# MECHANICAL ENGINEERING (MECH)

**MECH-100 Engineering Graphical Communication 4 Credits**
Prerequisites: None
This computer aided design and drafting course is an introduction to engineering graphics and visualization with topics to include sketching, line drawing, wire-frame section development and elements of solid modeling. Also, this course will include the development and interpretation of drawings and specifications for product realization. CAD, office, and web-based software will be used in student presentations and analysis.
Lecture: 2, Lab 4, Other 0

**MECH-197 MECH Free Elective 4 Credits**
Prerequisites: None
This is a Mechanical Engineering course used to record credit for transfer or guest courses ONLY that are not equivalent to existing Kettering University Mechanical Engineering courses.
Lecture: 4, Lab 0, Other 0

**MECH-210 Statics 4 Credits**
Corequisites: MATH-102, PHYS-114, PHYS-115
Prerequisites: MATH-101 or MATH-101X
This course deals with a discussion and application of the following fundamental concepts: (1) static force analysis of particles, rigid bodies, plane trusses, frames, and machines; (2) first and second moments of area; (3) friction; (4) internal forces; and (5) stress deflection analysis of axially loaded members. Topics covered will be (1) the static force and moment equilibrium of two and three dimensional systems; (2) resultant forces and moments due to the application of concentrated and/or distributed loads; (3) couples; (4) the center of mass and the area moment of inertia of a rigid body; (5) shear force and bending moment diagrams of a rigid body; and (6) the stress and deflection analyses of axially loaded members. Free body diagrams will be formulated in a computer-aided environment in order to enhance the students' critical thinking and problem solving capabilities. Several open-ended homework and mini projects will be assigned in order to incorporate a design experience in the course.
Lecture: 4, Lab 0, Other 0

**MECH-212 Mechanics of Materials 4 Credits**
Prerequisites: MECH-210
The fundamental topics of this course include: normal and shear stress and strain, Hooke's law, Poisson's ratio, generalized Hooke's law, axial translation, torsion of circular bars, angle of twist, bending of beams, flexure formula, flexural shear stress, beam deflections, combined stresses, transformation of stresses, Mohr's circle, statically indeterminate problems, columns. The use of basic computational tools will be introduced at the end of several lecture modules including: axial loading, torsional loading, and flexural loading. Homework and design projects will be assigned.
Lecture: 4, Lab 0, Other 0

**MECH-231L Signals for Mechanical Systems Lab 1 Credits**
Prerequisites: PHYS-224 and PHYS-225
This lab complements the electrical engineering course, EE-212, and provides the necessary knowledge and skills of electrical engineering to non-electrical engineering majors. It teaches students how to use sensors and instruments to make meaningful measurements in mechanical and electrical engineering systems. This lab course introduces students to: (1) the laws and methods of circuit analysis (2) sensors used in measurements of displacement, temperature, strain and fuel cell systems and (3) the amplifiers and other instrumentation used to process the signals from these sensors.
Lecture: 0, Lab 2, Other 0

**MECH-300 Computer Aided Engineering 4 Credits**
Prerequisites: MECH-100 and MECH-212
This is a threaded continuation of MECH-100, Engineering Graphical Communication using computer graphics and computer aided design techniques. These advanced techniques use graphics primitives, construction functions, transformations, image control, dimensioning and layers. Both two-dimensional drawings and three-dimensional wireframe, surface modeling, and simulation modeling such as FEA and kinematic motion are covered.
Lecture: 4, Lab 0, Other 0

**MECH-307 Materials Engineering 4 Credits**
Prerequisites: (CHEM-135 or CHEM-137) and CHEM-136
This course will develop the skills of identifying appropriate materials for a given design by considering mechanical properties which are based on experimental data. The manner in which processing can be used to engineer a material for specific applications will be explored. The mechanical performance of materials will be assessed by comparing a range of properties; strength, modulus, Poisson's ration, coefficient of thermal expansion, ductility, toughness, corrosivity, and others. Students will learn which properties can and cannot be engineered to meet a specific need via alloying and/or heat treating.
Lecture: 4, Lab 0, Other 0

**MECH-310 Dynamics 4 Credits**
Prerequisites: MECH-210 and PHYS-114 and PHYS-115 and (MATH-102 or MATH-102X or MATH-102H)
This course deals with a discussion and application of the following fundamental concepts: (1) application and basics of Newtonian mechanics and physical laws; (2) a study of the kinematics and kinetics of a particle including relative and absolute motion, friction concepts; (3) additional analysis of particle dynamics using work-energy and impulse-momentum methods, analysis of impact events; (4) analysis of a system of particle using work-energy, impulse, linear and angular momentum; (5) kinematics and kinetics of a rigid bodies analyzed in various reference systems; (6) additional analysis of rigid body dynamics using work-energy and impulse-momentum; (7) inertia quantities. Computational techniques will be incorporated into several design projects throughout the semester to illustrate alternative solution methods.
Lecture: 4, Lab 0, Other 0

**MECH-311 Introduction to Mechanical System Design 4 Credits**
Prerequisites: MECH-100 and MECH-210 and (MECH-231L or EE-211)
The objective of the course is to teach fundamentals of machine elements and mechatronics design, with an emphasis on product design and fabrication. Design, analysis and fabrication of prototype mechatronic systems and devices are completed. Mechanical designs concepts including transmission methods, force and torque analysis, mechanisms and simulation is covered. Formal design processes such as brainstorming and concept-tree development are utilized. Intellectual property law pertinent to design and invention is covered. The synergistic combination of sensors, actuators and controls technologies to create functionally "smart" and adaptive devices is implemented. Sensors and actuator technologies are covered. The course culminates with an open-ended project to design and fabricate a mechatronic system using basic machining equipment and a programmable controller.
Lecture: 2, Lab 4, Other 0

**MECH-312 Mechanical Component Design I 4 Credits**
Prerequisites: MECH-212
This course involves application of theory and techniques learned in the mechanics courses to the concepts of mechanical component design. Through lectures and class example and homework problems the student will be introduced to design methodology. This methodology requires learning to develop and set-up a mechanical component design problem, through properly understanding and solving the problem based upon the given data, design constraints, making and verifying assumptions. Selection of the proper analytical tools as required, producibility and maintainability of the design, materials selection, safety, and cost considerations. Take-home project problems will enhance and demonstrate the type of study and research required for design. Topics to be studied include strength and fatigue considerations, shaft design, threaded fasteners, lubrication and bearings, springs, and fundamentals of gear analysis, including forces, stresses and terminology.
Lecture: 4, Lab 0, Other 0

**MECH-320 Thermodynamics 4 Credits**
Prerequisites: PHYS-224 and PHYS-225
A study of the first and second laws of thermodynamics and their application to energy transformations during various processes. Property relations are studied for pure substances, ideal gases, mixture of ideal gases, and atmospheric air. Steam power cycles, refrigeration cycles, spark-ignition and compression-ignition engines, and turbine cycles are evaluated to determine performance parameters and energy efficiencies.
Lecture: 4, Lab 0, Other 0

**MECH-322 Fluid Mechanics 4 Credits**
Prerequisites: MECH-320
This is a first course in Fluid Mechanics that involves the study of fluid flow in ducts and over objects. The course introduces the fundamental aspects of fluid motion, fluid properties, flow regimes, pressure variations, fluid kinematics, and methods of flow description and analysis. Presents the conservation laws in their differential and integral forms, and their use in analyzing and solving fluid flow problems. In addition, the concept of using similitude and dimensional analysis for organizing test data and for planning experiments is introduced. The effects of fluid friction on pressure and velocity distributions are also discussed. The effects of compressibility (various density) on fluid flows are also included.
Lecture: 4, Lab 0, Other 0

**MECH-330 Dynamic Systems with Vibrations 3 Credits**
Corequisites: EE-212, MATH-305, MECH-331
Prerequisites: (MATH-204 or MATH-204H) and MECH-310
This is the first course in System Dynamics. The objective of this course is to provide an understanding into basic principles and methods underlying the time domain, dynamic characterization of physical systems and components. The focus is on a multi-discipline approach. Construction of mathematical models of systems using energy, power Bond-graph, and state space models is emphasized. Application of modeling techniques to understanding the behavior of free vibration (damped and undamped), forced vibration for harmonic excitation, and systems involving multi-degrees of freedom will be discussed. MECH-331 must be taken concurrently (or previously passed) with this course.
Lecture: 3, Lab 0, Other 0

**MECH-331 Dynamic Sys w Vibrations Lab 1 Credits**
Corequisites: EE-212, MATH-305, MECH-330
Prerequisites: (MATH-204 or MATH-204H) and MECH-310
MECH-330 with MECH-331 is the first course in System Dynamics. MECH-331 provides an understanding into basic principles and methods underlying the development and analysis of mathematical models in the time domain. Construction of mathematical models of systems using MATLAB and Simulink is emphasized. Application of modeling techniques, design characteristics and analysis of first and second order systems is stressed. MECH-330 must be taken concurrently (or previously passed) with this course.
Lecture: 0, Lab 1, Other 0

**MECH-350 Introduction to Bioengineering Applications 4 Credits**
Prerequisites: MECH-210
This course deals with a discussion and application of the following fundamental concepts: (1) basic anatomy and physiology of the overall human body; (2) basic anatomy and physiology of specific structures including brain, ear, eyes, heart, kidney, gastro-intestinal system, articular joints, and bones; (3) an appreciation of the engineering basis for current and developmental products designed to diagnose and replace these biological structures; (4) exposure to biochemistry, biomaterials, and biomechanics at a fundamental level; and (5) an understanding of current laws which govern bioengineering device manufacturing. A semester project will require the student to rigorously research an existing product or emerging technology of relevance to bioengineering and the human body.
Lecture: 4, Lab 0, Other 0

**MECH-397 MECH Free Elective 4 Credits**
Prerequisites: None
This is a Mechanical Engineering course used to record credit for transfer or guest courses ONLY that are not equivalent to existing Kettering University Mechanical Engineering courses.
Lecture: 4, Lab 0, Other 0

**MECH-412 Mechanical Component Design II 4 Credits**
Prerequisites: MECH-307 and MECH-312
This course is an extension of MECH-312, Mechanical Component Design I. Topics to be studied will include wear and contact stress analysis, helical and bevel gear systems, impact analysis, temperature effects in design, introduction to fracture mechanics, code based design, welded connections, and topics selected by the students. Course work will consist of lectures plus, the students will perform research on these topics and provide written and oral reports, including examples.
Lecture: 4, Lab 0, Other 0

**MECH-413 Mechanical Systems Design Project 4 Credits**
Prerequisites: MECH-307 and MECH-300 and MECH-312
The fundamental topics of this course include: The engineering design process, ethics, teamwork, brainstorming, conceptual designs, proposal writing, project planning, project management, product attributes, design criteria, engineering targets, physical simulation, virtual simulation, analysis techniques, design synthesis, alternative designs, bill of materials, bill of process, manufacturability, product variations, product quality, design reports and presentations. Note: Satisfies ME Senior Design Project requirement.
Lecture: 4, Lab 0, Other 0

**MECH-414 Experimental Mechanics 4 Credits**
Prerequisites: MECH-307 and MECH-312
The primary purpose of this course is to provide fundamental knowledge in the theory and practical experience in the application of mechanical engineering measurements. Viewed as a system, consideration is given to the performance, limitations, and cost of the detection - transducing stage, the signal conditioning stage and the final termination or readout – recording stage. Sensors such as resistive, capacitive or inductive are considered for the transducing stage. Signal conditioning stage emphasizes the use of a Wheatstone Bridge circuit, operational amplifiers and digital processing. The final readout or termination stage considers visual readouts such as analog or digital meters, charts or scopes in addition to memory devices such as computer hard drives and microprocessors. Nearly 2/3 of the time is spent on an approved team project that produces experimental measurements, which adds knowledge or understanding to some theoretical concepts or rhetorical inquiry. Course is structured so as to qualify as a capstone for cognate mechanical engineering students. Others may use it as a technical elective.
Lecture: 2, Lab 0, Other 4

**MECH-415 Engineering Optimization 4 Credits**
Prerequisites: MATH-204 and (MATH-305 or MATH-307)
Minimum Class Standing: Senior
Introduction to the general model of numerical optimization and its application to engineering design. The formulation and classification of the optimization problems will be discussed. The computational search techniques for solving the different classes of optimization problems will be studied. These techniques include single and multivariable, zero and first order constrained and unconstrained, linear and nonlinear search algorithms. The developed algorithms will be used to find the optimum solutions for a variety of engineering design problems.
Lecture: 4, Lab 0, Other 0

**MECH-416 Introduction to Finite Element Analysis with Structural Applications 4 Credits**
Prerequisites: None
The main objective of this course is to introduce the theory of Finite Element Method with applications to simple and real-world structural components. Both 1-D and 2-D formulations will be presented and discussed. Commercial F.E.A. codes such as NX, ANSYS and/or other software will be integrated to enhance the understanding of the theory presented. Other engineering and math software application programs such as MATLAB/Maple will also be used. Several practical design projects will be assigned during the term of this course.
Lecture: 4, Lab 0, Other 0

**MECH-420 Heat Transfer 4 Credits**
Prerequisites: MECH-320 and MECH-322
This course addresses the principles of heat transfer by conduction, convection, radiation and energy conservation, fins, steady-state and transient problems, and analysis and selection of heat exchangers.
Lecture: 4, Lab 0, Other 0

**MECH-421 Energy and Environmental System Design 4 Credits**
Corequisites: MECH-422
Prerequisites: MECH-300 and MECH-307 and MECH-312 and MECH-420
Minimum Class Standing: Senior
The objective of this course is to provide a comprehensive capstone design experience in the engineering and design of energy systems. Students will work in design teams to complete the design of an energy efficient and environmentally friendly system for use in a residential or commercial building, a power plant, or any other system that requires energy. The course covers one or more of the following energy sources or energy conversion devices: fossil, solar, wind, tidal, hydro, wave, biomass, geothermal, alternative fuels, or fuel cells.
Lecture: 4, Lab 0, Other 0

**MECH-422 Energy Systems Laboratory 4 Credits**
Corequisites: MECH-420
Prerequisites: MECH-320 and MECH-322
A laboratory course dealing with the detailed application of the first and second laws of thermodynamics; continuity, momentum, and energy equations; and principles of conduction, and convection to a variety of energy systems. Topics such as internal and external flows, refrigeration, psychrometrics, aerodynamic lift and drag, pump and fan performance, compressible flow and shock waves, free and forced convection, and heat exchangers are covered. Computational fluid dynamics (CFD), automatic data acquisition, flow visualization, and a design experience are incorporated into various laboratory experiments.
Lecture: 2, Lab 4, Other 0

**MECH-426 Fuel Cell Science and Engineering 4 Credits**
Prerequisites: CHEM-135 and CHEM-136 and MECH-322
The objectives of this course are to introduce the students to and provide an extensive experience in the engineering and design of fuel cell devices. The course lecture will cover the five main types of fuel cells and their operational parameters and applications, efficiency and open circuit voltages. Other topics include: fuel cell systems, compressors, turbines, fans, blowers, pumps, DC voltage regulation and voltage conversion, fuels for fuel cells and methods of processing. Codes and standards of operating a fuel cell powered device will be presented as well as laws regulating the transportation of hazardous materials contained within these devices. Students will also study the design requirements for the introduction of fuel cells into various devices such as: golf-cart, bicycles, laptops, toys, road signs, etc. The lecture is supported with laboratory experiences.
Lecture: 4, Lab 0, Other 0

**MECH-427 Energy and the Environment 4 Credits**
Prerequisites: None
This course covers energy conversion and conservation, fossil fuels, renewable and bio-fuels, solar, geothermal and nuclear energy, alternative energy (wind, water, biomass), hydrogen as an energy carrier, historical context of the technology, the role of energy in society (economic, ethical, and environmental considerations), energy forecasts and the trend toward a hydrogen economy. Public policy, global warming and Co2 footprints and offsetting are also discussed.
Lecture: 4, Lab 0, Other 0

**MECH-428 Bio and Renewable Energy 4 Credits**
Prerequisites: PHYS-114 and PHYS-115
This course provides an opportunity for the students to study bio and renewable energy and their applications around the globe. The students also perform hands-on experiments in several areas of sustainable energy. The fundamental principles required will be provided prior to laboratory experimentation. Topics covered include bur are not limited to solar thermal energy and photovoltaics, wind energy, energy storage, bioenergy used for power, transportation and heating, PEM fuel cells, and alternative energy vehicles.
Lecture: 3, Lab 1, Other 0

**MECH-430 Dynamic Systems with Controls 3 Credits**
Corequisites: MECH-431
Prerequisites: MECH-330 and MECH-331 and MATH-305
This is the second course in System Dynamics. The objective of this course is to build upon previous knowledge of multi-discipline system modeling to understand basic principles and design methods underlying steady-state and dynamic analysis of control systems. Construction of higher-order mathematical models of systems using Bond-graphs, block diagrams and development of transfer functions and state space models are used to model the plant (system being controlled). System performance is analyzed in both time and frequency domains using computer simulation. Classical control system design with both feed-forward and feedback configurations are emphasized. Introduction to advanced topics in control systems are also provided. MECH-431 must be taken concurrently (or previously passed) with this course.
Lecture: 3, Lab 0, Other 0

**MECH-431 Dynamic Systems with Controls Lab 1 Credits**
Corequisites: MECH-430
Prerequisites: MECH-330 and MECH-331 and MATH-305
MECH-430 and MECH-431 combined are a second course in System Dynamics. MECH-431 provides an understanding of time and frequency domain analysis of mathematical models. Simulation and analysis of mathematical models using MATLAB and Simulink are emphasized. Mathematical model validation is explored using hardware (e.g. DC Motors). Control system design and verification are explored using simulation and hardware (e.g. DC Motors). MECH-430 must be taken concurrently (or previously passed) with this course.
Lecture: 0, Lab 1, Other 0

**MECH-440 Introduction to Internal Combustion Engines 4 Credits**
Prerequisites: MECH-320
This course introduces the basic fundamentals of internal combustion engines and their operation. Topics covered include thermodynamic analysis of 4-stroke and 2-stroke cycles, spark ignition and compression ignition engines, intake systems, exhaust systems, fuel injection and moisture preparation, combustion, emissions, slider crank mechanism, vibrations, engine testing, and engine design. Recent technologies such as variable valve timing and lift, variable compression ratio, gasoline direct injection, homogeneous-charge compression ignition, turbocharging and supercharging of engines are also presented.
Lecture: 4, Lab 0, Other 0

**MECH-441 Advanced Automotive Power Systems 4 Credits**
Prerequisites: MECH-320
This course serves to expand student's knowledge of automotive power systems. Topics covered include, detailed thermodynamic cycle analysis of various power cycles, emerging alternative fuels and power systems for automotive use (current topics include high-blend alcohol/gasoline fuels, gasoline direct injections (GDI) engines, hybrid electronic Powertrains, and fuel-cells). Students are also expected to work on design projects which are determined by the instructor. Students are expected to work on projects leading to the development of presentations and/or technical papers for professional society meetings (i.e. SAE, Global Powertrain Congress, etc.).
Lecture: 4, Lab 0, Other 0

**MECH-442 Chassis Systems 4 Credits**
Prerequisites: MECH-330
The objective of this course is to provide a comprehensive experience in the area of automotive chassis engineering. The course covers tires, suspensions and steering. A vehicle system approach is used for learning. Vehicle dynamics concepts and improvement approaches are integrated into the course content. Professional computer-aided engineering tools are introduced (e.g. CarSim, SuspensionSim) and applied to the areas of suspension analysis and overall vehicle dynamics performance. Students work in teams to complete a chassis design project applicable to passenger cars or light trucks.
Lecture: 4, Lab 0, Other 0

**MECH-444 Introduction to Automotive Powertrains 4 Credits**
Corequisites: MECH-311
Prerequisites: MECH-212
An introduction to the performance of motor vehicle and the design of automotive power transmission systems. Topics covered include, loads on the vehicle, evaluation of various engine and vehicle drive ratios on acceleration performance and fuel economy, manual transmission design, and automatic transmission design.
Lecture: 4, Lab 0, Other 0

**MECH-445 Hybrid Electric Vehicle Propulsion 4 Credits**
Corequisites: MECH-430, MECH-431
Prerequisites: None
An introduction to the principles of hybrid electrical vehicle propulsion systems for Mechanical and Electrical Engineering students. A major emphasis of the course will be to broaden the mechanical engineering student's knowledge of electrical engineering so that he/she can understand the fundamentals of electrical motors, electrical motor controls, and electrical energy storage systems. The course is also intended to strengthen the knowledge of electrical engineering students relative to automotive powertrain design. With this background, the integration of these hybrid electric components into the hybrid electric vehicle powertrain system will be studied, including electric energy storage (batteries, flywheels, ultra-capacitors) and electrical energy production-fuel cells. Relevant codes and standards will be emphasized.
Lecture: 4, Lab 0, Other 0

**MECH-446 Vehicle Systems Dynamics 4 Credits**
Prerequisites: MECH-330
This course begins with an introduction to vehicle weight distribution and tire patch forces. Acceleration, braking, ride and handling concepts follow. Mathematical models for ride and handling are derived and presented. Chassis design factors (CDF) effects on ride and handling are emphasized. Computer simulation software (e.g. CarSim) is used as an integral part of the course and for projects assigned during the term. Overview of technology and latest developments in the field of vehicle dynamics (e.g. SAE publications) are part of the course.
Lecture: 4, Lab 0, Other 0

**MECH-448 Vehicle Design Project 4 Credits**
Prerequisites: MECH-300 and MECH-320 and MECH-330
Minimum Class Standing: Senior
This course provides an engineering project experience that is representative of automotive industry projects, except it is scaled down such that it can be performed in one school term. The project begins with setting specific and measurable goals in a project statement. This is followed by researching and brainstorming, producing design alternatives, selecting concepts, and developing and analyzing concepts. Project updates are required throughout the course. A mid-term and final oral presentation are mandatory, along with the submission of a final written report. This course satisfies the ME Senior Design Project requirement.
Lecture: 4, Lab 0, Other 0

**MECH-450 Automotive Bioengineering: Occupant Protection and Safety 4 Credits**
Prerequisites: MECH-310
A discussion and application of the following fundamental concepts: (1) an overview of Federal Motor Vehicle Safety Standards; (2) basic anatomy and physiology of the overall human body; (3) introduction to injury biomechanics including rate, load, and acceleration dependent injury mechanisms; (4) overview of injury prevention strategies including a variety of air bags, multipoint restraint systems, and occupant sensing methodologies; (5) the basic structure and function of anthropomorphic test devices; (6) introduction to experimental crash simulation; (7) virtual occupant simulation using MADYMO or similar computational tools.
Lecture: 4, Lab 0, Other 0

**MECH-451 Vehicular Crash Dynamics and Accident Reconstruction 4 Credits**
Prerequisites: MECH-310
A discussion and application of the following fundamental concepts: (1) 2D and 3D dynamics of vehicular crash, (2) application of linear and angular momentum principles to vehicular impact, (3) application of energy principle to vehicular impact, (4) estimation of crash energy from vehicular crush profile, (5) vehicular crash pulse analysis, (6) occupant kinematics, (7) dynamics of rollover and pole collision, (8) crash data recorder (CDR) analysis, (9) and special topics in accident investigation forensics.
Lecture: 4, Lab 0, Other 0

**MECH-454 Bioengineering Applications Project 4 Credits**
Prerequisites: MECH-300 and MECH-307 and MECH-310 and MECH-312 and MECH-350
Minimum Class Standing: Senior
A comprehensive design experience focusing on a project with direct application to the bioengineering field. The course emphasizes the steps of a typical design process (problem identification, research, and concept generation) culminating in a documentation of the preferred embodiment of the design concept. The conceptual design will then be further developed through the application of sound engineering analysis and tools. Note: Satisfies ME Senior Design Project requirement.
Lecture: 4, Lab 0, Other 0

**MECH-472 CAD/CAM/CAE & Additive Manufacturing Capstone Design 4 Credits**
Prerequisites: MECH-300
Capstone design project course in which students acquire an integrating experience leading them from CAD of a part (designed using sculptured surface and solid modeling techniques), through rapid prototyping of that part (using FFF) and into mold or die design and manufacture (using CAD/CAM/CAE system such as Siemens NX). This course can be used as a ME Elective or Free Elective if another ME capstone course is completed.
Lecture: 4, Lab 0, Other 0

**MECH-482 Mechanics and Design Simulation of Fiber-Reinforced Composite Materials 4 Credits**
Prerequisites: MECH-300
The properties, mechanics, and design simulation aspects of fiber-reinforced composite materials are covered in this course. Topics include: constituents and interfacial bonding, microstructure and micromechanics, theory of anisotropy, classical laminate theory, material characterization, failure and damage, manufacturing techniques, composite structure design, and introduction of nanocomposite.
Lecture: 4, Lab 0, Other 0

**MECH-490 Fluid Power Systems 4 Credits**
Corequisites: MECH-312
Prerequisites: MECH-300
This course begins with basic hydraulics circuits followed by the sizing and control of hydraulic cylinders and motors. Prime movers are introduced and matched to system requirements. Valves are described while circuit tracing and component recognition are emphasized. The course also addresses air consumption, pneumatic component sizing and ladder logic. There will be limited consideration of hydraulic servo and two design projects.
Lecture: 4, Lab 2, Other 0

**MECH-495 Senior Design Project 4 Credits**
Prerequisites: MECH-300 and MECH-312 and MECH-322 and MECH-330
Minimum Class Standing: Senior
The objective of this course is to provide a comprehensive capstone design experience that includes a design project in mechanical systems, or dynamic systems, or energy systems, based on knowledge and skills acquired in earlier coursework. The project begins with setting specific and measurable goals in a project statement. This is followed by researching and brainstorming, producing design alternatives, selecting concepts, and developing and analyzing concepts. Students work in teams to design and develop a prototype or a conceptual design to meet given specifications and to incorporate relevant engineering standards. Project updates are required throughout the course.
Lecture: 4, Lab 0, Other 0

**MECH-498 Mechanical Eng Study Abroad 4 Credits**
Prerequisites: None
Advanced Topics in Mechanical Engineering. This is a transfer course taken a part of Kettering's Study Abroad Program.
Lecture: 4, Lab 0, Other 0

**MECH-510 Analysis and Design of Machines and Mechanical Assemblies 4 Credits**
Corequisites: MECH-330
Prerequisites: MECH-300 and MECH-310 and MECH-312
The main aim of this course is to integrate the concepts of kinematic & dynamic analyses to the design of machines and mechanical assemblies used in automotive, medical equipment and other applications. These include (but are not limited to) the analysis and design of reciprocating engine sub-systems such as, piston cylinder mechanism, steering linkages, window and door-lock mechanisms, over-head valve linkage system, flywheel, gears & gearboxes, universal couplings and automotive differential. Synthesis of mechanism systems used in medical equipment area will also be covered. Kinematic and dynamic characteristics such as displacement, velocity, acceleration and forces are analyzed by graphical and analytical methods. CAE tools will be used to perform kinematic, dynamic and stress analyses and fatigue design of these systems using CAE tools. Temperature effects will also be included wherever appropriate in the design. Several practical design projects will be assigned during the term of this course.
Lecture: 4, Lab 0, Other 0

**MECH-515 Failure and Material Considerations in Design 4 Credits**
Corequisites: MECH-412
Prerequisites: None
Designing components that are safe and reliable requires efficient use of materials and assurance that failure will not occur. Even still, components do fail. In this course, students will be introduced to the techniques of designing for life and material considerations involved in that process. In addition, students will also study how to analyze those components which do fail, and evaluate safe-life and remaining life in a design through the study of real-life component design and current failures.
Lecture: 4, Lab 0, Other 0

**MECH-523 Applied Computational Fluid Dynamics 4 Credits**
Prerequisites: MECH-322 and (MATH-313 or MATH-418 or MATH-423)
This course includes solution methods to the Navier-Stokes equations in a discrete domain. Grid generation, coordinate transformation, discretization, explicit, implicit, semi-implicit, a variety of algorithms, post-processing, and interpretations of results are discussed. Solution techniques for compressible and incompressible flows, their applicability, robustness, and limitations are covered. External and internal flows with and without chemical reactions are also discussed. The learning process involves hands-on experience on grid generation, setting up a CFD code, post-processing, and a thorough discussion on the results. The students will work on a final project that is a practical problem of significant magnitude and importance to industry. This work must be publishable in the student's journal or presentable in a conference.
Lecture: 4, Lab 0, Other 0

**MECH-525 Introduction to Multiphysics Modeling and Simulation in Fluid Mechanics and Heat Transfer 4 Credits**
Prerequisites: MECH-322 and MECH-420
This course solves a variety of engineering problems with the aid of computational software mainly in the field of fluid mechanics and heat transfer. Pipe flow, incompressible flow, laminar and turbulent flow, drag, and lift are subjects covered during the first part of the course. In the second part, topics in heat transfer are used uch as conduction in solids, fin design, convection, heat exchangers, and radiation. In a third part, selected topics in electrical conductive media and reaction engineering are also covered. This course compliments MECH-322 and MECH-420 and could be considered an extension of the two courses where problems are solved in 2D and 3D using computational software. Different types of meshes will be discussed, post-processing of data will be analyzed through graphical techniques, and graphical results will be compared to well-known analytical solutions. Students will also complete a final project where both fluid mechanics and heat transfer physics will be used to solve practical engineering problems.
Lecture: 4, Lab 0, Other 0

**MECH-562 Compressible Flow/Gas Dynamics 4 Credits**
Prerequisites: MECH-322
The derivation and physical interpretation of the Navier-Stokes equations for compressible flows. Analysis of one-dimensional flows with discussions on normal, oblique, and bow shocks. Sound waves and unsteady wave motion are also covered. The method of characteristic (MOC) is taught and standard JANNAF CFD codes is utilized to understand the compressible flows and shock formation and behavior. The study is then further carried out to nozzle flows and jet/shock layer interaction. The students are required to not only understand the conventional methods used to obtain solution for compressible flow problems, but also to be able to utilize CFD and experimental methods to obtain solution for complex problems.
Lecture: 3, Lab 2, Other 0

**MECH-564 Aerodynamics and Wing Theory 4 Credits**
Prerequisites: MECH-322 and (MATH-305 or MECH-600)
Discussions on fundamentals of inviscid and viscous incompressible flows. Important topics in fluid mechanics such as potential flow, vortices, point sources, and coupling of inviscid and boundary layer flows are covered. Two and three dimensional wings (or airfoils) and some exact solutions to such flow problems are discussed. Semi-analytical methods for disturbance distribution on wings are introduced by perturbation method. The computational Panel method for two and three dimensional aerodynamics problems is discussed. Commercial computer programs are used to solve realistic problems in a three dimensional space.
Lecture: 4, Lab 0, Other 0

**MECH-595 Automotive Seminar I 4 Credits**
Prerequisites: None
Kettering has a partnership with the Society of Automotive Engineers (SAE) to offer both a certificate in Automotive Systems, as well as, a graduate degree in either Automotive Systems or the Mechanical Cognate. This seminar course would be comprised of a total of four Continuing Education Units (CEU) from SAE seminars, which have been reviewed and approved by a faculty review committee, consistent with Graduate academic policy. The transfer of credit must be supported by documentation from SAE for each individual applicant seeking such transfer.
Lecture: 4, Lab 0, Other 0

**MECH-596 Automotive Seminar II 4 Credits**
Prerequisites: None
Kettering has a partnership with the Society of Automotive Engineers (SAE) to offer both a certificate in Automotive Systems, as well as, a graduate degree in either Automotive Systems or the Mechanical Cognate. This seminar course would be comprised of a total of four Continuing Education Units (CEU) from SAE seminars, which have been reviewed and approved by a faculty review committee, consistent with Graduate academic policy. The transfer of credit must be supported by documentation from SAE for each individual applicant seeking such transfer.
Lecture: 4, Lab 0, Other 0