Mechanical Engineering (MECH)

MECH 1000. Design: Introduction to Mechanical 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. Corequisites: MECH 1005. FA.

MECH 1005. Design: Introduction to Mechanical 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. Design: 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. Design: Prototyping Techniques. 2.5 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. Mechatronics: 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 Dixie 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. Mechatronics: 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. Solid Mechanics: 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. Corequisites: MATH 1220 AND PHYS 2210. FA.
MECH 2030. Solid Mechanics: 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. Solid Mechanics: 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). ECE 1200 can be taken concurrently. Corequisites: PHYS 2220 AND MECH 2215. FA.

MECH 2210. Mechatronics: 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. 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. Corequisites: MECH 2210. FA.

MECH 2250. Mechatronics: Sensors & Actuators. 3 Hours.
Fundamentals of sensors and actuators required for Mechanical Engineering majors and open to makers. Students learn to implement sensors and actuators into an internet of things (IoT) application through lecture 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 Dixie 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); and MATH 2250 (can be concurrently enrolled) or OR MATH 2280 (can be concurrently enrolled). Corequisites: MECH 2220. SP.

MECH 2255. Mechatronics: 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. Mechatronics: 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. Mechatronics: 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. Mechatronics: 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 Dixie Design Day. **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 3250. SP.

MECH 3255. Mechatronics: 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. Solid Mechanics: 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 3100 (Grad C- or higher). Corequisites: MATH 2210 AND MECH 3305. FA.

MECH 3305. Solid Mechanics: 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. Thermofluids: 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 Grad C- or higher). Corequisites: MATH 2210 AND MECH 3305. FA.

MECH 3605. Thermofluids: 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. Thermofluids: 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. **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 Grad C- or higher). Corequisites: MECH 3655. SP.

MECH 3655. Thermofluids: 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. Thermofluids: 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 3705. Thermofluids: 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. Design: 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. Prerequisites: MECH 3650 AND MECH 3250 AND MECH 1100 AND MECH 1150 (All Grade C- or higher). Corequisites: ENGL 3010. FA.

MECH 4010. Design: 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 Dixie 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. Prerequisites: MECH 4000 (Grade C- or higher). SP.

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 Dixie 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.