**ENME - ENGINEERING, MECHANICAL**

**ENME201 Careers in Mechanical Engineering (1 Credit)**

**ENME202 Computing Fundamentals for Engineers (3 Credits)**
Introduction to computational tools for the solution of engineering problems. C++ & MATLAB programming including branching and loops, functions, file handling, arrays, and data structures. Students will be introduced to object-oriented programming, basic computing, algorithms, and principles of software engineering.

Corequisite: Must be concurrently enrolled in MATH141.
Restriction: Permission of ENGR-Mechanical Engineering department.
Credit Only Granted for: ENAE202 or ENME202.

**ENME207 Fabrication and Machine Tool Practices for Engineering (2 Credits)**
In order to make the best decisions in product design and development, it is important to understand the capabilities and limitations of different fabrication techniques. Students will learn to identify machine parts and functions, define machine shop terminology, calculate shop formulas and theories, execute machine operations, and apply proper measuring tools.

Prerequisite: PHYS161. And ENME272; or students who have taken courses with comparable content may contact the department.
Restriction: Permission of ENGR-Mechanical Engineering department.

**ENME208 Introduction to Automotive Engineering and Design (2 Credits)**
Selected concepts in automotive engineering and design at the introductory level utilizing the Terps Racing Baja SAE student project as a learning instrument. This class compliments ENME408, Automotive Design, which focuses on the Terps Racing Formula SAE car.

Prerequisite: ENES100.
Recommended: ENES220, and ENES221.
Restriction: Permission of ENGR-Mechanical Engineering department.
Repeatable to: 4 credits if content differs.

**ENME242 Building Products that Last - Failure is NOT an Option! (3 Credits)**
Have you ever wondered why airplanes crash or bridges collapse? Or even why your car is always in the shop or your computer screen goes blank? This course will let you in on the secret of why engineered products and structures fail and how designers are changing how they work to make products with higher reliability and longer life-spans. Even more, it will make you think about the many consequences that arise from failure ranging from direct replacement cost and legal liability to environmental impact and even changes in government policies and regulation

**ENME271 Introduction to Matlab (3 Credits)**
Develop the skills to generate readable, compact and verifiably correct MATLAB scripts and functions to obtain numerical solutions to a wide range of engineering models and to display the results with fully annotated graphics. Learn structured programming.

Prerequisite: ENES221.

**ENME272 Introduction to Computer Aided Design (2 Credits)**
Fundamentals of CAD, using solid modeling packages (Pro/E, SolidWorks, and Autodesk Inventor). Two and three dimensional drawing. Dimensioning and specifications. Introduction of CAD based analysis tools. Students will complete a design project.

Prerequisite: ENES100; and must have completed or be concurrently enrolled in MATH141.
Restriction: Permission of ENGR-Mechanical Engineering department.
Credit Only Granted for: ENME 414 or ENME272.

**ENME289 Exploring Topics in Mechanical Engineering (2 Credits)**
Introductory Design Topics in the Field of Mechanical Engineering.
Repeatable to: 4 credits if content differs.

**ENME331 Fluid Mechanics (3 Credits)**

Prerequisite: ENES232 and ENES221. Also offered as: BIOE331.
Credit Only Granted for: BIOE331 or ENME331.

**ENME332 Transfer Processes (3 Credits)**

Prerequisite: ENME331.

**ENME350 Electronics and Instrumentation I (3 Credits)**

Prerequisite: PHYS271 and PHYS270.

**ENME351 Electronics and Instrumentation II (3 Credits)**

Prerequisite: PHYS271, ENME350, and PHYS270.

**ENME361 Vibration, Controls and Optimization I (3 Credits)**

Prerequisite: ENES220, ENES221, and MATH246; and (MATH206 or ENME202).
Restriction: Must be in Engineering: Mechanical program.

**ENME371 Product Engineering and Manufacturing (3 Credits)**

Prerequisite: ENES221; and (ENME392 or STAT400).
Restriction: Must be in Engineering: Mechanical program.

**ENME382 Introduction to Materials Engineering (3 Credits)**

Prerequisite: ENES100; and permission of ENGR-Mechanical Engineering department.
Corequisite: MATH241.
Recommended: PHYS261 and PHYS260. Also offered as: ENMA300.
Credit Only Granted for: ENMA300 or ENME382.
ENME386 Experiential Learning (3-6 Credits)
Integrated statistical methodology for the improvement of products and processes in terms of performance, quality and cost. Designed experimentations. Statistical process control. Software application. Laboratory activities.
Prerequisite: MATH241.

ENME392 Statistical Methods for Product and Processes Development (3 Credits)
Integrated statistical methodology for the improvement of products and processes in terms of performance, quality and cost. Designed experimentations. Statistical process control. Software application. Laboratory activities.
Prerequisite: MATH241.

ENME398 Honors Research Project (1-3 Credits)

ENME400 Machine Design (3 Credits)
Design of mechanical elements and planar machines. Failure theories. Design of pressure vessels, joints, rotating elements, and transmission elements. Kinematic structures, graphical, analytical, and numerical analysis and synthesis of linkages, gear trains, and flywheels are covered.
Prerequisite: Must have completed or be concurrently enrolled in ENME361.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME406 Roller Coaster Engineering (3 Credits)
Engineering of roller coasters including: specifications, concept creation, structural design, car design, and safety. Course covers biomechanics and rider kinematics as well as manufacturing aspects.
Prerequisite: ENES220, ENES221, and ENME272. And ENME202; or MATH206.
Corequisite: ENME400.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME407 Iceland, The Land of Fire and Ice: Sustainability, Climate Change and Renewable Energy Systems (3 Credits)
Students travel to Iceland to explore innovative solutions to climate change, analyze geothermal, hydroelectric, wind and other renewable energy systems as well as their applications.
Prerequisite: PHYS161.

ENME408 Selected Topics in Engineering Design (3 Credits)
Creativity and innovation in design. Generalized performance analysis, reliability and optimization as applied to the design of components and engineering systems. Use of computers in design of multivariable systems.
Restriction: Must be in Engineering: Mechanical program; and senior standing. Or permission of ENGR-Mechanical Engineering department.
Repeatable to: 6 credits if content differs.

ENME410 Design Optimization (3 Credits)
Introduction to the formal process of design optimization, including analytical and computational methods. Step by step design optimization techniques. Design optimization concepts, necessary and sufficient optimality conditions and solution techniques. Solution evaluation and tradeoff exploration.
Prerequisite: ENME271; or MATH206.
Restriction: Permission of ENGR-Mechanical Engineering department; and junior or senior standing.

ENME414 Computer-Aided Design (3 Credits)
Introduction to computer graphics. Plotting and drawing with computer software. Principles of writing interactive software. The applications of computer graphics in computer-aided design. Computer-aided design project.
Prerequisite: MATH241; or students who have taken courses with comparable content may contact the department.
Credit Only Granted for: ENME 414 or ENME272.

ENME416 Additive Manufacturing (3 Credits)
Develop a comprehensive understanding of fundamental additive manufacturing, 3D printing approaches, including: extrusion-based deposition, stereolithography, powder bed-based melting, and inkjet-based deposition. Cultivate a design for additive manufacturing skillset for CAD and CAM methodologies to produce successful 3D prints. Fabricate 3D mechanical objects using a variety of 3D printing technologies on campus. Execute a design project that demonstrates how additive manufacturing technologies can overcome critical limitations of traditional manufacturing processes.
Prerequisite: ENME331. And ENME272; or ENME414.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME421 Engineering Design Ideation (3 Credits)
Engineering Design Methods is a technical elective for engineering students who wish to improve their ability to produce design ideas (i.e., the ideation process) for further development into conceptual ideas. Ideation is the creative, idea generation activity that happens at the beginning of the conceptual design process. Ideation methods are often built around creativity improving strategies and are often designed for individual use prior to presenting the results in a team setting.
Prerequisite: Must have completed or be concurrently enrolled in ENME371.
Restriction: Junior standing or higher.
Additional Information: Ideally, this course should be taken prior to capstone design.

ENME423 Modern Climate Control and Building Energy Design/Analysis (3 Credits)
Fundamentals and design calculations of heat and moisture transfer in buildings; evaluation of cooling, heating and power requirements of buildings; building energy consumption simulations, use of alternative energy and energy conservation measures in buildings; fundamentals of fans/pumps and air/water distribution in buildings; introduction to refrigeration and energy systems for data centers and other mission-critical facilities.
Prerequisite: ENES232.
Corequisite: ENME332.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME424 Urban Microclimate and Energy (3 Credits)
Urban microclimate from the perspective of transient heat and mass transfer using building energy simulations for building clusters as well as LEED building certification criteria. The focus is on understanding building energy consumption and environmental impacts from the individual building scale to a neighborhood scale.
Prerequisite: Must have completed or be concurrently enrolled in ENME332.
Recommended: ENME423.
Restriction: Permission of ENGR-Mechanical Engineering department.
Credit Only Granted for: ENME424 or ENME808I.

ENME426 Production Management (3 Credits)
The basic concepts and models needed to understand and design manufacturing systems, including the history of manufacturing, performance measures, queueing systems, variability, production planning and scheduling, lean manufacturing, and pull production control.
Credit Only Granted for: BMGT385 or ENME426.
ENME427 CSI Mechanical: Finding Reasons for Compromised Structural Integrity (3 Credits)
Understanding the causes of product failures including the political, societal, economic, environmental, and ethical impact of these failures, and the strategies to avoid, postpone, or mitigate them. Students will be encouraged to combine concepts from engineering, natural sciences, social sciences, and the humanities to address these complex issues. Basics of failure analysis, forensics, and reliability engineering and the scientific fundamentals underlying the most common types of failure. Issues of legal liability. Methods for monitoring the existing condition of a structure.
Prerequisite: ENES220 and ENME382.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME430 Fundamentals of Nuclear Reactor Engineering (3 Credits)
Fundamental aspects of nuclear physics and nuclear engineering, including nuclear interactions; various types of radiation and their effects on materials and humans; and basic reactor physics topics, including simplified theory of reactor critically.
Prerequisite: MATH246.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME431 Nuclear Reactor Systems and Safety (3 Credits)
Engineering, material and thermal aspects of light water reactors, fast reactors, high temperature gas reactors, heavy water moderated reactors, breeder reactors, advanced reactors including GEN IV designs. Evolution of light water reactor safety and regulation in the US that has culminated in the current body of regulations.
Prerequisite: MATH246.
Recommended: ENME430.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME432 Reactor and Radiation Measurements Laboratory (3 Credits)
Basics concepts of nuclear radiation and radiation detectors including types of radiation, radioactive decay, and interactions of radiation with matter.
Prerequisite: ENME430 and MATH246.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME436 Renewable Energy (3 Credits)
Fundamentals, design/analysis tools, and state of the art renewable energy technologies. Energy resources and global perspectives of current and future energy demand/consumption trends, followed by prime renewable energy technologies, including wind, solar, hydro, geothermal, and ocean thermal energy conversion. Economics of renewable energy, energy conservation opportunities, CO2 capture and storage, and thermal energy storage.
Prerequisite: ENME331.
Restriction: Must be in a major within the ENGR-Mechanical Engineering department.
Credit Only Granted for: ENME489K or ENME436.
Formerly: ENME489K.

ENME440 Applied Machine Learning for Engineering and Design (3 Credits)
Learn how to apply techniques from Artificial Intelligence and Machine Learning to solve engineering problems and design new products or systems. Design and build a personal or research project that demonstrates how computational learning algorithms can solve difficult tasks in areas you are interested in. Master how to interpret and transfer state-of-the-art techniques from computer science to practical engineering situations and make smart implementation decisions.
Prerequisite: ENME392; or permission of instructor.
Restriction: Permission of ENGR-Mechanical Engineering department.
Credit Only Granted for: ENME440, ENME808E, or ENME743.

ENME442 Information Security (3 Credits)
The materials presented are divided into three major components: overview, detailed concepts and implementation techniques. The topics to be covered are: general security concerns and concepts from both a technical and management point of view; principles of security, architectures, access control and multi-level security, trojan horses, covert channels, trap doors, hardware security mechanism, security models, security kernels, formal specifications and verification, networks and distribution systems and risk analysis.
Restriction: Must have Senior standing in engineering; and permission of ENGR-Mechanical Engineering department. Also offered as: ENRE684.
Credit Only Granted for: ENRE648J, ENME442, ENRE684, or ENPM808E.

ENME444 Assistive Robotics (3 Credits)
Fundamentals of assistive robots used in a wide variety of ways to help humans with disabilities. Three application areas will be covered: (1) Rehabilitation robotics to recover motor function from neurologic injuries such as stroke, (2) Prosthetics to enable mobility function in amputees, and (3) Social robotics for cognitive impairment and developmental disorders such as autism. Theory behind different control systems employed by assistive robotics, as well as the mechanical design, sensors & actuators, and user interfaces behind representative robots in the respective areas. Guidelines for designing assistive robots. Ethical and regulatory considerations in the design of assistive robots.
Prerequisite: ENME351.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME445 Design for Reliability (3 Credits)
Failure prevention, accident prevention, design requirements analysis, designing right the first time, high system reliability, software reliability, manufacturing defect prevention, life cycle costs reduction, design reviews, managing the design for reliability, design trustworthiness, product durability, and writing good specifications are covered.
Restriction: Junior standing or higher.

ENME454 Vehicle Dynamics (3 Credits)
The fundamentals of passenger vehicle and light truck design and vehicle dynamics are covered. The engineering principles associated with acceleration, braking, handling, ride quality, aerodynamics, and tire mechanics are discussed, as well as suspension and steering design.
Corequisite: ENME361.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME461 Control Systems Laboratory (3 Credits)
Students will design, implement, and test controllers for a variety of systems. This will enhance their understanding of feedback control, familiarize them with the characteristics and limitations of real control devices. Students will also complete a small project. This will entail writing a proposal, purchasing parts for their controller, building the system, testing it, and writing a final report describing what they have done.
Prerequisite: ENME351 and ENME361.
Restriction: Permission of ENGR-Mechanical Engineering department.
Credit Only Granted for: ENEE461 or ENME461.

ENME462 Vibrations, Controls, and Optimization II (3 Credits)
Prerequisite: ENME351 and ENME361.
ENME464 Cost Analysis for Engineers (3 Credits)
An introduction to the financial and cost analysis aspects of product engineering. Introduces key elements of traditional engineering economics including interest, present worth, depreciation, taxes, inflation, financial statement analysis, and return on investment. Provides an introduction to cost modeling as it applies to product manufacturing and support. Cost modeling topics will include: manufacturing cost analysis, life-cycle cost modeling (reliability and warranty), and cost of ownership. 
Prerequisite: ENME392; or students who have taken courses with comparable content may contact the department.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME466 Lean Six Sigma (3 Credits)
This course intends to provide in-depth understanding of Lean Six Sigma and its Define - Measure - Analyze - Improve - Control (DMAIC) Breakthrough Improvement Strategy. The emphasis is placed on the DMAIC process which is reinforced via application of semester long corporate projects and case study analysis.
Corequisite: ENME392; or students who have taken courses with comparable content may contact the department.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME467 Engineering for Social Change (3 Credits)
Critical analysis of issues at the intersection of engineering, philanthropy and social change. How engineering design, products and processes have impacted social change in the past and will do so in the future. Topics covered include energy, sustainability and climate change, autonomy, the digital future, low cost engineering, manufacturing, ethics and the impact of electronics on society. Faculty and external experts will engage with students on these topics. Students will award a significant amount of grant money to an organization involved in technology for social change.
Restriction: Permission of ENGR-Mechanical Engineering department; and junior standing or higher.

ENME471 Finite Element Analysis (3 Credits)
Basic concepts of the theory of the finite element method. Applications in solid mechanics and heat transfer.
Restriction: Senior standing; and permission of ENGR-Mechanical Engineering department.

ENME472 Integrated Product and Process Development (3 Credits)
Prerequisite: ENME371.

ENME473 Mechanical Design of Electronic Systems (3 Credits)
Design considerations in the packaging of electronic systems. Production of circuit boards and design of electronic assemblies. Vibration, shock, fatigue and thermal considerations.

ENME474 Design in Electronic Product Development (3 Credits)
Merges technology, analysis, and design concepts into a single focused activity that results in the completed design of an electronic product. A set of product requirements are obtained from an industry partner, the students create a specification for the product, iterate the specification with the industry partner, then design and analyze the product. Students will get hands-on experience using real design implementation tools for requirements capture, tradeoff analysis, scheduling, physical design and verification. Issues associated with transferring of the design to manufacturing and selection of manufacturing facilities will also be addressed.
Prerequisite: ENME473.

ENME476 Microelectromechanical Systems (MEMS) I (3 Credits)
Fundamentals of microelectromechanical systems (MEMS). Introduction to transducers and markets. MEMS fabrication processes and materials, including bulk micromachining, wet etching, dry etching, surface micromachining, sacrificial layers, film deposition, bonding, and non-traditional micromachining. Introduction to the relevant solid state physics, including crystal lattices, band structure, semiconductors, and doping. The laboratory covers safety, photolithography, profilometry, wet etching.
Restriction: Senior standing.
Credit Only Granted for: ENME476 or ENME489F.
Formerly: ENME489F.

ENME477 Microelectromechanical Systems (MEMS) II (3 Credits)
Fabrication of devices designed in MEMS I, including everything from mask printing through training on state-of-the-art fabrication equipment through device testing. In-depth understanding of MEMS devices and technologies, such as mechanical and electromagnetic transducers, microfluidics, and chemical sensors.
Prerequisite: ENME476.

ENME481 Lab-on-a-Chip Microsystems (3 Credits)
Fundamentals and application of lab-on-a-chip and microfluidic technologies. A broad view of the field of microfluidics, knowledge of relevant fabrication methods and analysis techniques, and an understanding of the coupled multi-domain phenomena that dominate the physics in these systems.
Restriction: Senior standing; and permission of ENGR-Mechanical Engineering department.
Credit Only Granted for: ENME481, ENME808E, ENME740.
Formerly: ENME489E.

ENME483 Physics of Turbulent Flow (3 Credits)
Specific problems of turbulent flow including automobile and truck aerodynamics and canonical flows including pipes, jets and boundary layers that are measured and simulated to gain basic understanding of turbulence. A goal of the course is to impart the necessary background for students to be able to critically assess and most effectively employ the turbulent flow prediction codes (e.g. Fluent) that are a mainstay of how turbulence is analyzed in modern industries.
Prerequisite: ENME331.
Restriction: Permission of ENGR-Mechanical Engineering department. Also offered as: ENME656.
Credit Only Granted for: ENME483 or ENME656.
ENME484 Analysis of Turbulent Flow (3 Credits)
Relentless growth in the speed and size of supercomputers has encouraged the ever expanding use of numerical simulation in the practice of fluids engineering. For the flow past ground vehicles, in the urban grid, re-entering rockets, helicopters landing on ships at sea and countless other examples, the flow is turbulent, and simulation is becoming or will one day become the methodology of choice in analyzing and designing such technologies. The goal of this course is to give an introduction to the analysis of turbulent flow via simulation and the modeling that is used in its development. Among the questions to be considered: What can one hope to learn from flow simulation? What are the strengths of the approach and what obstacles inhibit its application? What kind of physical considerations are required in setting up simulations? How does one analyze the results of a simulation?
Prerequisite: ENME331.
Restriction: Permission of ENGR-Mechanical Engineering department.
Also offered as: ENME657.
Credit Only Granted for: ENME484 or ENME657.

ENME486 Computational Modeling, Simulation, and Interactive Visualization (3 Credits)
Creation of interactive graphic displays from the numerical simulation of mechanical engineering models. Brief description of each model provided, along with varied parameters to explore models’ characteristics. Conclusions drawn from use of each interactive graphic. Mathematica language introduced and interwoven with the numerical simulation of the models, which will include: robotics and mechanisms, static response of beams, control systems, measurement systems, fluid flow, vibrations, geometric modeling, finite element analysis, and nonlinear phenomena.
Restriction: Senior standing; and permission of ENGR-Mechanical Engineering department.

ENME488 Special Problems (3 Credits)
Advanced problems in mechanical engineering with special emphasis on mathematical and experimental methods.
Restriction: Permission of ENGR-Mechanical Engineering department.

ENME489 Special Topics in Mechanical Engineering (3 Credits)
Selected topics of current importance in mechanical engineering.
Restriction: Permission of ENGR-Mechanical Engineering department.
Repeatable to: 6 credits.