by projects.

**Assessment and Evaluation:**

*Course objectives*

The course objectives will be evaluated by the following methods:
1. FE exam
2. Exit assessment
3. Alumni survey

*Course outcomes*

The course outcomes will be evaluated, and the final letter grades (no curve) will be based, on the following criteria:
1. Professionalism = 22.5%
   - Attendance at required meetings = 5%
   - EIT = 7.5% (documentation required).
   - Exit Exam = 7.5%.
   - Engineering society = 2.5% (documentation required).
2. Design Review = 25% (Average of evaluator's scores).
3. Design Fair = 17.5% (Average of evaluator's scores)
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**Prepared By:**
C. H. M. Jenkins January 9, 2004
EE 220/220L: Circuits I

CATALOG DATA:
EE 220/220L – Circuits I: (3-1) 4 Credits. Prerequisites: MATH 125 completed with a grade of "C". Corequisite: MATH 321. This course is designed to provide the electrical engineering student with an understanding of the basic concepts of the profession. Topics covered include resistive circuits, transient circuits, and sinusoidal analysis. Students also investigate essential principles by conducting laboratory experiments related to the topics studied in the classroom. P-spice is used to analyze electrical circuits using personal computers.

TEXTBOOK:

COORDINATOR:
Dr. Thomas P. Montoya, Assistant Professor

GOALS:
The objective of this course is to provide students with a working knowledge of the fundamentals of electrical engineering. A particular emphasis is made on DC, transient, and AC steady-state circuit analysis.

CLASS SCHEDULE:
Lecture: 3 hours per week.
Laboratory: 2 hours every week (1 credit hour).

TOPICS:
1. DC Circuits:
2. Basic Laws:
3. Methods of Analysis:
4. Circuit Theorems:
5. Operational Amplifiers:
6. Capacitors and Inductors:
7. First-Order Circuits:
8. Second-order Circuits:
9. Sinusoids and Phasors:
10. Sinusoidal Steady-State Analysis:
11. AC Power Analysis:

COMPUTER USAGE:
Students use circuit simulation software (such as PSpice) to analyze simple circuits containing current & voltage sources, resistors, capacitors, inductors, operational amplifiers, and semiconductor devices such as BJTs. Also, students are encouraged to use computer programs for mathematics and graphing (e.g., MS Excel, MathCad, MATLAB, ...).

LABORATORY:
A one credit hour laboratory EE 220L accompanies this course. The laboratory meets for two hours every week for a total of 13 laboratories during the semester. The following laboratories are performed:

1. Using the Digital Multimeter
2. Ohm's Law
3. Voltage and Current Division
4. Nodal Analysis
5. Mesh Analysis-Transistor Circuit
6. PSpice Demonstration and Use
7. Thevenin and Norton Circuits
8. Use of the Signal Generator and Oscilloscope
9. The Operational Amplifier
10. RL and RC Circuits
11. First-Order Circuits
12. Second-Order Circuits
13. AC Sinusoidal Circuits
The students use basic measurement equipment in the labs including the power supply, digital multimeter, function generator and oscilloscope. All the circuits are breadboarded. In the pre-laboratory work, the students typically analyze the circuits to familiarize themselves with the upcoming lab and often are asked to verify their solutions using PSpice.

OUTCOMES:

Upon completion of this course, students should demonstrate the ability to:

1. Understand, apply, and use the definitions of and the SI units for charge, current, voltage, energy, and power.
2. Apply Ohm’s Law to calculate voltages, currents, and impedances/resistances for AC and DC circuits.
3. Understand and calculate equivalent capacitances, inductances, resistances, and impedances for series, parallel, Wye, and Delta connected resistors, capacitors, and inductors.
4. Understand and apply the voltage and current division rules to AC and DC circuits.
5. Understand and apply Kirchoff’s Laws, including Nodal and Mesh analysis, to AC and DC circuits.
6. Understand and apply the principles of linearity and superposition to AC and DC circuits.
7. Understand and calculate the Thevenin and Norton equivalents for AC and DC circuits.
8. Analyze and design simple operational amplifier circuits.
9. Understand the properties of capacitors and inductors and apply the current-voltage relationships of capacitors and inductors.
10. Analyze natural and step response of first order circuits (series RC and RL).
12. Understand, apply, and use phasors for sinusoidal steady-state AC circuit analysis.
13. Understand and calculate apparent, complex, instantaneous, and average power, effective or RMS voltages and currents, power factor, and power factor correction for AC circuits.
14. Use PSpice to model/simulate simple DC, transient, and AC circuits.
15. Use basic laboratory measurement equipment including the power supplies, digital multimeters, function generators, and oscilloscopes to conduct experiments.
16. Understand and use a laboratory notebook for documenting experiments and writing technical reports.

RELATION OF COURSE TO PROGRAM OBJECTIVES:

These course outcomes fulfill the following program objectives:

(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.
(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 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.

The following table indicates the relative strengths of each course outcome in addressing the program objectives listed above (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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PREPARED BY: Thomas P. Montoya, Date: October 18, 2001 (last modified August 20, 2003)

120
Course Description:
Prerequisite Math 124 completed with a grade of "C" or better. The study of the effects of external forces acting on stationary rigid bodies in equilibrium. Vector algebra is used to study two and three-dimensional systems of forces. Trusses, frames and machines, shear and moment in beams. Friction, centroids, moments of inertia and mass moments of inertia are discussed.

Textbook:

Instructor:
Lois Arneson-Meyer, CM 121
Office Hours: Open door

Teaching Assistants:
Homework Grader -

Expectations:
Students should know all trigonometric functions associated with right angles. Sine and cosine law, algebra skill: solving linear equations, exponents, factoring, solving systems of equations, similar triangles and fundamental calculus skills (integration, differentiation)

Course Objectives:
This course is designed to provide students with a basic knowledge in the study of the effects of external forces acting on stationary rigid bodies in equilibrium.

Course Outcomes:
The students successfully completing this course will have the ability to:

1. Determine the components of a force in rectangular coordinates.
2. Draw complete and correct free-body diagrams and write the appropriate equilibrium equations from the free-body diagrams.
3. Evaluate forces acting on static bodies including determining resultants and 3D components.
4. Calculate moments in 2D and 3D about a point and an axis utilizing cross products and dot products.
5. Determine the support reactions on a structure.
6. Determine the connection forces in trusses and in general frame structures.
7. Given standard shapes and corresponding centroids and or moment of inertia be able to compute centroids and or moment of inertia for composite bodies
8. Determine how to identify and solve problems involving dry friction, wedges and belt friction.
9. Determine the internal reactions in a beam, draw correct shear force and bending moment diagrams.

Class Schedule and Topics:

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Review fundamental concepts</td>
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<tr>
<td>2</td>
<td>Particles – equilibrium in 2D and 3D</td>
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<tr>
<td>3</td>
<td>Rigid bodies moments – 2D and 3D and couples</td>
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<tr>
<td>4</td>
<td>Rigid bodies moments – 2D and 3D and couples</td>
</tr>
<tr>
<td>5</td>
<td>Rigid bodies – equilibrium 2D and 3D and 2 and 3 force members</td>
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<tr>
<td>6</td>
<td>Equilibrium 3D, centroids – areas and lines, and centroids by integration</td>
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<tr>
<td>7</td>
<td>Distributed loads on beams, submerged surfaces</td>
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<tr>
<td>8</td>
<td>Trusses – method of joints and sections</td>
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<tr>
<td>9</td>
<td>Frames and machines</td>
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<tr>
<td>10</td>
<td>Internal forces in members, shear and bending moment diagrams</td>
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<tr>
<td>11</td>
<td>Shear and bending moment diagrams for beams</td>
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<tr>
<td>12</td>
<td>Friction, belt friction</td>
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<tr>
<td>13</td>
<td>Moment of inertia, area and composite areas</td>
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<tr>
<td>14</td>
<td>Mass moment of inertia</td>
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<td>15</td>
<td>Semester review</td>
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</tbody>
</table>

Laboratory Projects:

Professional Component:
Engineering Topics: 3 credits or 100%

Relationship Between Course Outcomes and ABET a-k Outcomes:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>ABET Program Outcomes</th>
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</thead>
<tbody>
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</table>

Assessment and Evaluation:
Independent Course Assessment (homework, exams, quizzes)
FE Exam Topical Results
Student Self Assessment Survey
Institutional Student Course Evaluation

Prepared by: Lois Arneson-Meyer
Course Description:
Basic concepts of stress and strain that result from axial, transverse, and torsional loads on bodies loaded within the elastic range. Shear and moment equations and diagrams; combined stresses; Mohr's circle; beam deflections; and column action and equations.

Textbook:

Instructor:
Dr. M. R. Hansen, CM 242

Teaching Assistants: Munkhzhul Distabazar

Course Objectives:
1. This course is designed to provide sophomores in Civil, Mechanical, and other engineering majors with a basic understanding of stress, strain, and deformation analysis due to axial, torsional, flexural, and combined loads.
2. Design of torsional, flexural, and compression members will be introduced. Basic engineering design concepts are integrated.
3. Responsibility to society is introduced, especially with respect to designing structures to prevent failure.
4. The students must communicate effectively and demonstrate problem formulation and solution procedures for solving basic engineering problems.

Course Outcomes:
The students successfully completing this course will have the ability to:

1. Apply concepts for axial stress and strain, axial deflection, and the application to solve simple indeterminate problems (a, b, c, e, g).
2. Apply concepts for torsional stress and strain, torsional deflection, and the application to solve simple indeterminate problems (a, c, e, g).
3. Apply concepts for shear and moment diagrams, and equations, and the ability to construct these for complex loading combinations on beams (a, c, e, g).
4. Apply concepts for flexural stress and strain and the ability to apply these principles in elementary design of beams (a, c, e, g).
5. Apply concepts for horizontal shear stress in beams and the ability to apply these principles in elementary design of nails, bolts, glue, or welding (a, c, e, g).
6. Apply concepts for two-dimensional combined stress and the ability to demonstrate this through construction and labeling of Mohr's circle (a, c, e, g).
7. Apply concepts for beam deflection and the ability to demonstrate this by double integration and superposition methods (a, b, c, e, g).
8. Apply concepts for basic column analysis and design (a, c, e, g).
Class Schedule and Topics:  

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1</td>
<td>Types of stress</td>
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<td>Stress-strain</td>
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<td>Axial stress</td>
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<td>Statically indeterminate</td>
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<td>Torsion</td>
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<td>7</td>
<td>Shear and Moment diagrams</td>
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<td>8</td>
<td>Flexural stress</td>
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<td>Horizontal shear stress</td>
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<td>10</td>
<td>Horizontal shear stress</td>
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<td>11</td>
<td>Combined stress</td>
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<td>12</td>
<td>Stress transformation</td>
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<td>13</td>
<td>Beam deflection</td>
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<td>14</td>
<td>Superposition</td>
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</tbody>
</table>

Laboratory Projects:  None

Professional Component:  Engineering Topics:  3 credits or 100%

Relationship Between Course Outcomes and ABET a-k Outcomes:  
(1 = min.  2 = avg.  3 = max)

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>ab</th>
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Assessment and Evaluation:

1. One or two short quizzes will be given in class each week. Regular examinations will be designed to demonstrate mastery of the basic concepts and the ability to solve basic problems.
2. Students will compete one “mini-lab report” to present and analyze deflection data obtained in class. Students will also complete several spreadsheet exercises, using given data, to present and analyze stress and strain data. Students will participate in the West Point Bridge Design contest, which emphasizes efficiency of truss bridge design.
3. A comprehensive final examination will be designed to demonstrate the student’s ability to solve basic problems and to integrate concepts presented during the course. The students must achieve a minimum score of 60 percent to pass the course.

Prepared by:  M. R. Hansen
GE 115: Professionalism in Engineering and Science I

CATALOG DATA:
GE 115 - Professionalism in Engineering and Science I: (1-1) 2 Credits
A course based upon professional issues pertinent to engineers and scientists along with an overview of the various engineering and science disciplines. Case studies based upon actual technical problems will be presented by practicing engineers and scientists. These case studies will involve both societal and professional questions. The format for a particular case study will involve an overview of a particular engineering or science discipline, and introduction to an actual technical problem, and a discussion of the societal implications of decisions that result.

DESIGNATION: Required

TEXTBOOK:
Student Manual (CD available at the Tech Bookstore. Supplements online)

INSTRUCTORS:
Dr.'s Stetler, Kellar, Dixon, Kellogg, Stone, Simonson, and Hladysz, Mr. Ash, Ms. Sieverding

PREREQUISITE KNOWLEDGE:
This is a freshman course with no specific incoming expectations except a commitment to pursue a degree in engineering.

COURSE OBJECTIVES:
To make the most of this course, it is recommended that students adopt the following five learning objectives to guide their priorities and actions during this term.
1. Be able to use technology tools (World Wide Web, Excel, PowerPoint, analysis software) to analyze, solve, and present solutions to engineering problems.
2. Become an effective team member.
3. Develop the communication skills necessary to package acquired technical and professional abilities that are required to succeed in engineering practice.
4. Understand the engineering profession enough to commit to a major and create an education/career plan.

CLASS SCHEDULE:
Lecture/Lab: 3 hours per week, 11:00PM-11:50PM, MWF (Section 9), 1:00PM-1:50PM, MWF (Section 1).

ENGINEERING COMPONENT:
Engineering Topics – 1 credit, Other – 1 credits (significant design)

TOPICS:
The course will cover the following engineering related topics
- Technical Library Orientation
- Teams and Teaming
- Webpage Development and Publishing
- Professional Engineering Ethics
- Dimensions, Units, and Significant Figures
- Technical Writing Overview
- Analytical Methods for Engineering
- Problem Solving and Chart Creation Using Excel
- Experimental Lab and Data Analysis
- Final Teaming Project

COMPUTER USAGE:
Microsoft FrontPage – web development
Microsoft Excel – engineering problem solving
Microsoft Word – for writing memos/technical reports
Microsoft PowerPoint – final team presentation
Logger Pro – data acquisition software used for experimental lab
**Course Outcomes:**
Upon completion of this course, students will have demonstrated the ability to:
1. Document a rational for selection in their chosen major.
2. Author a web page and post to the Internet.
3. Incorporate the rules of significant digits when solving problems and check for dimensional consistency.
4. Incorporate the 7-step approach to solving engineering problems.
5. Utilize Excel to solve fundamental problems in engineering.
6. Use a data acquisition system to collect experimental data.
7. Utilize Excel to analyze data and conduct a trend analysis on experimental data.
8. Utilize the fundamental principles of engineering design and team problem solving to design a rudimentary engineering system.
9. Utilize fundamental principles of technical writing to prepare a technical report, resume, and technical memorandum.
10. Utilize ethical principles in professional engineering decision making.

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strength of each course outcome in addressing the program outcomes (on a scale of 1 to 4, 4 indicating strong emphasis).

<table>
<thead>
<tr>
<th>GE 115 Course Outcomes</th>
<th>ABET Criteria a-k</th>
<th>a</th>
<th>b</th>
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**Laboratory:**
The students will utilize the Lab Pro data acquisition devices to measure the temperature in a coffee pot as a function of time from when the coffee pot is turned on. This data will be collected and analyzed by the students and then placed into a technical report. In addition, extensive lab work is used during the final team project.

**Assessment and Evaluation:**
- Homework
- Laboratory Project
- Writing, reports, presentation
- Professionalism/Attendance
- Portfolio
- FE Exam
- Exit Exam

**Prepared By:**
S. Kellogg, Date: April 20, 2004
GE 117: Professionalism in Engineering and Science II
Required Course

CATALOG DATA:
GE 117 – Professionalism in Engineering and Science II: (1-1) 2 Credits

The course is a continuation of GE 115. A survey of team skills, problem solving skills, and communication skills necessary for today's environment. The laboratory component continues the societal and professional questioning required of engineers and scientists through the application of student teams working on applied projects with faculty members.

*Note: This is the catalog description as listed, but the course has evolved and now only ME's, MET's, and IE's take the course as either a requirement or free elective. The Spring 2004 semester is the last time it will be taught and the course name will revert back to a previous ME 110 course – Introduction to Mechanical Engineering who's course description fits more closely with what is currently taught and reads:

An introductory course for incoming mechanical engineering freshman which will introduce the student to the profession they have chosen. Topics to be covered include: Solid modeling, CAD lab, professional development, engineering design, technical communications, personal development, and academic success skills.

TEXTBOOK:

INSTRUCTOR:
Mr. Jason Ash, ME Instructor
Office: CM102 Office Hours: 10-12 and 4-5 MWF or by appointment.
Phone: 355-3736 Email: Jason.Ash@sdmt.edu

EXPECTATIONS:
This is a freshman course with no specific incoming expectations except a commitment to pursue a degree in engineering.

COURSE OBJECTIVES:

To make the most of this course, it is recommended that students adopt the following five learning objectives to guide their priorities and actions during this term.
1. Be able to use physical principles in the design process to address engineering problems.
2. Become an effective team member.
3. Develop the communication skills necessary to package their technical and professional skills to succeed in engineering practice.
4. Develop an understanding of 3-D modeling.
5. Understand the engineering design process and how 3-D modeling fits into it.

CLASS SCHEDULE:
Lecture/Lab: 3 hours per week, 2:00PM-2:50PM, MWF (Section 2), 3:00PM-3:50PM, MWF (Section 1).

PROFESSIONAL COMPONENT:
Engineering Science: 1.50 credits or 75%
Engineering Design: 0.50 credit or 25%

TOPICS:
The course will cover the following engineering related topics
- Engineering Design
- Engineering Drawings/Sketching
- Solid Modeling (SolidWorks)
- Dimensioning and Tolerancing Standard Introduction

COMPUTER USAGE:
Much of the class and lab time will be devoted to learning the use of SolidWorks. Microsoft Word and PowerPoint will be used as needed for memos and course projects.
**Course Outcomes:**
Upon completion of this course, students will have demonstrated the ability to:

1. Discuss the concept of concurrent engineering and how it relates to engineering design and manufacturing.
2. Read and produce mechanical drawings/sketches (orthographic/multiview, isometric, oblique).
3. Visualize and/or produce a conversion between the various drawing/sketching forms.
4. Understand how 3-D modeling fits into the engineering design process.
5. Be able to produce a 3-D solid model for a specific part and create a dimensioned orthographic drawing of it.
6. Be able to combine numerous part files into an assembly drawing.
7. Understand the need for a dimensioning and tolerancing standard and where to locate that if needed.

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

<table>
<thead>
<tr>
<th>GE 117</th>
<th>ME Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Outcome</td>
<td>Objective 1</td>
</tr>
<tr>
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</tbody>
</table>

* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/MEobjectives_outcomes)

**Laboratory:**
The students will utilize the SolidWorks software extensively to produce 3-D solid parts, mechanical drawings of those, and take in-class quizzes.

**Assessment and Evaluation:**

**Course Objectives:**
The course objectives will be evaluated from input supplied from instructors of cohered courses such as: ME 262. Also the following assessment instruments will be used for evaluating the course objectives:

1. FE exam
2. Exit exam

**Course Outcomes:**
The course outcomes will also be evaluated from in-class testing and other instruments deemed suitable. The following weights will be used to determine the final grade.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quizzes</td>
<td>30%</td>
</tr>
<tr>
<td>Homework</td>
<td>30%</td>
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<tr>
<td>Projects</td>
<td>20%</td>
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<tr>
<td>Attendance</td>
<td>10%</td>
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<tr>
<td>Portfolio</td>
<td>10%</td>
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</tbody>
</table>

Grading Scale: A (90-100)  B (80-90)  C (70-80)  D (60-70)  F (<60)

**Prepared By:**
Jason Ash, Date: April 12, 2004
IENG 302: Engineering Economics

CATALOG DATA:
IENG 302 – Engineering Economics: (3-0) 3 Credits
Prerequisite: Junior or higher standing preferred. Studies economic decision making regarding capital investment alternatives. Covers compound interest and depreciation models, replacement and procurement models. Analysis is made variously assuming certainty, risk and uncertainty. Graduation credit cannot be given for both IENG 301 and IENG 302.

DESIGNATION: Required

TEXTBOOK:

INSTRUCTOR:
Jennifer Karlin
Office hours: M, W: 10-11 AM; M, F. 1-2 PM, or by appointment

PREREQUISITE KNOWLEDGE:

CLASS SCHEDULE:
Lecture: 3 hours per week, M, W, F 12 - 12:50 PM, CB 204W

ENGINEERING COMPONENT:
Engineering Topics – 1 credit, Other – 2 credits

TOPICS:
1. Time Value of Money
2. Nominal and Effective Interest Rates
3. Present Worth Analysis
4. Annual Worth Analysis
5. Rate of Return Analysis
6. Benefit / Cost Analysis
7. Replacement and Retention Decisions
8. Inflation
9. Depreciation
10. After-Tax Analysis

COMPUTER USAGE:
Application of Microsoft Excel to spreadsheet based problems.

LABORATORY:
No laboratory component is included in this course.

COURSE OBJECTIVES:
After completing this course, students should be able to:
1. Identify how time and interest affect cash flows.
2. Identify the best engineering economy tool for evaluating alternatives.
3. Utilize present worth analysis, annual worth analysis, rate of return analysis, and benefit/cost analysis for evaluating alternatives.
5. Incorporate various depreciation methods in after-tax economic analysis.
**Course Outcomes:**
Engineering Economy Fundamentals
1. Be able to move various cash flows across time while accounting for discrete or continuous compound interest, e.g., single payment factors, uniform-series factors, and arithmetic and geometric gradient factors.
2. Apply the concept of minimum attractive rate of return in economic decision-making.
3. Tools for Evaluating Alternatives
4. Be able to identify the best engineering economy tool for evaluating alternatives.
5. Be able to evaluate asset alternatives using present worth analysis, annual worth analysis, rate of return analysis, benefit / cost analysis.
6. Be able to utilize computer spreadsheets and their functions to solve engineering economy problems.
7. Making Decisions on Real-World Projects
8. Be able to determine the economic service life of an asset that minimizes the total annual worth of costs.
9. Be able to perform an asset replacement study between the defender and the best challenger.
10. Advanced Techniques
11. Be able to determine the difference inflation makes between money now and money in the future.
12. Be able to apply straight-line and MACRS depreciation models to reduce the value of the capital investment in an asset.
13. Be able to calculate before-tax and after-tax cash flows.

**Relation of Course Outcomes to Program Outcomes**
The following table indicates the relative strengths of each course outcome in addressing the program objectives (on a scale of 1 to 4 where 4 indicates a strong emphasis):

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<thead>
<tr>
<th>Course Outcomes</th>
<th>IE Program Outcomes</th>
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**Assessment and Evaluation:**
Course assessment will involve embedded assessments. Sample problems from student exams will be collected and scored by the instructor against a proficiency rubric. Problems will be saved for IE faculty review. Course results will be compared to weighted average results on FE in engineering economy.

**Prepared By:**
Jennifer Karlin, Date: November 6, 2003.
MET 231 STRUCTURES AND PROPERTIES OF MATERIALS LAB

CATALOG DATA:
(0-1) 1 credit. Prerequisites: Concurrent registration in MET 232, or permission of instructor. A laboratory involving quantitative metallography, heat treating practice, mechanical property measurements and metallurgical design of the thermal mechanical treatment of metals.

TEXTBOOK:

INSTRUCTOR:
Dr. Glen A Stone, Office Hours: 2:00-3:00 p.m. M-W-F

REQUIRED/ELECTIVE:
This course is required for all B.S. Metallurgical, Mechanical and Industrial Engineering students.

COURSE OBJECTIVES:
The objective of this laboratory program is to relate the properties of engineering materials to the materials microstructure developed during thermal mechanical processing. Students develop tools to make informed engineering material selection decisions that will be safe and economic. All students must attend the common recitation period before each laboratory period so as to receive important safety information as well as general directives and goals of each laboratory exercise.

COURSE OUTCOMES:
- compute the Mean, Variance and Standard Deviation.
- Given a comprehensive laboratory handout discussing cold rolling, the student will produce a rolling schedule for C11000 copper alloy defining the total cold reduction and number of passes to achieve 70% reduction in area.
- Given a set of samples the student will measure hardness as a function of percent reduction of area, using the Rockwell HRB and HRF scales. The student will download these data and produce a least squares polynomial curve fit of the data and compute the goodness of fit.
- ASTM E8 tensile specimens subjected to known thermal-mechanical processing steps.
  1. The student will set-up and use the TestStar II MTS controller to conduct tensile tests according to ASTM E8, and generate engineering stress-strain plots from the measured load-elongation data.
  2. Each student will perform a statistical analysis on the data set consisting of their data and instructor-provided data. The analysis must answer the question: "Are the experimental results within the expected statistical range of the literature values?"
- Students will be able to recognize the microstructure and name of phases present in instructor-provided aluminum, copper, brass, cast iron, and steel alloys.
- Olympus microscope and the LECO Image Analysis System
  1. Students will be able to operate the Olympus microscope and the LECO Image Analysis System.
  2. Each student will use the Olympus Metallograph with LECO Image Analysis System to measure the ASTM E112 grain size and area fraction of pearlite in a minimum of ten connecting areas of the specimen and perform a statistical analysis of collected data.
- Charpy impact specimens
  1. Students will measure the energy required to fracture the plain carbon steel alloy at four temperatures between -78°C and 100°C. Students will report their findings on the statistical analysis of their data and compare it to literature data.
  2. SEM Fracture Morphology Charpy impact fracture surfaces from will be examined to determine their characteristics and modes of failure. Students will photograph and characterize fractures for their report.
• Carburization
  1. Given a polished and etched case hardened gear tooth, the student will measure the hardness profile of a case hardened part using the LECO microhardness tester (HV scale).
  2. The students, using the LECO image analyzer, will photograph and characterize the microstructure of the steel in the case hardened zone and core of the case hardened part.
• Given ASTM A255 samples of a moderate and high hardenability steel alloy, the student will measure the hardness profile of each alloy and compare the results to literature data.

TOPICS COVERED:
• Review of Statistics
• Cold Working of Metals
• Hardness Measurement
• Tensile Testing
• Metallography – Structure and Properties
• Quantitative Metallography
• Impact Testing
• SEM Fracture Analysis
• Hardenability
• Case and Core Hardness of Steels
• Case and Core Metallography of Steels
• Atomic Force Microscope Demonstration
• Seminar

CLASS SCHEDULE:
3 hours per week Tu, 1:00-3:50 p.m.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES: (a), (b), (d), (g), (k)

LABORATORY:
For safety reasons many of the laboratory instruments have a virtual laboratory-learning tool that is require before students use the equipment. The course laboratory parallels the lecture portion, both in terms of objectives and topics covered. In addition, the laboratory stresses hands-on applications of course content, and a large technical communication component.

CONTRIBUTION OF COURSE TO MEETING THE PROFESSIONAL COMPONENT:
Writing is emphasized in the laboratory program. About half of the lab reports are prepared in a teaming environment.

PERSON WHO PREPARED THIS DESCRIPTION AND DATE OF PREPARATION:
Glen Stone, January 14, 2004
MET 232 PROPERTIES OF MATERIALS
(Required Course)

CATALOG DATA:
(3-0) 3 credits. Prerequisite: MATH 123 and PHYS 111
A course in engineering materials and their applications. The different technological uses of metals, ceramics, plastics, and composite materials are discussed and explained in terms of their basic atomic structure, and mechanical, thermal, optical, electrical, and magnetic properties. Material selection in engineering design is emphasized.

TEXTBOOK:

INSTRUCTOR:
Dr. Glen A Stone, Office Hours: 2:00-3:00 p.m. M-W-F

REQUIRED/ELECTIVE:
This course is required for all B.S. Metallurgical, Mechanical and Industrial Engineering students.

COURSE OBJECTIVES:
The objective of this lecture program is to relate the properties of engineering materials to the materials microstructure developed during thermal mechanical processing. Students develop tools to make informed engineering material selection decisions that will be safe and economic. The majority of laboratory exercises in M 231 are timed to follow or coincide with lecture content.

COURSE OUTCOMES:
- Student will understand the basics of atomic bonding and the resulting structure of crystalline solids.
- Student will know and be able to identify the role imperfections in solids play in the development of mechanical and physical properties of materials.
- Students must be accomplished in using mass transport in solids as it pertains to design of homogeneous alloys and the carburization of steels.
- Students will have experience in the interpretation of mechanical properties of materials, and apply these material properties in the design system components.
- Student will be introduced to dislocation theory and the role dislocations play in the development of mechanical and physical properties of materials.
- Student must be able to identify ductile, brittle, fatigue and high strain rate fractures.
- Student must be accomplished in the use of binary phase diagrams to predict equilibrium and non-equilibrium structures.
- Students be accomplished in the thermal processing of ferrous and non-ferrous alloys.
- Students must understand the basic mechanical properties of polymers as they pertain to the Voigt and Maxwell mechanical models.
- Student are introduced and have some skills as to predicting the properties of composite materials using the most basic rules of superposition.

TOPICS COVERED:
- Metal Structures
- Imperfections in Solids
- Solid State Diffusion
- Mechanical Behavior of Metals
- Strengthening Mechanisms
- Phase diagrams
- Kinetics of Phase Transformations
• Iron Carbon Alloys -- Properties/Microstructure
• Nonferrous metals Alloys -- Properties/Microstructure
• Polymer Structures/Polymer Types/Mechanical Properties
• Composite Materials

CLASS SCHEDULE:
3 hours per week MWF, 1:00-1:50 p.m.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES: (a), (c)

LECTURE:
The course lectures parallels the laboratory portion, both in terms of objectives and topics covered. A design project beginning at midterm involves individual team research and the preparation of a technical style report.

CONTRIBUTION OF COURSE TO MEETING THE PROFESSIONAL COMPONENT:
One major team prepared design report is a critical part of this course.

PERSON WHO PREPARED THIS DESCRIPTION AND DATE OF PREPARATION:
Glen Stone, January 14, 2004
ME 419/416: THERMO-FLUID SYSTEMS DESIGN

Catalog Data:
ME 419: THERMO-FLUID SYSTEMS DESIGN: (3-1) 4 credits, w/ME 416.

Prerequisites: ME 311, ME 313, ME 331, ME 351 and ME 416 as a co-requisite. Investigation and design of thermal and fluid systems and components, emphasizing the major thermal/fluid design issues that arise in internal combustion engine power conversion; analysis and synthesis involving modeling and optimization of thermo-fluid systems, components and processes. Development and application of fundamental numerical tools and algorithms for thermal and fluid problems.

Textbooks:
Thermal Design and Optimization

Internal Combustion Engines

Instructors:
Dr. D. Dolan Phone: 394-1273 Office hrs: Posted
Office: CM 207 E-Mail: daniel.dolan@sdsmte.edu
Dr. G. Buck Phone: 394-2346 Office hrs: Posted
Office: CM 124 E-Mail: gregory.buck@sdst.edu

Incoming Expectations:
Upon entering this course students will be considered fluent in the following areas:
5) Basic thermodynamics (1st law, 2nd law, concept of entropy)
6) Basic conduction, convection and radiation heat transfer problems
7) Basic fluid mechanics principles and the governing equations of fluid dynamics
8) Analytic and numerical solution of ordinary differential equations

Course Objectives:
The objective of this course is to provide students with the skills to:
7) Organize and formulate the process required to create a design that will achieve a specified goal in a thermal or fluid system
8) Create and analyze concept solutions to meet given design constraints by applying fundamental principles in thermodynamics, heat transfer and fluid mechanics
9) Locate and employ existing empirical knowledge to a new design situation
10) Use modern design tools and software to augment the design process and communicate the results to interested parties

Class Schedule:
Lecture: 3 hours per week, 11:00-11:50 AM, MWF
Lab 3 hours per week TBD

Professional Component:
Engineering Science: 3 credit or 75%; Engineering Design: 1 credit or 25%

Topics:
The course will center around the design of a thermal/fluid system or component required to meet an existing or future project need. The central problem will be decomposed into the relevant thermal and fluid aspects which will be used as example problems throughout the course. The initial plan is to divide the course into 4 units, the first reviewing the basics of the design process and physical processes important to thermal-fluid problems (basic thermodynamics, heat transfer and fluid mechanics), the second discussing the fundamentals of building and solving mathematical models, and the third addressing design issues and concepts unique to internal combustion engines. At the end of each of the first 2 units, students will be required to implement one of the Fluent learning modules to introduce the use of CFD in thermal/fluid system design. The fourth unit will allow the student to incorporate skills developed in the learning modules into the required design of the system or component. The laboratory will include experiments to compliment the lecture material and provide a means for hands on validation of concepts.

Unit 1 – Basic Concepts
Fluent learning module I – Developing pipe flow

Unit 2 – Fun with Math
Fluent learning module II – Flat plate w/heat transfer

Unit 3 – Internal Combustion Engine Applications
Unit 4 – Design Project – TDB (possibly compact heat exchanger design)

Computer Usage:
Students must be proficient in the use of a programming language (of their choice) as well as the basics of Microsoft Excel for parsing data from a file into a spreadsheet for subsequent plotting and processing, the WEB, and engineering application software: Textbook WEB site: http://www.engr.colostate.edu/~allan/engines.html

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The Fluent CFD software (and the Gambit preprocessor) will be taught assuming only basic knowledge of file structures and directory trees in the Windows OS, and basic mouse/keyboard operations.

Course Outcomes:
Upon completion of this course students will have demonstrated the ability to:

1. Generate and analyze potential solutions to design problems that arise in the thermal and fluid sciences
2. Understand and apply the basic principles of heat transfer and fluid mechanics to create realistic models of thermal-fluid systems and components by making the appropriate simplifying assumptions and incorporating the relevant physical mechanisms
3. Apply basic thermodynamic models for internal combustion engine simulation
   - Calculate cycle efficiencies for air standard cycles
   - Calculate basic engine performance parameters
4. Apply more advanced models for internal combustion engine design purposes
   - Predict the effects of basic variable changes (spark timing, compression ratio, air/fuel ratio, throttle setting, rotational speed, etc.)
5. Perform thermochemistry analysis for any hydrocarbon or alcohol fuel
6. Conduct and present thermal science laboratory experiment including exhaust analysis to determine exhaust based air/fuel ratio
7. Use the modern design tool of computational fluid dynamics (Fluent 6.1) to create and validate models for some classical fluid/thermal problems and report on the comparisons
8. Apply knowledge of computational fluid dynamics (Fluent 6.1) to create, analyze, and validate a design for a new thermal fluid system of interest and subsequently to communicate the results to an audience of peers
9. Document and communicate results and findings in written and oral form

Relation of Course Outcomes to Program Outcomes:

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<tr>
<th>ME 419/416</th>
<th>ME Program Outcomes</th>
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<td>Program Outcome</td>
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* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/****assessment)

Laboratory:
Armfield convective heat transfer experiment
3 Horsepower Briggs and Stratton Engine with Go-Power water brake dyno
10 Horsepower DC dyno
200 Horsepower Water brake dyno with high performance MC engine
Perform power, emission, and fuel economy analysis on two engines

Assessment and Evaluation:
Because this is a senior level class, attainment of the course objectives will be evaluated from input supplied by the industrial advisory board and the alumni survey.

Prepared By:
ME 422: MACHINE DESIGN II

CATALOG DATA:
ME 422 MACHINE DESIGN II: (3-0) 3 credits.
Prerequisite: ME 322. This course will explore advanced structural design concepts within an integrated framework of theory, simulation, experiment, and materials. Of particular importance will be the study of modern topics, such as plastic materials and their response to service loads. Structural mechanics and materials response will be brought together in support of machine component design.

TEXTBOOK:

INSTRUCTOR:
Dr. Karim Heinz Muci, Associate Professor of Mechanical Engineering
Office: Civil & Mechanical Engineering Bldg., CM-131
Office hours: Monday and Wednesday, 1:00 pm - 3:00 pm. Tuesday and Thursday, 2:00 pm - 3:00 pm.
           Friday, 1:00 pm - 2:00 pm
           (Other times may be possible making and appointment at the end of one of our lecture hours).

EXPECTATIONS:
• The students are expected to enter the class with a good working knowledge of:
  ✓ Developing free-body diagrams (EM-214)
  ✓ Static and dynamic principles (EM-214 and ME-221)
  ✓ Stress analysis and failure criteria (ME-316 and ME-322)
  ✓ Integral calculus (MATH-123 and MATH-125)
  ✓ Ordinary differential equations (MATH-321)
• Basic computer skills, such as the ability to work in the MS Windows environment, are a prerequisite.
• The students should be able to comfortably work with MS Excel, MS Word, and MS Power Point.
• The students should be able to program in their favorite programming language.
• The students should be able to use the software Mathcad or another program with similar capabilities.

COURSE OBJECTIVES:
After taking this course the student should be able to:
• Use basic dynamic principles to perform the kinematic analysis of simple mechanisms.
• Apply solid mechanics principles and appropriate failure criteria to derive equations that can be used to design a machine component.
• Establish an algorithm that can be used for the design of a particular machine component and use existing software tools to implement it.
• Take into account factors such as cost, service environment, material and manufacturing, during the design of a machine component.
• Prepare technical reports and presentations documenting the relevant information corresponding to the design of a machine component.

CLASS SCHEDULE:
Lecture: 3 hours per week, Tuesday and Thursday, 12:00 noon - 1:15 pm. Classroom: CB-205W

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: .5 credit or 17%

TOPICS:
1. Introduction to the kinematic analysis of mechanisms.
2. Shafts, keys, and couplings.
3. Bearings and lubrication.
4. Spring design.
5. Spur gears.

COMPUTER USAGE:
• Use of the software Mathcad.
  Important note: You may use another program that has capabilities similar to the ones provided by Mathcad. However, the instructor won’t be able to help you if you run into problems while trying to solve a homework assignment or project with that software. Also, the instructor may grade your homework/project taking only into account your final results.
• Students are encouraged to explore and use the software accompanying the textbook.
• Students will be required to use various computer tools, including but not limited to word processing, CAD, spreadsheets, modeling and programming.
• All the students must have and regularly read an e-mail account. During the semester, the instructor may send important information to the students via e-mail.
• Written reports must be prepared in a word processor.
• Some assignments and/or projects may require electronic submission of work.

**Course Outcomes:**
After taking this course the student should be able to:
13. Perform the kinematic analysis of a slider-crank mechanism and a four-bar mechanism.
14. Use the commercial software Mathcad to implement the equations corresponding to the kinematic analysis of a slider-crank mechanism and a four-bar mechanism.
15. Apply high-cycle fatigue considerations for the design of machine components subjected to cyclic loading.
17. Use the commercial software Mathcad to implement an algorithm that can be used to determine the required diameter for a simply supported transmission shaft subjected to combined loading.
18. Design parallel square keys.
19. Identify the type of coupling most suited for a particular type of application.
20. Select rolling-element bearings based on the information commonly found in catalogs provided by the manufacturers of those components.
22. Design standard helical compression springs.
23. Use the commercial software Mathcad to implement a suitable algorithm to design a standard helical compression spring.
24. Understand the terminology used and the considerations that need to be taken into account for the design of spur gears.
25. Communicate in an effective fashion the process used, the calculations performed, and the results obtained during the design of a mechanical component.

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4, where 4 indicates a strong emphasis):

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<th>ME Program Outcomes</th>
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*(For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/**assessment](http://www.hpcnet.org/**assessment)*

**Laboratory:**
This course does not have a laboratory component.

**Assessment and Evaluation:**
Course objectives:
The course is a senior level elective and therefore will only be evaluated by the following courses corresponding to the Senior Design Project: ME 477 and ME 479.
Course outcomes:
The course outcomes will be evaluated by two in-class exams, homework, and project related material.

**Prepared By**
Dr. Karim Heinz Muci, Date: September 3, 2003.
ME 423: MECHANICAL VIBRATIONS (Senior Elective)

CATALOG DATA:
ME 423: Mechanical Vibrations (3-0) 3 credits
Prerequisite: ME 352. Study of the oscillatory nature and vibration design of mechanical systems. One, two, multi, and infinite degree of freedom systems are analyzed for their response in both free and forced regimes. Particular emphasis is given to designing for vibration control. Brief introductions are made to vibration testing and measurement, and human response to vibrations.

TEXTBOOK:

INSTRUCTOR:
Dr. U.A. Korde, CM 132, 355-3731, Fax: 394-2405, Umesh.Korde@sdsmt.edu
Office Hours: M 1-3 PM, T 10-11 AM, W3-4 PM, F1-2 PM; and by prior arrangement.

EXPECTATIONS:
As this is a senior-level course, students are expected to bring together foundational engineering knowledge from a number of courses in their undergraduate background. Specifically, students are expected to have:
1. an ability to apply principles of mechanics, including basicstatics, dynamics, and strength of materials,
2. an ability to apply introductory linear systems analysis methods,
3. written and oral communication skills,
4. problem solving skills,
5. an ability to apply basic principles of modern engineering design.

COURSE OBJECTIVES:
The objective of this course is to provide the basic working knowledge required for a study of the oscillatory nature of mechanical systems so we may design such systems and their vibratory response. Upon completion of the course, the student will:
1. perform detailed analysis of the response of one and two degree of freedom systems in both free and forced vibration regimes,
2. perform basic free vibration analysis of multi and infinite degree of freedom systems,
3. demonstrate knowledge of methods of vibration control,
4. become familiar with the interaction of mechanical vibrations with humans,
5. effectively communicate engineering work by oral or written means,
6. design for vibrations of simple mechanical systems that can be approximated by one, two, or infinite degree of freedom systems.

CLASS SCHEDULE:
Lecture: 3 hours per week, T 2-3:50 PM, W 2-2:50 PM; C302

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credit or 83%; Engineering Design: 0.5 credit or 17%

TOPICS:
Overview; spring, mass, damping review
Terminology, Harmonic analysis
SDOF free vibration
2-DOF free vibration
MDOF free vibration
Continuous systems free vibration
SDOF forced vibration
2-DOF forced vibration
Vibration Control: Balancing
Vibration Control: Isolation
Vibration Control: absorbers
Human Effects

COMPUTER USAGE:
Students will use MATLAB with SIMULINK for homework and project assignments.

COURSE OUTCOMES:
Upon completion of this course, students will have demonstrated the ability to:
1. use basic problem solving skills,
2. apply analytical tools from a variety of their technical courses,
3. perform free-vibration analysis of one, two, and infinite degree of freedom systems,
4. perform forced-vibration analysis of one and two degree of freedom systems,
5. design simple mechanical systems for vibrations,
6. explain the operation of vibration control systems,
7. make oral presentations and deliver written communications effectively,
8. work effectively in groups on design and human-impact-related projects.

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strength of each course outcome in addressing the program outcomes (on a scale of 1 to 4, 4 indicating strong emphasis).

<table>
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<tr>
<th>ME 423</th>
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* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/MechEngr)

LABORATORY:
A laboratory course, ME 426 Mechanical Systems Analysis Lab is associated with this course.

ASSESSMENT AND EVALUATION:
Course objectives:
The course objectives will be evaluated in the senior year capstone design course. A Program Outcomes exit exam will be administered at this time.

Course outcomes:
The course outcomes will be evaluated from in-class testing and other instruments deemed suitable. Also the course outcomes will be externally evaluated on an ongoing basis from input supplied by instructors of courses cohered to ME 423, such as ME 477 and ME 479.

PREPARED BY:
U.A. Korde, January 5, 2004
ME 426: MECHANICAL SYSTEMS ANALYSIS LAB (Senior Elective)

CATALOG DATA:
ME 426: Mechanical Systems Analysis Lab (0-1) 1 credit
Prerequisite: ME 423 (concurrent). Use of experimental methods and modern instrumentation techniques to understand the free and forced oscillations of machines and machine components, as well as the control of these vibrations. Laboratory exercises are designed to reinforce material learned in the companion lecture class ME 423, extend knowledge into new areas, and help to make the connection between theory and practice.

TEXTBOOK:
No textbook is required.

INSTRUCTOR:
Dr. U.A. Korde, CM 132, 355-3731, Fax: 394-2405, Umesh.Korde@sdemt.edu
Office Hours: M 1-3 PM, T 10-11 AM, W3-4 PM, F1-2 PM; and by prior arrangement.

EXPECTATIONS:
As this is a senior-level course, students are expected to bring together foundational knowledge from other undergraduate courses, primarily those that deal with experimental measurements. Specifically, students are expected to have:
1. an ability to apply principles of measurement uncertainty,
2. written and oral communication skills,
3. basic measurement skills,
4. problem solving skills,
5. basic analysis techniques in dynamics, dynamic systems, and solid mechanics.

COURSE OBJECTIVES:
In this lab, we will use experimental methods and modern instrumentation techniques to understand the free and forced oscillations of machines and machine components, as well as the control of these vibrations. Students will work under the mentorship of a faculty member. Upon completion of the course, the student will have:
1. an ability to perform basic experimental vibration analysis,
2. an ability to carry out a formal experiment in support of developing a design concept,
3. an ability to effectively communicate the design by oral and written means,
4. team-working skills.

CLASS SCHEDULE:
Laboratory: 3 hours per week, scheduled TH 8-11 AM, or TH 1-3 PM; CM 234.

PROFESSIONAL COMPONENT:
Engineering Science: 1 credit or 100%

TOPICS:
Experiments
Lab #1: Natural frequencies of a spring-mass system
Lab #2: 2DOF vibration system
Lab #3: Transverse vibrations of beams
Lab #4: Machinery fault diagnosis

COMPUTER USAGE:
Students will use data acquisition software and computer-based analysis as required by laboratory experiments.

COURSE OUTCOMES:
Upon completion of this course, students will have demonstrated the ability to:
1. apply basic tools of experimental vibration analysis,
2. interpret experimental results in light of theoretical models,
3. make oral presentations and deliver written communications effectively,
4. work effectively in a team environment.
**RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**
The following table indicates the relative strength of each course outcome in addressing the program outcomes (on a scale of 1 to 4, 4 indicating strong emphasis).

<table>
<thead>
<tr>
<th>Program Outcome</th>
<th>ME Program Outcomes</th>
<th>Objective 1</th>
<th>Objective 2</th>
<th>Objective 3</th>
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* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/MechEngr)

**ASSESSMENT AND EVALUATION:**
Course objectives:
The course objectives will be evaluated in the senior year capstone design course. A Program Outcomes exit exam will be administered at this time.

Course outcomes:
Of utmost importance in this course is the demonstrated understanding of experimental results, which goes hand-in-hand with the ability to communicate in written form. Also the course outcomes will be externally evaluated on an ongoing basis from input supplied by instructors of courses cohered to ME 426 including ME 477 and ME 479.

**PREPARED BY:**
U.A. Korde, January 5, 2004
ME428: APPLIED FINITE ELEMENT ANALYSIS

CATALOG DATA:
ME-428 – Applied Finite Element Analysis: (2–1) 3 Credits

Prerequisites: ME-316 Solid Mechanics or permission of instructor.
Basic mathematical concepts of finite element analysis will be covered. The students will learn finite element modeling using state of the art software, including solid modeling. Modeling techniques for beams, frames, two and three-dimensional solids, and thin walled structures will be covered in the course.


INSTRUCTOR: Dr. Lidvin Kjerengtroen, Professor, Mechanical Engineering
            Office Hours: Posted or by appointment
            Phone: 394-2409

EXPECTATIONS:
1. Based on Physics 211, EM214 Statics, EM216 Mechanics of Materials, and ME316 the students are expected to enter the class with a good working knowledge of applied solid mechanics.
2. The students should have good working knowledge of calculus.
3. Basic computer skills, such as the ability to work in a Windows based environment are prerequisite.
4. The student should be able to work comfortably with MS-Excel and MS-Word.

COURSE OBJECTIVE:
1. The student will become familiar with finite element notation and terminology
2. One-dimensional finite element theory will be covered
3. The course will cover most element types used in solid mechanics
4. The student will learn concerns and techniques relating to 1) convergence 2) numerical accuracy, and 3) modeling techniques

CLASS SCHEDULE:
Lecture: 2 hours per week, 2 PM-9:50 PM M, W Lab: 1 hour per week 9AM –2:50 PM, F

PROFESSIONAL COMPONENT:
Engineering Science: 3 credit or 100%

TOPICS:
Matrix Algebra, Introduction
Stiffness Method
Development of Truss Equations
Introduction to and an overview of Algor
Beams and Frames
Plane Stress and Strain
Axi-symmetric Elements
Structural Dynamics and Time Dependent Heat
Plate Bending Element

COMPUTER USAGE
It is expected that the student is proficient in the use of spreadsheets, math application packages, and MS-windows.

COURSE OUTCOMES:
At the end of the course the students should be capable of working introductory industrial like finite element problems.
Specifically, after taking this course the student should be able to:
1. Prepare and run a finite element model for a simple static or dynamic stress analysis problem.
2. Use the finite element method to perform the static stress analysis of a component made of a linear elastic material.
3. Understand the sources of error associated with a finite element analysis and perform a convergence study.
4. Critically interpret the results.
RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:

The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

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* (For a list of Program Objectives and Program Outcomes, please go to http://www.hpsnet.org/MechEngr)

LABORATORY:
The students will be in the computer laboratory on a weekly basis. They will individually work on tutorials as well as industrial type FEM projects and problems.

ASSESSMENT AND EVALUATION:
Course outcomes:
The course outcomes will be ME 477, and ME 479. Also the following assessment instruments will be used for evaluating the course objectives:
FE exam
Exit exam
Course outcomes:
The course outcomes will also be evaluated from in-class testing and other instruments deemed suitable.

PREPARED BY:
Lidvin Kjerengtroen, Date: January 9, 2004
CHEM 112 GENERAL CHEMISTRY I
(Required Course)

CATALOG DATA:
CHEM 112 GENERAL CHEMISTRY I
(3-0) 3 credits. Prerequisites Prerequisite or corequisite MATH 102. An introduction to the basic principles
of chemistry for students needing an extensive background in chemistry (including chemistry majors, sci-
ence majors, and pre-professional students). Completion of a high school course in chemistry is re-
mended. Duplicate credit for CHEM 106 and 112 not allowed.

TEXTBOOK:
2003.
2. Arrington, D. E., "General Chemistry I CD." This CD contains self-tests for this course. You will
need an IBM-compatible computer, equipped with a CD-ROM drive, and Windows 9x or NT
variants as the operating system.
3. Cruickshank, Brandon and Chang, Raymond. Problem-Solving Workbook for use with General

INSTRUCTOR:
Dr. Dale Arrington, C-313 (394-1236)
E-mail: dale.arrington@sdsmte.edu
Office Hours: 10 a.m. MWF

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
• Algebra
• Prior course in chemistry

COURSE OBJECTIVES:
Students will obtain a foundation in the fundamental principles and models of chemistry necessary for an
understanding of the composition, structure, and properties of matter and the changes that matter under-
goes.

CLASS SCHEDULE:
C-228 (sec. 1) Monday-Wednesday-Friday; 8:00 – 8:50 a.m.
C-228 (sec. 2) Monday-Wednesday-Friday; 9:00-9:50 a.m.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

TOPICS:
• Properties of matter
• Atomic structure
• Stoichiometry
• Reactions in aqueous solution
• Thermochemistry
• Electronic structure
• Periodic properties
• Bonding
• States of matter
• Intermolecular forces
• Properties of solutions

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COMPUTER USAGE:
None

COURSE OUTCOMES:
Each student successfully completing Chem112 is expected to have the following abilities:

- Understand, and use correctly, the symbolic representations, chemical notation, formulas, and systematic rules of nomenclature that characterize the language of chemistry.
- Understand and apply the mole concept in a variety of chemical calculations, including calculating the number of particles in a given mass of substance (and vice versa), and the quantitative relationships between reactants and products in a chemical reaction.
- Recognize the different types of chemical transformations: acid-base, precipitation, combination, decomposition, single-replacement, oxidation-reduction, double replacement, and combustion.
- Understand the basic principles of energy transfer involving chemical systems, including the transfer of heat and work between system and surroundings, the qualitative and quantitative interpretation of thermochemical equations, and the application of Hess's Law.
- Understand the various models of atomic structure, the basic principles of quantum theory, and the experiments that led to those principles.
- Write ground-state electron configurations for atoms and ions of any representative element and the 3d transition series elements.
- Understand the fundamental aspects of chemical bonding, including writing Lewis structures, describing the bonding in molecules by simple valence-bond theory, and using Valence Shell Electron Pair Repulsion Theory to predict the geometries of molecules and ions.
- Use modern atomic theory to understand and predict the properties of different elements.
- Recognize, and account for, in terms of the underlying electronic factors involved, the characteristic properties of the different groups in the periodic table.
- Understand the properties of the different states of matter.
- Qualitatively and quantitatively describe the properties of the gaseous state and the fundamental laws governing the behavior of gases.
- Understand, qualitatively and quantitatively, the behavior of solutions and their colligative properties.
- Understand how fundamental intermolecular interactions among particles determine the physical and chemical properties of a system.
- Understand the fundamental postulates of kinetic-molecular theory and use them to explain the physical behavior of the three states of matter.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 112, General Chemistry I, meets part of ABET Criterion 3, outcome (a):

(a) Ability to apply knowledge of mathematics, science, and engineering.

LABORATORY:
None

ASSESSMENT AND EVALUATION:
Cumulative percent average on the five hour exams is the sole determinant of the grade in this course.

PREPARED BY:
Dale Arrington, Fall 2003

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CHEM 112L GENERAL CHEMISTRY I LAB
(Required Course)

CATALOG DATA:
CHEM 112L GENERAL CHEMISTRY I LAB
(0-1) 1 credit. Prerequisite or corequisite: CHEM 112. Laboratory designed to accompany CHEM 112.

TEXTBOOK:
1. Prepackaged set of experiments from the Modular Laboratory Program in Chemistry (Chemical Education Resources, Palmyra, PA). A complete set consists of the following numbered experiments: 368, 387, 388, 389, 394, 395, 399, 451, 455, 460, 484, and 498.
2. Approved safety goggles, which must be worn at all times while in the laboratory. Goggles may be purchased in the bookstore or at the first and second lab meetings.
3. Roll of paper towels. A roll of paper towels should be purchased by you and kept in your lab locker. Any budget brand will do.

INSTRUCTOR:
Dr. Dale Arrington, C-313 (394-1236)
E-mail: dale.arrington@sdsmt.edu
Office Hours: 10 a.m. MWF

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
• Algebra
• Prior course in chemistry

COURSE OBJECTIVES:
Students will gain familiarity with common chemical laboratory safety practices and the apparatus and experimental methods used in analyzing and investigating the properties and behavior of matter.

CLASS SCHEDULE:
C-204/201 (sec. 51 & 52) Tuesday; 8:00 – 9:50 a.m.
C-201/204 (sec 55 & 56) Thursday; 8:00 – 9:50 a.m.
C-204/201 (sec. 53 & 54) Tuesday 1:00-3:50 p.m.
C-201/204 (sec. 57 & 58) Thursday 1:00-3:50 p.m.

TOPICS:
• Safety Video. Locker check-out.
• Relating Mass and Volume (bring a metric ruler to lab).
• Detecting Signs of Chemical Change.
• Separating and Isolating the Components of a Binary Mixture of Solids.
• Empirical Formula of an Oxide.
• Single Replacement Reactions and Relative Reactivity.
• Percent Water in a Hydrate.
• Heat of Neutralization (partners; bring a watch with a second hand).
• Paper Chromatography of Selected Transition-metal Cations (bring a ruler to lab).
• Separating and Determining the Mass of Calcium Ion in a Calcium-Enriched Tablet.
• Paper Chromatography of Selected Transition-metal Cations (bring a ruler to lab).
• Determining the Molar Concentration of a Sodium Hydroxide Solution.
• Titrating Vinegar and locker check-in.

COMPUTER USAGE:
None
COURSE OUTCOMES:
Each student successfully completing Chem112L is expected to have the following abilities:
- Understand the distinction between qualitative and quantitative chemical analysis.
- Understand the fundamental and operational principles upon which common methods of separation and purification of chemical substances are based.
- Identify sources of error in chemical experiments.
- Interpret experimental results and draw reasonable conclusions.
- Analyze data in terms of the precision and accuracy of results.
- Learn and understand laboratory safety procedures.
- Anticipate, recognize, and respond to hazards of chemical materials and manipulations.
- Learn the importance of performing accurate and precise quantitative measurements.
- Keep legible and complete experimental records.
- Collaborate with peers in obtaining and interpreting data.
- Understand the concept of standardization.

LABORATORY:
100%

ASSESSMENT AND EVALUATION:
Pre-lab questions
Lab Reports

PREPARED BY:
Dale Arrington, Fall 2003
ENG 101 COMPOSITION I
(Required Course)

CATALOG DATA:
ENGL 101 COMPOSITION I
(3-0) 3 credits. Appropriate student placement based on entry level assessment or completion of (or concurrent enrollment in) ENGL 031, 032, or 033. Practice in the skills, research, and documentation needed for effective academic writing. Analysis of a variety of academic and non-academic texts, rhetorical structures, critical thinking, and audience will be included.

TEXTBOOK:
Mims and Nollen, Mirror on America: Short Essays and Images, 2nd Edition
Raimes, Keys for Writers, third edition.

INSTRUCTOR:
Palmer, Morgan, Antonen, and Neumann
Humanities office phone: 394-1243. Leave a message if no one answers.

EXPECTATIONS:
None

COURSE OBJECTIVES:

At the conclusion of English 101, students should be able to:

- understand the basic principles of organization and development necessary to write an essay
- understanding writing as a process that requires analysis, interpretation, drafting and revision
- master basics of expository prose and use of rhetorical strategies to write effectively and critically for a variety of audiences
- know techniques of basic research in order to communicate knowledge and ideas professionally and ethically of the composition, structure, and properties of matter and the changes that matter undergoes.

PROFESSIONAL COMPONENT:
English: 3 credits or 100%

TOPICS:
- Critical Reading
- Argumentation
- Logical Fallacies
- Peer Review
- Brainstorming, Freewriting
- Titles, Topic Sentences, Thesis Statements
- Using & Citing Sources
- Textural Analysis
- Using the Library
- Research Writing, MLA Style
- Documentation
- Sentences, Punctuation, Analyzing Texts
- Portfolio Consultations
COMPUTER USAGE:
Word Processing

COURSE OUTCOMES:
In English 101 students will demonstrate effective communication by:
- designing and producing writing adapted to various audiences and purposes
- composing clear, effective sentences and combining them into focused, coherent paragraphs that support the purpose of their essays
- using basic research skills and appropriate documentation of sources
- exhibiting awareness of ethical standards by accurately using sources and formulating text
- practicing a prose style based on conciseness, clarity, and fluency
- using standard English grammar, punctuation, and other mechanical aspects

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
ENGL 101, Composition I, meets part of ABET Criterion 3, outcome (g):
(g) Ability to communicate effectively.

LABORATORY:
None

ASSESSMENT AND EVALUATION:
- Papers
- Quizzes & Assignments
- Oral Presentation
- Portfolio

PREPARED BY:
Sally Palmer, Spring 2004
ENG 279 TECHNICAL COMMUNICATIONS I
(Required Course)

CATALOG DATA:
ENGL 279 TECHNICAL COMMUNICATIONS I
(3-0) 3 credits. Prerequisites: ENGL 101 or equivalent and sophomore standing. Introductory written and oral technical communications with emphasis on research and explanations of scientific and engineering topics.

TEXTBOOK:
Companion Website to text: http://www.ablongman.com/lannontechcomm

Class WebCT Site: http://webct.sdsmt.edu:8900/

Other Materials: Computer disk for storing writing & videotape for recording speeches

INSTRUCTORS:
Sneller, Hudgens, Palmer, and Boysen,
Humanities office phone: 394-1243. Leave a message if no one answers.

EXPECTATIONS:
Students will have completed English 101, or equivalency.

COURSE OBJECTIVES:
At the conclusion of English 279, students should be able to
• understand the principles of organization and development that are required to produce a variety of short, basic technical documents,
• understand technical writing as a process requiring analysis, interpretation of data, drafting and revision;
• understand the basic components of planning and preparing effective oral presentation of technical and professional material;
• conduct basic technical research using both traditional and electronic methods to communicate in an ethical manner; and
• improve communication and problem solving skills by working on speaking and writing projects in teams.

PROFESSIONAL COMPONENT:
English: 3 credits or 100%

TOPICS:
• What is “technical communication” and what does it entail?
• Audience Analysis
• The “How To’s” of speaking in public
• “Students Take Charge” presentations
• Peer Review
• Summary Writing
• Research / Identifying Sources
• Ethics and/in technical communication
• Visual Aids
• Job Search
• Resumes
• Definitions & Descriptions
• Persuasive Speaking
COMPUTER USAGE:
- Word Processing
- PowerPoint

COURSE OUTCOMES:
Students will demonstrate effective technical communication by
- producing well organized and effectively designed short, basic technical documents;
- employing drafting, revision, and analytical skills to take a document from initial conception to final product;
- producing individual and collaborative documents and oral presentations for a variety of technical, professional, and general audiences;
- recognizing and using appropriate conventional formats and visuals for a variety of basic technical/professional documents;
- the basic research skills and documentation techniques necessary to produce effective written and oral technical communications;
- exhibiting awareness of ethical standards by accurately using sources and formulating text; and
- practicing a technical communication style based on conciseness, clarity, fluency; and using standard English grammar, punctuation, and other mechanical aspects.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
ENGL 279, Technical Communication I, meets part of ABET Criterion 3, outcome (d), (f), (g):
(d) Ability to function on multi-disciplinary teams
(f) Understanding of professional and ethical responsibility
(g) Ability to communicate effectively

LABORATORY:
None

ASSESSMENT AND EVALUATION:
- Formal writing assignments
- Formal speeches
- Quizzes
- Attendance & participation

PREPARED BY:
Judy Sneller, Spring 2004
ENG 289/289L TECHNICAL COMMUNICATIONS II
(Required Course)

CATALOG DATA:
ENGL 289/289L TECHNICAL COMMUNICATIONS II
(2-1) 3 credits. Prerequisites: ENGL 279 or equivalent and sophomore standing. Advanced written and oral technical communications with emphasis on the research, preparation, and delivery of complex technical documents.

TEXTBOOK:

INSTRUCTORS:
Rice, Boysen, Lee, Westergaard, and Antonen
Humanities office phone: 394-1243. Leave a message if no one answers.

EXPECTATIONS:
Students will have completed ENGL 279 or equivalent.

COURSE OBJECTIVES:
At the conclusion of English 289, students should be able to
- Understand the advanced principles of organization and development that are required to produce different types of complex technical documents,
- Understand technical writing as a process requiring analysis, interpretation of data, drafting and revision;
- Understand the advanced principles of planning and preparing effective oral presentations of technical and professional material;
- Conduct advanced technical research using a variety of traditional and electronic methods to communicate in an ethical manner;
- Improve communication and problem solving skills by working on speaking and writing projects in teams; and
- Use writing, speaking, researching, and networking skills to compete effectively in the job market.

PROFESSIONAL COMPONENT:
English: 3 credits or 100%

TOPICS:
- Elements of the proposal
- Formal reports: preliminary guidelines
- Style review
- Style: clarity
- Style: conciseness
- Summaries and abstracts
- Writing evaluations
- Proposal briefing
- Communication issues in professional writing
- Communication issues workshop
- Team communication problems
- Peer review
- Oral presentations
COMPUTER USAGE:
- Word Processing
- PowerPoint

COURSE OUTCOMES:
In English 289 students will demonstrate effective technical communication by:
- Producing well organized and effectively designed complex technical documents;
- Producing well organized and effectively designed resumes and other job application documents;
- Employing drafting, revision, and analytical skills to take a document from initial conception to final product;
- Producing individual and collaborative documents and oral presentations for a variety of technical, professional, and general audiences;
- Recognizing and using appropriate formats and elements of document design applicable to a variety of complex technical documents;
- Using appropriate, effective graphics in speaking and writing projects;
- Using the advanced research skills and documentation techniques necessary to produce effective written and oral technical communications;
- Exhibiting awareness of ethical standards by accurately using sources and formulating text;
- Adopting a technical communication style based on conciseness, clarity, fluency, and consistency;
- Using standard English grammar, punctuation, and other mechanical aspects.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
ENGL 289/290/389, Technical Communication II, meets part of ABET Criterion 3, outcome (d), (f), (g):
(d) Ability to function on multi-disciplinary teams
(f) Understanding of professional and ethical responsibility
(g) Ability to communicate effectively

LABORATORY:
None

ASSESSMENT AND EVALUATION:
- Written Assignments
- Presentations
- Attendance & Participation

PREPARED BY:
Rodney Rice, Spring 2004
MATH 123 Calculus I
(Required Course)

CATALOG DATA:
MATH 123 CALCULUS I
(4-0) 4 credits. Prerequisite: MATH 115 or appropriate mathematics placement or permission of instructor. Prerequisite: MATH 115 completed with a minimum grade of “C.” The study of limits, continuity, derivatives, applications of the derivative, antiderivatives, the definite and indefinite integral, and the fundamental theorem of calculus.

Prerequisite: Pre-calculus.

INSTRUCTORS:
Geary, Carda, Corwin, Dahl, McGough, Riley, Teets, and Trimble

TEXT:
Calculus 2nd edition Smith and Minton.

TOPICS:
1) Functions
2) Limits and continuity
3) Derivatives of polynomial and trigonometric functions
4) Derivatives of logarithmic and exponential functions
5) Applications of derivatives
   i) Curve sketching
   ii) Related rates
   iii) Newton’s method
   iv) Velocity and acceleration
6) Applications of derivatives
   i) Optimization
7) Antiderivatives
8) Integration using u-substitution
9) Topics for Exam 4
10) Definite integrals
11) Applications of integration
   i) Area
   ii) Volume using disks, shells, and washers

COURSE OBJECTIVE:
This course is intended for students majoring in mathematics, physics, chemistry, engineering and related fields. Students will apply the concepts of limits, derivatives and integrals in solving problems in their respective disciplines. They will be able to identify, graph, integrate, and differentiate polynomial, trigonometric, logarithmic, exponential and algebraic functions.
PROFESSIONAL COMPONENT:
Mathematics  4 credits or 100%

OUTCOMES.
A student who successfully completes this should, at a minimum, be able to:

1. Understand functions.
2. Be able to use functional notation in manipulating mathematical expressions.
3. Understand the concept of a limit and how it applies to calculus.
4. Be able to compute limits using various methods.
5. Be able to determine where a function is continuous.
6. Understand the concept of the derivative.
7. Be able to compute derivatives using the power rule, product rule, quotient rule and chain rule.
8. Be able to use the concept of the derivatives in applications such as related rates, linear approximations, Newton’s Method, curve sketching, optimization, velocity and acceleration.
9. Understand the concept of an antiderivative.
10. Be able to manipulate expressions using sigma notation.
11. Be able to integrate using substitution and the power rule.
12. Understand and be able to apply the Fundamental Theorem of Calculus.
13. Be able to use the concept of the integral in applications such as area, volume, velocity and acceleration.
14. Understand the use of numerical integration techniques such as Trapezoidal and Simpson’s rules.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
MATH 123, Calculus I, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

PREPARED BY:
Laura Geary and Arden Davis     May, 2004
MATH 125 Calculus II
(Required Course)

CATALOG DATA:
MATH 125 CALCULUS II
(4-0) 4 credits. Prerequisite: MATH 120 completed with a minimum grade of “C” or appropriate score on departmental Trigonometry Placement Examination and MATH 123 completed with a minimum grade of “C.” A continuation of the study of calculus, including the study of sequences, series, polar coordinates, parametric equations, techniques of integration, applications of integration, indeterminate forms, and improper integrals.

Prerequisite: Calculus I.

INSTRUCTORS:
Math office phone: 394-2471. Leave a message if no one answers.

TEXT:
Calculus (Smith, Minton 2nd ed.) We will cover Chapters 5-9.

OBJECTIVES:
1) The student will continue to learn differentiation and integration techniques, building on the skills learned in Calculus I.
2) The student will learn basic concepts dealing with infinite sequences and series.
3) The student will learn how to work with parametric equations and polar coordinates.

TOPICS:
1. Further applications of the definite integral
   a. Arc length
   b. Surface area
   c. Work
   d. Moments and center of mass
2. Properties of logarithms, exponentials, trig and inverse trig functions Derivatives and antiderivatives of exponential, logarithms, trig and inverse trig functions.
3. Evaluation of antiderivatives using:
   a. Trig integrals
   b. Trig substitutions
   c. Parts
   d. Partial fractions
4. L'Hospital's rule and improper integrals
5. Infinite series and convergence using:
   a. Definition
   b. Integral test
   c. Ratio test
   d. Comparison test
   e. n Th term test
   f. Alternating series, conditional and absolute convergence
6. Interval of convergence of power series
7. Taylor series expansions
8. Fourier series expansions
9. Parametric and polar graphs and equations, derivatives and integrals

PROFESSIONAL COMPONENT:
Mathematics  4 credits or 100%

OUTCOMES:
A student who successfully completes this course should, at a minimum:
1. Know how to differentiate exponential and logarithmic functions and integrate the corresponding functions.
2. Know how to differentiate inverse trigonometric functions and integrate the corresponding functions.
3. Know how and when to use various integration techniques, including integration by parts and partial fractions.
4. Know how to evaluate limits of infinite sequences, including how and when to use L'Hopital’s Rule.
5. Know how to evaluate improper integrals.
6. Recognize common infinite series, including the geometric and harmonic series.
7. Know how and when to use various tests for convergence of infinite series, including the Ratio Test, the Alternating Series Test, and Comparison Tests.
8. Know how to determine the interval of convergence for a power series.
9. Know how to use infinite series such as the Taylor Series or Fourier Series to approximate functions.
10. Know how to convert between rectangular and parametric form, graph parametric curves, find derivatives, and do other calculus applications using parametric functions.
11. Know how to convert between rectangular and polar coordinates, graph polar curves, and do calculus applications using polar coordinates.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
MATH 125, Calculus II, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

PREPARED BY: Don Teets, Harold Carda, and Arden Davis      May, 2004
MATH 225 Calculus III
(Required Course)

CATALOG DATA:
MATH 225 CALCULUS III
(4-0) 4 credits. Prerequisite: MATH 125 completed with a grade of “C.” A continuation of
the study of calculus, including an introduction to vectors, vector calculus, partial der-
ivatives, and multiple integrals.

Prerequisite: Calculus II.

INSTRUCTORS:
Teets, Burgoyne, Carda, Dahl, and Riley.
Math office phone: 394-2471. Leave a message if no one answers.

TEXT:
Calculus (Smith, Minton 2nd ed.) We will cover Chapters 10-14 with some omissions.

TOPICS:
- Vector and vector functions.
- Functions of several variables.
- Partial derivatives.
- Multiple and line integrals.
- Vector analysis.

OBJECTIVES:

1) The student will learn the basic tools and methods of multivariate calculus.
2) The student will understand applications of multivariate calculus.

PROFESSIONAL COMPONENT:
Mathematics: 4 credits or 100%

OUTCOMES:
A student who successfully completes this course should, at a minimum:
1. Know basic vector operations.
2. Know how to work with lines and planes in space.
4. Be able to compute position, velocity, and acceleration vectors.
5. Understand functions of several variables.
6. Be able to compute partial derivatives and gradients using multivariate chain
   rules
7. Be able to find extremals of constrained and unconstrained functions.
8. Understand iterated integrals.
9. Be able to set up and evaluate double and triple integrals in various coordinate
   systems.
10. Understand field vectors.
11. Be able to compute line integrals.
12. Understand the basic integral theorems of vector analysis.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
MATH 225, Calculus III, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

PREPARED BY: Don Teets, Kyle Riley, and Arden Davis May, 2004
MATH 321 Differential Equations
(Required Course)

CATALOG DATA:
MATH 321 DIFFERENTIAL EQUATIONS
(4-0) 4 credits! Prerequisites: MATH 125 with a minimum grade of "C." Selected topics from ordinary differential equations including development and applications of first order, higher order linear and systems of linear equations, general solutions and solutions to initial-value problems using matrices. Additional topics may include Laplace transforms and power series solutions. MATH 225 and 321 may be taken concurrently or in either order. In addition to analytical methods this course will also provide an introduction to numerical solution techniques.

Prerequisite: Calculus II.

INSTRUCTORS:
Geary, Burgoyne, Carda, and Dahl
Math office phone: 394-2471. Leave a message if no one answers.

TEXT:

TOPICS:
1) Basic definitions and terminology
2) Direction fields and solution curves
3) First order differential equations and their applications
   a) Separable
   b) Linear
   c) Exact
   d) Bernoulli
   e) Numerical Methods
4) Higher order differential equations...homogeneous and nonhomogeneous
5) Method of undetermined coefficients
6) Method of variation of parameters
7) Applications of higher order differential equations
   a) Simple harmonic motion
   b) Damped motion
   c) Forced motion
   d) Electric circuits and analogous systems
8) Basic Laplace transforms and their inverses
9) Laplace transforms
10) Inverse Laplace transforms
11) Operational Properties
12) Applications
13) Systems of linear first order equations
14) Matrices
15) Gauss elimination
16) Systems of ordinary differential equations
17) Eigenvalues
18) Variation of parameters
PROFESSIONAL COMPONENT:
Mathematics  4 credits or 100%

COURSE OBJECTIVES:

1) The student will learn how to apply basic techniques to solve ordinary differential equations.
2) The student will understand how to determine whether a function is a solution to a given ordinary differential equation or initial value problem.

STUDENT OUTCOMES:

A student who successfully completes this should, at a minimum, be able to:

1) Know how to use separation of variables.
2) Be able to solve first order ordinary differential equations.
3) Be able to solve second order linear ordinary differential equations.
4) Understand the difference between homogeneous and non-homogeneous linear systems.
5) Be familiar with at least one science or engineering application of differential equations.
6) Be able to compute the Laplace transform and inverse Laplace transform for simple functions.
7) Understand the basic process of how to use the Laplace transform to solve an initial value problem.
8) Be familiar with a numerical technique for solving an initial value problem, such as Euler’s Method or the Runge Kutta method.
9) Be able to carry out basic matrix addition and matrix multiplication.
10) Be able to solve a linear system in matrix form.
11) Be able to use matrices to solve simple linear first order systems of ordinary differential equations.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
MATH 321, Differential Equations, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

PREPARED BY: Laura Geary and Arden Davis  May, 2004
MATH 373 INTRODUCTION TO NUMERICAL ANALYSIS
(3-0) 3 credits. Prerequisite: MATH 321 and CSC 150 or permission of instructor. This course is an introduction to numerical methods. Topics include elementary discussion of errors, polynomial interpolation, quadrature, non-linear equations, and systems of linear equations. The algorithmic approach and efficient use of the computer will be emphasized. Additional topics may include: calculation of eigenvalues and eigenvectors, numerical differentiation and integration, numerical solution of differential equations.

TEXT:
The primary reference material for this course in available on WebCT: http://webct.sdsmt.edu:8900/webct/public/home.pl. However, a numerical methods or applied numerical methods book will provide thorough explanations of the method in italics in the topical outline above. An optional text specified for the course is Applied Numerical Analysis 7th Ed by Gerald and Wheatley.

INSTRUCTOR
Dr. S. M. Howard MI 114 Ph. 394-1282
Stanley howard@sdsmt.edu Open Office Policy

REQUIRED/ELECTIVE
MATH 373 is required for all B.S. Metallurgical Engineering and Mechanical Engineering students. It is a required course for B.S. Environmental Engineering students taking the Metallurgical Engineering emphasis.

COURSE OBJECTIVE
Students who complete this course successfully will be able to solve numerically a wide range of problems encountered in science and engineering that
- are described by ordinary differential equations
- are described by parabolic and elliptical partial differential equations,
- are described as a linearly bounded systems having a linear objective function,
- require integration of incrementized data, and
- require optimization.

COURSE OUTCOMES
1. Students will be able to write finite approximations of the first and second derivatives.
2. Students will be able to explain the Mean Value Theorem and its relationship to error estimation.
3. Students will be able to derive the Laplace Equation in rectilinear, cylindrical, and spherical coordinates with a generation term.
4. Students will be able to solve on a spreadsheet
   - 1D SS HT problems
     Explicitly
   - 1D USS HT problems
     Explicitly, by Saul'yev, by Frankel-DuFort, and by Crank-Nicolson all with fixed, zero-flux, gradient, and convection BC's.
   - 2D SS HT problems
     Explicitly by relaxation with fixed, zero flux, gradient, and convection BC's.
   - 2D USS HT problems
     Explicitly and Implicitly by ADI methods with fixed, zero flux, gradient, and convection BC's.
5. Students will be able to perform numerical integration by
   - Rectilinear Rule
   - Trapezoid Rule
   - Simpson's 1/3 and 3/8 Rules
   - Gaussian Quadrature
6. Students will be able to solve a system of Ordinary Differential Equation of any order by Runge-Kutta Methods including the Fourth Order form by hand and by using MathCad.
7. Students will be able to find roots by the following methods
   - Interval Halving
   - False Position
   - Secant
   - Newton-Raphson
   - One-point Iteration
8. Students will be able to construct objective functions necessary for LP and Data Adjustment problem solutions solved by Excel Solver.
9. Students will submit a written project report and orally present the numerical solution to an engineering problem.

TOPICS
- Approximations of Derivatives
- Mean Value Theorem and Approximation Errors
- Modeling Engineering Systems with Differential Equations
- Heat Conduction in Solids
- Velocity Gradients in Laminar Flow, Well Draw Down Profiles
- Solution of Partial Differential Equations (PDQ's) using Spreadsheets
- Explicit Methods: Steady State
- Gradient and other Boundary Conditions
- Explicit Methods, Unsteady State, Implicit Methods
- Excel\textsuperscript{®} Solver and Linear Programming Problems
- Optimization & Objective Functions and Excel\textsuperscript{®} Solver
- Linear Programming
- Data Adjustment
- Curve Fitting by Least Squares Regression
- Root Finding Methods: Bisection, False Position, Secant, Newton, One-Point Iteration
- Gauss Elimination: Systematic Solution of Linear Equations
- Numerical Integration: Rectangular Rule, Trapezoid Rule, Simpson's 1/3 Rule, Gauss Quadrature
- Numerical Solutions to Ordinary Partial Differential Equations
- One Step Methods: Milne's Method, Runge-Kutta Methods
- MathCad
- MathCad Solutions of Ordinary Differential Equations (ODE's)
- Student Projects

CLASS SCHEDULE:
11:00 – 11:50 MWF Spring  2:00 – 2:50 MWF Fall  MI 222

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES: (a), (b), (e), (k)

CONTRIBUTION OF COURSE TO MEETING THE PROFESSIONAL COMPONENT:

LABORATORY: yes

ASSESSMENT AND EVALUATION:
One Final Exam – optional
Three Hour Exams
Homework
Project Report

EXPECTATIONS:
Metallurgical Thermodynamics
College Calculus, Chemistry, Physics

COMPUTER USAGE:
Advanced Excel including Macros; MathCad

PREPARED BY: S. M. Howard
IENG/MATH 381 Introduction to Probability and Statistics

CATALOG DATA:
IENG/MATH 381
(3-0) 3 credits. Prerequisite: MATH 225 concurrently. Introduction to probability theory, discrete and continuous distributions, sampling distributions and the Central Limit Theorem with general principles for statistical inference and applications of random sampling to hypothesis testing, confidence limits, correlation, and regression.

Prerequisite: Calculus III (concurrently).

INSTRUCTORS:
Geary, Johnson, Riley, Trimble
Math office phone: 394-2471. Leave a message if no one answers.

TEXT:
Probability and Statistics for Engineering and the Sciences, 6th edition, Jay L. Devore

TOPICS:
1) Graphical and numerical summaries of data
2) Counting techniques to compute probabilities in the equally-likely outcome case
3) The addition and multiplication rules for computing probabilities
4) Conditional probability including “Law of Total Probability”, and “Bayes’ Rule”
5) Special discrete (e.g. binomial) and continuous (e.g. normal) random variables
6) Summary measures for random variables
7) Central Limit Theorem and applications to confidence intervals and tests on a single mean in the large sample case
8) Least squares and simple linear regression

COURSE OBJECTIVE: Students will learn fundamental language and notation of probability and statistics, learn how to summarize data, compute probabilities, estimate parameters, and conduct some simple hypothesis tests.

PROFESSIONAL COMPONENT:
Mathematics: 2 credits
Engineering: 1 credit

OUTCOMES:
A student who successfully completes this should, at a minimum, be able to:

1. Produce and interpret a variety of descriptive summaries of data (e.g. numerical summary statistics, boxplots, and histograms).
2. Determine the least-squares line for a bivariate dataset.
3. Compute probabilities . . .
   a. Using elementary counting techniques
   b. Using fundamental rules of probability, including Bayes’ Rule and the Law of Total Probability

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c. By recognizing and using standard probability mass functions (e.g. binomial) and density functions (e.g. normal)
d. Approximately, using the Central Limit Theorem
4. Produce and interpret point and interval estimates for a population mean.
5. Understand the fundamental logic behind a formal hypothesis test and be able to carry out such tests on a population mean.
6. Develop some proficiency in the use of a statistical software package.
7. Learn, and correctly use, fundamental probability and statistics language and notation.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
EEng/Math 381, Introduction to Probability and Statistics, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering

PREPARED BY: Roger Johnson May 2004
PHYS 211/211A UNIVERSITY PHYSICS I  
(Required Course)

CATALOG DATA:
PHYS 211/211A UNIVERSITY PHYSICS I  
(3-0) 3 credits. Prerequisite: MATH 123 or permission of instructor. This is the first course in a two (2) semester calculus-level sequence, covering fundamental concepts of physics. This is the preferred sequence for students majoring in physical science or engineering. Topics include classical mechanics and thermodynamics. Credit will not be allowed in both Phys 111-113 and Phys 211-213

TEXTBOOK:
University Physics by Halliday and Resnick

INSTRUCTOR:
Dr. M. Foygel, EEP 219 (394-1227)  
E-mail: michael.foygel@sdsmte.edu  
Office Hours: 2:00 – 4:00 p.m. MW

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
- Areas and volumes of simple geometric figures (example: circle, triangle, cylinder and sphere).
- Pythagorean Theorem.
- Solution of quadratic equations.
- Solution of simultaneous linear equations.
- Finding x and y components of a given vector.
- Find the magnitude and direction of a vector from the x and y component.
- Vector addition and subtraction.
- Scalar and vector products of two vectors.
- Integration and differentiation of linear equations.
Generally, most material from algebra, geometry, trigonometry, and calculus should be known thoroughly.

COURSE OBJECTIVES:
1. To present the basic concepts and principles of mechanics;
2. To strengthen an understanding of the concepts and principles through a broad range of interesting applications in the real world.

To meet these objectives, emphasis is placed on sound physical arguments and problem-solving methodology.

CLASS SCHEDULE:
C-228 Monday & Wednesday, 11:00 – 11:50 a.m.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

TOPICS:
The basic physical principles of Newton’s laws of motion. The conservation laws concerning momentum, energy and angular momentum are applied to the linear and curvilinear motion of particles, simple harmonic motion and the rotation of rigid bodies.

COMPUTER USAGE:
None

COURSE OUTCOMES:
Upon completion of this course, students should demonstrate the ability to:
1. Use SI units and convert units from one system to another.
2. Perform basic operations on vectors such as adding and subtracting vectors geometrically and by components in the unit-vector notation; converting components into polar coordinates; multiplying a vector by a scalar and performing the dot and cross multiplication of vectors.
3. Given a position vector of a particle calculate its displacement, average and instantaneous velocity and acceleration; describe projectile motion and uniform circular motion; relate velocities in different frames of reference.
4. Use the free-body diagrams in solving dynamics problems; apply Newton's laws to a system of several interacting bodies in order to find their accelerations.
5. Calculate work done by a constant or general variable force; calculate power given the force and instant velocity; use the work-energy theorem to relate a change in kinetic energy to the net work done on a system.
6. Calculate gravitational and elastic potential energy; apply energy conservation principle to systems involving gravity, springs, and friction.
7. Find the center of mass of a system of several particles; apply Newton's second law to a system of particles in order to relate the net external force and the acceleration of the system's center of mass.
8. Use conservation of linear momentum and of energy to relate velocities of colliding bodies before and after collision for the cases of elastic and purely inelastic collisions in one and two dimensions.
9. Calculate angular displacement, velocity and acceleration; relate angular and linear variables; calculate rotational kinetic energy; use the parallel-axis theorem to find the rotational inertia of a body; calculate torque; apply the Newton's second law in angular form to relate the net torque and the angular acceleration.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
PHYS 211/211A University Physics I, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

LABORATORY:
None

ASSESSMENT AND EVALUATION:
Quizzes
Homework
Special Projects
Exams

PREPARED BY:
Michael Foygel, Fall 2003

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PHYS 213/213A UNIVERSITY PHYSICS II
(Required Course)

CATALOG DATA:
PHYS 213/213A UNIVERSITY PHYSICS II
(3-0) 3 credits. Prerequisite: PHYS 211. This course is the second course in a two (2) semester calculus-level sequence, covering fundamental concepts of physics. This is the preferred sequence for students majoring in physical science or engineering. Topics include electricity and magnetism, sound, light, and optics.

TEXTBOOK:

INSTRUCTOR:
Dr. Vladimir Sobolev, EEP 220 (394-1225)
E-mail: vladimir.sobolev@sdsmt.edu
Office Hours: open

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
- Areas and volumes of simple geometric figures (example: circle, triangle, cylinder and sphere).
- Pythagorean Theorem.
- Solution of quadratic equations.
- Solution of simultaneous linear equations.
- Finding x and y components of a given vector.
- Find the magnitude and direction of a vector from the x and y component.
- Vector addition and subtraction.
- Scalar and vector products of two vectors.
- Integration and differentiation of linear equations.
- Knowledge of polar coordinate systems and its relation to Cartesian coordinate system.
- Ability to calculate indefinite and definite integrals of power and rational functions, and ability to use table of integrals.

Generally, most material from algebra, geometry, trigonometry, and calculus should be known thoroughly.

COURSE OBJECTIVES:
As a result of this course students will be familiar with basic terminology, processes and fundamental laws in electricity and magnetism. Students will have an understanding of how the mathematical techniques of complex numbers, vector analysis, differentiation and integration can assist in formulating and solving physical problems and will then be able to use these techniques when studying other more-advanced courses in Physics. Student will have also further developed generic problem-solving skills, and scientific world-view.

CLASS SCHEDULE:
EP 252 Monday & Wednesday, 11:00 – 11:50 a.m.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

TOPICS:
- Electric Charge
- Electric Fields
- Gauss’ Law
- Electric Potential
- Capacitance
- Current and Resistance
• Circuits
• Magnetic Fields
• Magnetic Fields Due to Currents
• Induction and Inductance
• Magnetism of Matter; Maxwell’s Equations
• Electromagnetic Oscillations and Alternating Current

COMPUTER USAGE:
None

COURSE OUTCOMES:
Upon completion of this course, students should demonstrate the ability to:
• use SI units for electric and magnetic physical quantities; know non-system units used in electricity and magnetism;
• understand the basic concepts and laws of classical electrostatics and electrodynamics;
• quantitatively describe the forces between point charges; know major application of electrostatics and electrodynamics in modern technology;
• calculate the electric fields and electric potentials due to point charges and simple continuous charge distributions;
• understand the notions of capacitance and resistance, to find equivalent capacitances and resistances for capacitors and resistors connected in series and in parallel; know major application of capacitors and resistors in electric circuits;
• to apply the Kirchhoff’s laws for calculations of multi-loop circuits;
• understand the phenomena taking place in circuits contain resistor and capacitor and how these phenomena are described by corresponding equations;
• calculate magnetic fields due to electric currents;
• understand the laws of motion of charged particles in uniform electric and magnetic fields or combined electric and magnetic fields and applications of these phenomena in modern science and technology;
• understand the laws of electromagnetic induction and their role in modern technology;
• improve ability to use mathematics and problem solving skills

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
PHYS 213/213A University Physics II, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

LABORATORY:
None

ASSESSMENT AND EVALUATION:
Quizzes
Homework
Exams

PREPARED BY:
Vladimir Sobolev, Fall 2003
PHYS 213L UNIVERSITY PHYSICS II LABORATORY
(Required Course)

CATALOG DATA:
PHYS 213L UNIVERSITY PHYSICS II LABORATORY
(0-1) 1 credit. Corequisite: PHYS 213. This laboratory accompanies PHYS 213. Introduction to physical phenomena and measurements. Recording and processing data, determining uncertainties, reporting results. The experiments supplement the work in PHYS 211 and PHYS 213L.

TEXTBOOK:
Experimentation, Third Edition, by D. C. Baird

INSTRUCTOR:
Dr. Vladimir Sobolev with TA’s, EEP 220 (394-1225)
E-mail: vladimir.sobolev@sdsmt.edu
Office Hours: posted on EEP 220

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
- Algebra
- Trigonometry
- Differential and integral calculus
- Calculus based classical mechanics (PHYS 211)

COURSE OBJECTIVES:
The broad objective of this laboratory course is to reinforce student’s understanding of the fundamental physical laws in classical mechanics, electricity, and magnetism.

CLASS SCHEDULE:
Tuesday/Thursday, 8-10:50 a.m. or 1-3:50 p.m.

PROFESSIONAL COMPONENT:
Basic Science: 1 credit or 100%

TOPICS:
- Introduction to Motion Detectors
- Human Reaction Time
- Simple Pendulum
- Kinematics
- Ballistic Pendulum
- Newton’s Laws #1
- Hooke’s Law
- Work Energy Theorem
- Motion of Inertia
- Collisions #1
- Kirchhoff’s Rules
- Wheatstone Bridge
- RC Circuits: Intro to Oscilloscope

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
PHYS 213L University Physics II Laboratory, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.
COMPUTER USAGE:
Microsoft Word
Excel
Data Studio

COURSE OUTCOMES:
Upon completion of this course, students should demonstrate the ability to:
- gather experimental data both manually and with various computer controlled detectors;
- graphically represent the data both manually and using standard data manipulation software;
- evaluate and interpret the data in the context of physical laws and theory and draw reasonable conclusions from the data.

LABORATORY:
100%

ASSESSMENT AND EVALUATION:
- Lab Notebooks
- Experiments
- Pre-Labs

PREPARED BY:
Robert Corey, May 2004