Mechanical Engineering (MECH)

MECH 1000. Introduction to Design & Rapid Prototyping. 3 Hours.
An introduction to mechanical design and rapid prototyping required for Mechanical Engineering majors and open to makers. Students learn about mechanism design through design projects and rapid prototyping. Topics include: computer-aided design, dimensioning, tolerances, standard mechanical components, linkages, cams, gears, and 3D printing. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Produce 2D engineering drawings and 3D models of components and systems using CAD software. 2. Develop solutions to a problem using engineering design principles. 3. Produce 1st order designs of joints using principles of tolerances, fits, and statistics. 4. Produce 1st order designs of mechanisms such as linkages, gear trains, and cams. 5. Work in a team to design and prototype a mechanism using standard mechanical components and 3D printers. Course fee required. Corequisites: MECH 1005. FA.

MECH 1005. Introduction to Design & Rapid Prototyping Lab. 0 Hours.
Lab portion of MECH 1000. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Explain basic 3D printing technology, materials, and software. 2. Prepare files for and operate a 3D printer. Corequisites: MECH 1000. FA.

MECH 1100. Manufacturing Processes. 3 Hours.
An introduction to manufacturing processes required for Mechanical Engineering majors and open to makers. Students learn about various manufacturing processes through lecture and tours of local manufacturing facilities. Topics include: advantages and limitations of common manufacturing methods, component assembly, quality control, and manufacturing economics. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Describe both the technical and business considerations of various manufacturing processes seen in local manufacturing facilities. 2. Compare the advantages and disadvantages of different manufacturing processes when determining how to manufacture a part. 3. Develop and construct a solution to a defined task using manufacturing methods taught in the course. 4. Employ basic experimental techniques to examine the effectiveness of multiple manufacturing processes. 5. Summarize a wide range of manufacturing processes, including reduction, consolidation, and additive techniques. FA.

MECH 1150. Prototyping Techniques. 2 Hours.
Prototyping required for Mechanical Engineering majors and open to makers. Students learn the following prototyping techniques through hands-on training: basic machining, manual and CNC milling and turning, laser/plasma/EDM/waterjet cutting, laying composites, injection/blow molding, lost wax/foam casting, welding, vacuum forming, electroplating, post processing of 3D printed parts, and the use of adhesives and fasteners. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Compare the advantages and disadvantages of different prototyping techniques when creating a product. 2. Demonstrate competency in various prototyping techniques, including machining, casting, coating, and plastic extrusion. 3. Design, model, and create prototypes that meets specified design criteria using modern and varied prototyping techniques. Course fee required. Prerequisite: MECH 1000 (Grade C- or higher). FA.

MECH 1200. Coding. 3 Hours.
An introduction to coding required for Mechanical Engineering majors and open to makers. Students learn and apply the fundamentals of procedural and graphical programming to control microcontrollers, create user interfaces, and perform engineering analysis. The course culminates in a major design project that will be presented to the public at Engineering Design Day. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Solve simple engineering problems using procedural programming principles and constructs such as variables, conditional statements, logic, loops, and functions. 2. Manipulate and display data of various data types such as numerical, strings, and structures. 3. Create a simple app using event-based programming. 4. Control a microcontroller using graphical programming. Course fee required. Prerequisites: MECH 1000 (Grade C- or higher). Corequisites: MECH 1205. SP.

MECH 1205. Coding Lab. 1 Hour.
Lab portion of MECH 1200. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Program a microcontroller to take data from various types of sensors. 2. Program a microcontroller to control various types of motors such as servo, stepper, and DC motors. 3. Prepare files for and operate a laser cutter. 4. Work in a team to design and prototype a microcontroller-controlled system that utilizes sensors and/or actuators that meets defined specifications. Corequisites: MECH 1200. SP.

MECH 2010. Statics. 3 Hours.
Fundamentals of static analysis required for Mechanical Engineering majors. Students learn to analyze bodies in equilibrium. Topics include: force vectors, equilibrium of particles and rigid bodies, structural analysis, internal forces, friction, centroids, and moments of inertia. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Reduce real-world problems into solvable statics problems using appropriate simplifying assumptions and free-body diagrams. 2. Analyze particles, 2D rigid bodies, and 3D rigid bodies subject to mechanical loads, such as forces, moments, and/or friction, using vector mathematics. 3. Calculate forces and moments in trusses and/or machines using method of sections and/or method of joints. 4. Produce shear and moment diagrams for beams subject to forces, moments, and/or distributed loads. 5. Calculate the center of mass of rigid bodies. Prerequisites: MATH 1220 AND PHYS 2210 OR ENGR 2050 AND PHYS 2010 and can be taken concurrently. FA.

MECH 2030. Dynamics. 3 Hours.
Fundamentals of dynamic analysis required for Mechanical Engineering majors. Students learn to analyze bodies not in equilibrium. Topics include: force, acceleration, work, energy, impulse, and momentum of particles and rigid bodies. Inclusive Access Course Material fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Reduce real-world problems into solvable dynamics problems using appropriate simplifying assumptions and free-body diagrams. 2. Model and analyze particles and rigid bodies subject to velocity, acceleration, and/or forces in multiple coordinate systems using kinematics and/or energy methods. 3. Model and analyze impulse and momentum of particles and rigid bodies. 4. Analyze one-degree-of-freedom vibrations in rigid bodies. Prerequisites: MECH 2010 (Grade C- or higher) AND PHYS 2210 (Grade C- or higher). SP.

MECH 2160. Materials Science. 3 Hours.
Fundamentals of materials science required for Mechanical Engineering majors. Students learn about properties and microstructure of metals, ceramics, polymers, and composites. Topics include: atomic bonding and structure, diffusion, modes of material failure, phase diagrams, and material selection. Inclusive Access Course Material fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Explain the origin of mechanical, thermal, and electrical properties of materials using atomic theory and crystal structure. 2. Predict the microstructure of materials using phase diagrams and kinetic constraints. 3. Design the mechanical properties of steel using heat treatment and diffusion processes. 4. Describe the key advantages and limitations for designing with metals, ceramics, polymers, and composites using failure mechanisms such as creep, corrosion, fatigue and crack propagation. 5. Propose materials for an application using the material selection process to optimize properties and cost. Prerequisites: CHEM 1210 (Grade C- or higher) and MATH 1220 (Grade C- or higher; can be enrolled concurrently). SP.

MECH 2210. Circuits. 3 Hours.
Fundamentals of circuit analysis required for Mechanical Engineering majors and open to makers. Students learn to analyze DC and AC circuits through lecture and laboratory experiments. Topics include: resistive circuits, inductance and capacitance, transients, diodes, transistors, operational amplifiers, and transformers. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Calculate voltage, current, and power in DC circuits. 2. Calculate voltage, current, power, impedance, and phase angle in AC circuits. 3. Identify and analyze basic circuit components such as resistors, capacitors, inductors, diodes, transistors, op-amps, and transformers. 4. Analyze time-dependent transient effects in circuits. 5. Analyze circuits using software. Course fee required. Prerequisites: MECH 1200 (Grade C- or higher) OR CS 1400 and ECE 1200 (ECE 1200 can be taken concurrently). Corequisites: MECH 2215. FA.

MECH 2215. Circuits Lab. 1 Hour.
Lab portion of MECH 2210. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Understand electronic testing equipment, safety, procedures; voltage dividers and wheatstone bridge; 1st order transients, capacitor discharge; resonance; diodes, rectifiers, and LEDs; MOSFETs and BJTs; and op-amps. Course fee required. Corequisites: MECH 2210. FA.

MECH 2250. Sensors & Actuators. 3 Hours.
Fundamentals of Sensors and Actuators is required for Mechanical Engineering majors and is open to makers. Students learn to implement sensors and actuators into an internet of things (IoT) application through lectures and laboratory experiments. Topics include: data acquisition, signal conditioning, uncertainty analysis, sensors and measurements, actuator control, and IoT. The course culminates in a major design project that will be presented to the public at Engineering Design Day. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Solve engineering problems using fundamental principles of statistics. 2. Analyze signals using signal processing techniques such as Fourier transforms. 3. Write simple programs using principles of the Internet-of-Things (IoT). 4. Describe principles of acquiring measurements of physical phenomena, such as temperature, pressure, velocity, flow, and strain. Prerequisites: MECH 2210 (Grade C- or higher). Corequisites: MECH 2255 and (MATH 2250 or MATH 2280 or ENGR 2050). SP.

MECH 2255. Sensors & Actuators Lab. 1 Hour.
Lab portion of MECH 2250. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Acquire and process measurements of physical phenomena such as temperature, pressure, velocity, flow, and strain using data acquisition equipment. 2. Work in teams to design and prototype an Internet-of-Things (IoT) enabled system that meets defined specifications. Corequisites: MECH 2250. SP.

MECH 3200. Systems & Controls. 3 Hours.
Fundamentals of systems and controls required for Mechanical Engineering majors. Students learn to model and control multi-domain systems through lecture and laboratory experiments. Topics include: mechanical, electrical, electromechanical, fluidic, and thermal systems, time and frequency domain analysis, feedback control, and control system design. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Analyze response of dynamic systems using Laplace transforms. 2. Model physical systems in multiple domains, such as mechanical, electrical, fluid, and thermal. 3. Analyze dynamic systems in both the time and frequency domains. 4. Design stabilizing controllers using relevant control theory in dynamic systems. 5. Model, analyze, and control dynamic systems in software. Prerequisites: PHYS 2210 AND MECH 2250 AND (MATH 2250 OR (MATH 2280 AND MATH 2270)) (All Grade C- or higher). Corequisites: MECH 3205. FA.

MECH 3205. Systems & Controls Lab. 0.5 Hours.
Lab portion of MECH 3200. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Measure relevant system parameters when prototyping physical system models. 2. Implement control algorithms in mechatronic systems. Corequisites: MECH 3200. FA.

MECH 3250. Machinery. 3 Hours.
Fundamentals of machine design required for Mechanical Engineering majors. Students learn to design mechanical components in power transmission systems. Topics include: failure criteria, fatigue, and analytical and finite-element analysis of stress in shafts, fasteners, joints, springs, bearings, and gears. The course culminates in a major design project that will be presented to the public at Engineering Design Day. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. At the successful conclusion of this course, students will be able to: 1. Predict failure in machine components and/or joints due to static and/or cyclic loading. 2. Design and analyze simple power transmission systems. 3. Describe fundamental theory and implementation of finite element analysis. 4. Model and analyze stresses in machine components and/or power transmission systems using finite element analysis. Prerequisites: MECH 3200 AND MECH 3300 AND MECH 2160 (All Grade C- or higher). Corequisites: MECH 3255. SP.

MECH 3255. Machinery Lab. 1 Hour.
Lab portion of MECH 3250. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Acquire and analyze data from machine components or power transmission systems subject to mechanical loading. 2. Evaluate uncertainty and/or error between experimental measurements and analytical/simulated predictions. 3. Design and prototype, in teams, a power transmission system that meets defined specifications. Corequisites: MECH 3250. SP.

MECH 3300. Strength of Materials. 3 Hours.
Fundamentals of strength of materials required for Mechanical Engineering majors. Students learn to analyze stress, strain, and deflection in deformable bodies through lecture and laboratory experiments. Topics include: stress and strain, mechanical properties of materials, axial loading, torsion, bending, transverse shear, combined loadings, stress and strain transformations, deflection in beams and shafts, column buckling, and energy methods. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Analyze stress, strain, and deflection in deformable bodies subject to mechanical loading such as axial, torsional, bending and/or transverse shear. 2. Describe modes of failure in deformable bodies and behavior of various materials subject to stress loading and unloading. 3. Predict failure in deformable bodies using failure criteria and stress and strain transformations. 4. Design mechanical components, such as beams, columns, and pressure vessels, to withstand failure due to static mechanical loading. Prerequisites: MECH 2010 (Grade C- or higher). Corequisites: MATH 2210 AND MECH 3305. FA.

MECH 3305. Strength of Materials Lab. 0.5 Hours.
Lab portion of MECH 3300. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Acquire and analyze data from various materials subject to mechanical loading. 2. Evaluate uncertainty and/or error between experimental measurements and analytical/simulated predictions. Corequisites: MECH 3300. FA.

MECH 3600. Thermodynamics. 4 Hours.
Fundamentals of thermodynamics required for Mechanical Engineering majors. Students learn to apply the laws of thermodynamics to open and closed systems through lecture and laboratory experiments. Topics include: energy transfer, laws of thermodynamics, power cycles, refrigeration and heat pump cycles, gas mixtures, psychrometrics, combustion, and chemical and phase equilibrium. Inclusive Access Course Material fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Characterize pure substances and obtain their thermodynamic properties using equations of state, charts, tables and/or software. 2. Model and analyze thermodynamic components, such as heaters, coolers, pumps, turbines, and pistons, using the laws of thermodynamics. 3. Model and analyze thermodynamic cycles such as power and refrigeration cycles. 4. Analyze vapor/gas mixtures in HVAC systems and combustion processes. Prerequisites: PHYS 2210 AND MATH 2210 (Both Grade C- or higher). SP.

MECH 3602. Thermodynamics II. 1 Hour.
Second half of fundamentals of thermodynamics required for Mechanical Engineering majors who have previously taken a lower division thermodynamics course at another institution. Students learn to apply the laws of thermodynamics to open and closed systems. Topics include: power cycles, refrigeration and heat pump cycles, gas mixtures, psychrometrics, combustion, and chemical and phase equilibrium. This class meets with MECH 3600 starting after mid-terms. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course students will: 1. Model and analyze thermodynamic cycles such as power and refrigeration cycles. 2. Analyze vapor/gas mixtures in HVAC systems and combustion processes. Prerequisites: Instructor permission. SP.

MECH 3605. Thermodynamics Lab. 0.5 Hours.
Lab portion of MECH 3600. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Acquire and analyze data from thermodynamic components and/or systems. 2. Evaluate uncertainty and/or error between experimental measurements and analytical/simulated predictions. Corequisites: MECH 3600. SP.

MECH 3650. Heat Transfer. 3 Hours.
Fundamentals of heat transfer required for Mechanical Engineering majors. Students learn to analyze conduction, convection, and radiation heat transfer through lecture and laboratory experiments. Topics include: steady state and transient conduction, forced and natural convection, boiling and condensation, heat exchangers, and radiation heat transfer. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Model and analyze components or systems subject to conduction heat transfer. 2. Model and analyze components or systems subject to free- or forced-convection heat transfer. 3. Model and analyze components or systems subject to radiation heat transfer. 4. Build and analyze representative models of real-world steady-state and/or transient heat transfer systems using analytical expressions and/or numerical analysis. Prerequisites: MATH 3500 AND MECH 3700 (both Grade C- or higher). Corequisites: MECH 3655. SP.

MECH 3655. Heat Transfer Lab. 0.5 Hours.
Lab portion of MECH 3650. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Acquire and analyze data from systems subject to conduction, convection, and/or radiation heat transfer. 2. Evaluate uncertainty and/or error between experimental measurements and analytical/simulated predictions. Corequisites: MECH 3650. SP.

MECH 3700. Fluid Mechanics. 4 Hours.
Fundamentals of fluid mechanics required for Mechanical Engineering majors. Students learn to analyze fluids through lecture and laboratory experiments. Topics include: fluid statics, conservation of mass, work and energy of moving fluids, fluid momentum, dimensional analysis and similitude, viscous flow within enclosed surfaces, pipe flow, compressible flow, and turbomachines. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Model and analyze systems involving hydrostatic equilibrium, internal flow, and/or flow over immersed bodies using kinematics, energy, conservation of mass, and/or conservation of momentum. 2. Describe scaling of fluid flow using dimensional analysis and similitude. 3. Model and analyze turbomachines such as pumps and propellers. 4. Build and analyze representative models of real-world steady-state and transient fluid systems using analytical expressions and/or numerical analysis. Prerequisites: MATH 2210 AND MECH 2030 AND MECH 3600 (All Grade C- or higher). Corequisites: MATH 3500 AND MECH 3705. FA.

MECH 3702. Fluid Mechanics II. 1 Hour.
Second half of the fundamentals of fluid mechanics required for Mechanical Engineering majors who have previously taken a course at another institution. Students learn to analyze compressible flow and turbomachines. This class meets with MECH 3700 starting after mid-terms. **COURSE LEARNING OUTCOMES (CLOs)*** At the successful conclusion of this course students will: 1. Model and analyze turbomachines such as pumps and propellers. 2. Build and analyze representative models of real-world steady-state and transient fluid systems using analytical expressions and/or numerical analysis. Prerequisites: Instructor permission required. FA.

MECH 3705. Fluid Mechanics Lab. 0.5 Hours.
Lab portion of MECH 3700. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Acquire and analyze data from systems subject to hydrostatic forces and/or fluid flow. 2. Evaluate uncertainty and/or error between experimental measurements and analytical/simulated predictions. Corequisites: MECH 3700. FA.

MECH 4000. Product Design I. 3 Hours.
First course in the product design series required for Mechanical Engineering majors. Students work in teams to develop a product through customer needs identification, concept generation and selection, concept testing, benchmarking, design parameter specification, engineering analysis, and critical function prototyping. The course culminates in an alpha prototype and formal design review of the product with faculty and industry leaders. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Define and propose, in teams, solutions to a team-perceived problem using engineering design principles and ethics. 2. Formulate background for a team-defined project using prior work such as journal articles, patent databases, and/or benchmark data. 3. Propose project milestones and a plan to achieve project milestones. 4. Design and perform a feasibility study. 5. Prototype, in teams, an alpha solution to a team-defined problem. Course fee required. Prerequisites: MECH 3650 AND MECH 3250 AND MECH 1100 AND MECH 1150 (All Grade C- or higher). Corequisites: ENGL 3010. FA.

MECH 4010. Product Design II. 3 Hours.
Second course in the product design series required for Mechanical Engineering majors. Student teams further develop their product through engineering analysis, beta testing, economic analysis, design for manufacturing, design reviews, and documentation. The course culminates in a final product that will be presented to the public at Engineering Design Day. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Evaluate economic considerations of a team-defined problem. 2. Propose a design and/or improvement to a component and/or system using engineering analysis. 3. Prepare and present a technical oral and poster presentation. 4. Prototype, in teams, a beta solution to a team-defined problem. Course fee required. Prerequisites: MECH 4000 (Grade C- or higher). SP.

MECH 4170. Additive Manufacturing. 3 Hours.
Design principles and prototyping techniques for additive manufacturing. Students are introduced to various additive manufacturing technologies which may include SLA, SLS, 3D scanning, epoxy casting, vacuum forming, and injection molding. Emphasizes using engineering analysis during the design process, applying advanced CAD techniques, selecting appropriate materials, and applying ergonomic design principles. Non-mechanical engineering majors may take this course with instructor permission. ** COURSE LEARNING OUTCOMES (CLOs) ** At the successful completion of this course, students will be able to 1) apply engineering analysis to design and prototype a system that meets defined specifications 2) design for and print engineered parts using SLA technology 3) design for and print engineered parts using SLS technology 4) create and manipulate meshes using 3D scanning technology and CAD programs 5) design for and prototype engineered parts using epoxy casting, injection molding, and/or vacuum forming technology. Course fee required. Prerequisites: MECH 2250 (Grade C- or higher) OR Instructor Permission.

MECH 4350. Fracture Mechanics. 4 Hours.
Fundamentals of Fracture Mechanics elective course for Mechanical Engineering majors. Students learn about basic principles of Fracture Mechanics. Students learn stress intensity and energy approach to predict crack growth and the nature of crack growth in various types of materials using theoretical concepts, numerical estimation as well as experimental and computational tools. A brief introduction to non-destructive testing techniques is also included. ***COURSE LEARNING OUTCOMES (CLOs)***At the successful conclusion of this course students will 1) Model and analyze crack growth in brittle and ductile materials using computational/theoretical tools. 2) Make informed design decisions to prevent catastrophic failures in components due to crack propagation, including effects from environmental factors. 3) Identify ATSM standards for testing of brittle and ductile materials for destructive fracture testing. Apply non-destructive testing techniques to study existing flaws. 4) Acquire and apply new knowledge using appropriate learning strategies. Prerequisites: MECH 3250 (grade C- or higher) OR Instructor Permission. FA.

MECH 4500. Advanced Engineering Math. 3 Hours.
Students learn to solve a wide range of engineering problems involving ordinary and partial differential equations. Topics include the method of characteristics, separation of variables, Fourier-Legendre series, Fourier-Bessel series, Multi-step methods, numerics for higher-order ODEs, radius of convergence, Newtons divided difference interpolation, Sturm-Liouville theory, numerics for elliptic, parabolic, and hyperbolic PDEs, and Blasius similarity solution for boundary layer flow. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course students will: 1. Derive ordinary and partial differential equations governing problems in engineering. 2. Solve differential equations having analytical solutions. 3. Classify partial differential equations as parabolic, hyperbolic, or elliptic. 4. Discretize and solve partial differential equations using a range of numerical techniques and assess numerical stability. Prerequisites: MECH 2250 (grade C- or higher) OR Instructor Permission. SP.

MECH 4520. Optimization. 3 Hours.
Fundamentals, advantages, and drawback of various optimization algorithms with an emphasis on engineering applications. Practical examination of how optimization algorithms are implemented in commercial engineering design software. ** COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to 1) Use built-in optimization functions in MATLAB to solve multi-dimensional and multi-constraint optimization problems 2) Write their own gradient-based optimization algorithms and compare them to those available within MATLAB 3) Apply optimization algorithms to analyze engineering scenarios 4) Use commercial CAD packages to perform structural shape/topology optimization and validate their designs. Course fee required. Prerequisites: MECH 2250 (Grade C- or higher) OR Instructor Permission.

MECH 4790. Computational Fluid Dynamics. 3 Hours.
Students learn the basic principles behind the development of numerical solutions to the partial differential equations (PDEs) governing fluid flow and are introduced to commercial computational fluid dynamics (CFD) software. Techniques for characterizing PDEs are introduced along with discretization methods. Numerical methods are applied and students develop Matlab scripts to solve a handful of model equations. More complex problems are solved using CFD software. **COURSE LEARING OUTCOMES (CLOs) ** At the successful completion of this course, students will be able to: 1. Classify the basic partial differential equations (PDEs) governing fluid flow (and other physical processes) and develop basic space and time discretization methods leading to numerical representations of these PDEs. 2. Discretize model PDEs, choose and apply appropriate boundary and initial conditions, and write their own individual Matlab scripts to solve these model equations numerically. 3. Assess the accuracy and stability of numerical results and the efficiency of the chosen numerical methods. 4. Demonstrate a basic understanding of grid generation techniques. 5. Solve two- and three-dimensional problems involving internal and external flow using commercial computational fluid dynamics (CFD) software. Prerequisites: MECH 3700 AND MECH 4500 (All grade C- or higher).

MECH 4800R. Independent Research. 1-3 Hours.
An independent research course that allows upper-level mechanical engineering students to work closely with a faculty member to explore engineering through research. Projects are chosen at the discretion of the faculty member. Students will have an opportunity to present their research at Engineering Design Day or similar venue. Repeatable up to 3 credits subject to graduation restrictions. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Identify and compile background pertaining to the research project. 2. Propose solutions pertaining to the research project using engineering design principles and/or the scientific method. 3. Model and analyze a system pertaining to the research project. 4. Design and conduct experiments and interpret associated results pertaining to the research project. 5. Draw conclusions and identify future work pertaining to the research project. Prerequisites: Instructor permission.

MECH 4860R. Design Practicum. 1-3 Hours.
Practical design experience in collaboration with Atwood Innovation Plaza. Students may be required to sign a non-disclosure agreement prior to working on projects. Repeatable up to only 3 credits, subject to graduation restrictions. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Collaborate effectively with others both orally and in writing to establish goals, plan tasks, meet deadlines, and articulate results. 2. Create solutions using the engineering design process that meet specified needs with appropriate consideration for global, cultural, social, environmental, ethical, and economic factors. 3. Model, analyze, design, and/or prototype physical systems, components or processes. Prerequisites: MECH 1000 AND MECH 1150 (Both Grade C- or higher) AND Instructor Permission.

MECH 4990. Special Topics Lecture. 1-4 Hours.
Specialized topics in Mechanical Engineering used to fulfill technical elective requirements. Repeatable up to 16 credits, subject to graduation restrictions. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Formulate and evaluate complex engineering problems by applying principles of engineering, science, and mathematics. 2. Model, analyze, and design physical systems, components or processes.

MECH 4991. Special Topics Lecture - Mirror. 1-4 Hours.
Specialized topics in Mechanical Engineering used to fulfill technical elective requirements. This course is taught virtually from another institution under technical elective sharing agreements. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Formulate and evaluate complex engineering problems by applying principles of engineering, science, and mathematics. 2. Model, analyze, and design physical systems, components or processes.

MECH 4995. Special Topics Lab. 0.5-3 Hours.
Specialized topics in Mechanical Engineering used to fulfill technical elective requirements. Repeatable up to 12 credits subject to graduation restrictions. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Design experiments for physical systems or processes, analyze experimental data, and make informed conclusions from the data. 2. Model, analyze, design, and prototype physical systems, components or processes.