AUTOMOTIVE ENGINEERING (AENG)

Course Descriptions

AENG 500 Automobile: An Integrated Syst 3 Credit Hours
Factors external to engineering such as markets, financing, and sales; the customers and their perceptions as influenced by marketing and performance; volume markets; international. An abc of engineering factors in all the components and sub-systems areas and in the plant, labor, and supplies area. Vehicle characteristics and dynamic interactions.
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 502 Modeling of Automotive Systems 3 Credit Hours
This course will first introduce systems modeling approach and then develop mathematical models for ride, vibration, handling control, etc. of automobiles. The models will then be used to examine the design and performance of an automobile from a systems point of view. (F, YR).
Prerequisite(s): ME 265 or ME 345
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 505 Intro to Embedded Systems 3 Credit Hours
Introduction to modern digital computer logic. Numbers and coding systems; Boolean algebra with application to logic systems; examples of digital logic circuits; simple machine language programming and Assembly and C/C+ programming language; microprocessors programming (both assembly and C/C+) for input/output, interrupts, and system design. (May not be available to students with EE or CE degrees) Three lecture hours per week.
Restriction(s):
Can enroll if Class is Graduate
Cannot enroll if Level is
Can enroll if Major is , Software Engineering, Automotive Systems Engineering

AENG 510 Vehicle Electronics I 3 Credit Hours
This course discusses the principles of electrical engineering and applications of electrical and electronic systems in automobiles, including resistive, inductive, and capacitive circuit analysis, semiconductor diodes, junction transistors, FETS, rectifiers, and power supplies, small signal amplifiers, biasing considerations, gain-bandwidth limitations, circuit models. Some automotive EE applications are used for case study. Three lecture hours per week. (Not open to students with EE degree.)
Restriction(s):
Can enroll if Class is Graduate
Cannot enroll if Level is
Cannot enroll if Major is Electrical Engineering, Automotive Systems Engineering, Computer Engineering

AENG 517 Vehicle Mobility Systems 3 Credit Hours
With rapidly growing technologies, future vehicle mobility systems will make an impact on society in many aspects. This course provides an overview of new technologies in intelligent vehicles (connected and automated), environment/road infrastructure (communication/traffic system management), and Mobility as a service business model. Upon completion of this course, students will have a better understanding of the current technology development and its impact on future vehicle mobility systems. (F, W).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 545 Vehicle Ergonomics I 3 Credit Hours
Overview of drive characteristics, capabilities, and limitations. Human variability and driver demographics, driver performance measurements. Driver information processing models, driver errors and response time. Driver sensory capabilities: vision, audition, and other inputs. Vehicle controls and displays. Driver anthropometry, biomechanical considerations.
Restriction(s):
Can enroll if Level is Rackham or Graduate
Can enroll if College is Engineering and Computer Science

AENG 546 Vehicle Ergonomics II 3 Credit Hours
This course covers advanced human factors engineering and ergonomics topics related to incorporation and integration of new display, information, lighting and sensor technologies to improve driver convenience, performance, safety, and to reduce driver distractions. The students will learn new evaluation methodologies, driver performance models, and use research equipment to measure driver performance, and evaluate usability issues. Some advanced topics to be covered include: driver workload, evaluation and design of new in-vehicle devices, advanced vehicle lighting, and driver vision systems, models to predict and evaluate field of view, target detection, disability and discomfort glare, legibility, etc. Three lecture hours including laboratory projects and demonstrations. Prerequisite: Graduate standing. (W).
Prerequisite(s): AENG 545
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 547 Automotive Powertrains I 3 Credit Hours
Topics in kinematics and dynamics including engine output and balance; mechanisms and machine theory. Force analysis and design of gears and shaft systems. Analysis of planetary gear trains. Design and analysis of automotive gear boxes. (YR).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if College is Engineering and Computer Science
Can enroll if Major is , Automotive Systems Engineering

AENG 550 Design of Automotive Chassis 3 Credit Hours
This course provides a systems approach to the design of automotive chassis and body components and examines the influence of their design on the overall structural performance of the automobile. Design issues related to structural rigidity, ride comfort, safety and crash-worthiness, durability and assembly are covered. Applications of advanced materials and joining techniques are discussed. Analytical tools used in automotive structural design are also discussed.
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Doctorate or Rackham or Graduate or

AENG 553 Structural Design and CAE Analysis for Electric Vehicle Batteries 3 Credit Hours
The course aim is to provide the knowledge on Electric Vehicle (EV) battery structural design, development, and validation using CAE analysis. Discussion is centered on the intertwined relationship between EV and batteries during the entire phase of their design, development, and validation. Topics include the discussion on structural analysis for battery module/pack and cells as well as battery components, module/pack sizing, PSD profile development for shaker table, shaker table analysis, and thermal cyclic analysis. Battery manufacturing variations are discussed as well. Finite element techniques for batteries in vehicle validation are also covered. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 555 Vehicle Stability & Control 3 Credit Hours
Introduction to static and dynamic stability characteristics of vehicles. Study on directional vehicle responses and stability in small disturbance maneuver. Design, numerical simulation, and analysis of vehicle control systems (ABS, active suspension, and yaw stability). Prerequisite: Dynamics (ME 345), Control Systems Design and Analysis (ME 442) or equivalent.
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 5561 Vehicle Structure Design with CAE 3 Credit Hours
This course provides a comprehensive introduction to key design principles related to the stress and strength of machines and structures under both monotonic and cyclic loadings. Students will explore both analytical and numerical methods for stress analysis and structural strength evaluation, addressing steady-state and fatigue conditions. Emphasis is placed on vehicle structure design. By the end of the course, students will be able to apply analytical techniques to calculate stress and strain in vehicle structures subjected to mechanical loads. They will also gain proficiency in using commercial software to analyze stress and strain for both linear and nonlinear materials. Either AENG 551 or AENG 5561 may be applied to degree, but not both. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 557 Sustainable Fuels for Transportation 3 Credit Hours
This course will cover the fundamentals of combustion relevant to transportation fuels and the working principles of combustion-based energy conversion devices. We will explore various forms of sustainable fuels, such as biodiesel, bioethanol, hydrogen, e-fuels, and advanced biomass-derived fuels. Additionally, methods for life cycle analysis will be taught to quantify the true impact of sustainable fuels on carbon and pollutant emissions. The course will also discuss the practical implications of integrating sustainable fuels into the current transportation infrastructure. This course includes hands-on projects using computational tools. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 562 Energy Management of Electrified Vehicles 3 Credit Hours
This course covers the longitudinal dynamics of electrified vehicles and optimization of energy consumption. Mathematical models are developed for analyzing the energy consumption of vehicle systems. Fundamentals of optimization and optimal control are studied for developing energy management strategies for energy-efficient ground vehicle propulsion. The topics include: vehicle longitudinal dynamics, modeling powertrain components, optimization and optimal control. (OC).
Restriction(s):
Can enroll if Level is Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 563 Introduction to Autonomous Vehicles 3 Credit Hours
This course provide an overview of autonomous vehicle systems. It will cover a short history of AVs including the advancement of key hardware and software components, progress of regulatory requirements. Student will learn basic principles of various sensors and actuators used in AVs, fundamental of vehicle dynamics in both longitudinal and lateral motions, design of simple vehicle motion control system (lane keeping, AEB, etc.). This course will use commercial software tool. Using this tool, students will develop AV systems with various sensors and demonstrate basic AV motion control systems. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 564 Autonomous Vehicle Perception 3 Credit Hours
This course focuses on perception technologies used in autonomous vehicles (AVs). Topics include computer vision, deep neural networks (CNNs, Transformers), Kalman filtering, camera-based and LiDAR-based object detection, sensor fusion, object tracking, lane and traffic sign detection, segmentation (semantic and instance segmentation), and cooperative perception techniques. Students will develop hands-on projects using industry-standard software tools, ROS, OpenCV, PyTorch/TensorFlow, and real-world datasets such as KITTI, nuScenes, and Waymo Open Dataset. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 566 Vehicle Thermal Management 3 Credit Hours
This course covers fundamental thermo-fluid principles and advanced topics in thermal management of conventional and electric drive vehicles (EDVs). The topics include: principles of energy conservation, heat transfer, and fluid mechanics; vehicle thermal management system and components; electrification of vehicle thermal management system; EDV thermal management; battery thermal management in EDVs; and waste energy recovery.
Restriction(s):
Can enroll if Class is Graduate or Doctorate
Can enroll if College is Engineering and Computer Science

AENG 569 Autonomous Vehicle Sensors and Localization 3 Credit Hours
This course covers the fundamental principles, technologies, and methodologies related to sensors and localization in autonomous vehicles. Students will explore sensor systems such as LiDAR, radar, cameras, along with sensor fusion techniques, calibration methods, health monitoring systems, localization algorithms including Kalman Filters, Simultaneous Localization and Mapping (SLAM), global navigation satellite system (GNSS)/inertial navigation system (INS) integration, and cooperative localization. The course includes hands-on projects using industry-standard tools and software platforms to reinforce theoretical knowledge through practical application. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 576 Battery Systems, Modeling, and Control 3 Credit Hours
Full Course Title: Battery Systems, Modeling, and Control This course will cover modeling, control, and estimation techniques for battery systems. Students will learn how electrochemical systems work and how they can be mathematically described. A simple phenomenological electrical circuit model and a detailed physics-based model that can capture diffusion dynamics will be covered. The thermal behavior of a battery system and its modeling will be covered as well. Students will learn the basic functions of battery management systems for monitoring state-of-charge, state-of-power, and state-of-health in applications to automotive and consumer electronics. (OC)
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 578 Advanced Vehicle Energy Systems 3 Credit Hours
Sustainability is an increasingly important topic for the automotive industry. This course discusses sustainable vehicle technology with focus on energy-related aspects, such as resources, consumption, environmental impacts, and regulations. It reviews sustainable technologies employed in automotive systems to reduce emissions in an energy-efficient manner and discusses their impacts on the industry. The course covers the fundamentals, characteristics, and design considerations of the vehicle energy systems. Students have a hands-on practice using numerical simulation tools. Specific technical topics include advanced internal combustion engines, alternative fuels with the focus on biofuels, hybrid, electric, and fuel cell vehicles, waste energy recovery systems, and smart grid system. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 579 Aerodynamics of Road Vehicles 3 Credit Hours
This course covers the fundamental principles, numerical modeling, and experimental analysis of the aerodynamics of road vehicles. Practical applications to the design and operation of cars, vans, trucks, buses, and motorcycles are also discussed. The course includes hands-on projects using computational fluid dynamics software. (OC).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 581 Materials Sel in Auto Design 3 Credit Hours
This course develops an understanding of the properties of modern engineering materials and explains the role of the materials selection process in product design, development, and manufacturing. Materials selection/design problems and case studies involving automotive and other commercial products are discussed. The role of environmental regulations, societal pressures and customer wants on the selection of alternate materials is discussed. (YR)
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 584 Lightweight Automotive Alloys 3 Credit Hours
This course introduces structure-processing-property relationships in the lightweight automotive alloys that are candidates for automotive applications such as aluminum, titanium, and magnesium. Metal matrix composite and intermetallic materials are also discussed. Emphasis will be placed on the processing and design of these materials in future automotive applications. (YR).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 586 Design & Mfg: Ltwt Auto Mat 3 Credit Hours
This course will address the design issues and manufacturing considerations for various lightweight automotive structural materials. Design issues will include stiffness, fatigue, vibrations, dent resistance, crush resistance, etc. Methods of producing lightweight automotive stuctures are discussed. Design for manufacturing, assembly, disassembly and recycling are emphasized. (YR).
Prerequisite(s): AENG 581 and AENG 587
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is , Automotive Systems Engineering

AENG 587 Automotive Manuf Processes 3 Credit Hours
Manufacturing processes, including casting, forging, forming, machining, molding, etc., are examined specifically in the context of their applications in the automotive industry. Quality control and techniques, process selection and methods are emphasized.
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if College is Engineering and Computer Science
Can enroll if Major is , Automotive Systems Engineering

AENG 589 Auto Assembly Systems 3 Credit Hours
This course deals with in-depth analysis of automotive assembly systems. Design, analysis and economics of manual and automatic assembly of automotive components are to be emphasized. It includes design of assembly stations for manual assembly; automatic assembly stations; design for assembly and disassembly; analysis of automatic feeding and orientation techniques of small parts; assembly of large parts; application of robotics in assembly; and economics of assembly for automotive systems as well as electronic systems.
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if College is Engineering and Computer Science
Can enroll if Major is , Automotive Systems Engineering

AENG 590 Selected Topics 1 to 3 Credit Hours
Individual or group study of an automotive systems engineering topic of contemporary interest.
Restriction(s):
Can enroll if Level is Graduate

AENG 591 Guided Study in Automotive Sys 1 to 3 Credit Hours
Individual or group study of an automotive systems engineering topic of contemporary interest.
Restriction(s):
Can enroll if Class is Graduate
Can enroll if College is Engineering and Computer Science

AENG 596 Internal Combustion Engines I 3 Credit Hours
Comparison of several forms of internal combustion engines including Otto and Diesel-type piston engines; performance parameters and testing; thermodynamic cycles and fuel-air cycles; combustion in SI and Diesel engines; charge formation and handling; ignition; elements of exhaust emissions. (Not available to students with ME 496 or equivalent background.) (YR).
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if College is Engineering and Computer Science
Can enroll if Major is Automotive Systems Engineering

AENG 650 Analysis and Design for Vehicle Crashworthiness 3 Credit Hours
This course aims to provide applied engineering knowledge on vehicle crash mechanics, design of structural components and load paths for crash energy management, definition of measurement metrics for the assessment of battery electric vehicle structures to protect vehicle occupants and energy storage systems, and on the use of nonlinear finite element technique for the simulation of crash structures. Prior knowledge of finite-element analysis is required to succeed in the course. (OC).
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if College is Engineering and Computer Science
Can enroll if Major is Automotive Systems Engineering

AENG 687 Adv Auto Mfg Processes 3 Credit Hours
This course deals with in-depth analysis of select manufacturing processes used for the fabrication and assembly of automotive vehicles. Modeling and simulation of selected classes of manufacturing processes using numerical methods; such as finite difference and finite element methods, will be studied. Process optimization approaches will be introduced and applied to selected processes.
Prerequisite(s): AENG 587
Restriction(s):
Can enroll if Class is Graduate
Can enroll if Level is Doctorate or Rackham or Graduate or

AENG 698 Capstone Proj(Case Stud/Dsn) 3 to 6 Credit Hours
Individual or team design or case study of interest to the students. Topics may be chosen from any of the areas of automotive engineering. The student (or the team) will submit a project report and give an oral presentation at the end of the second term. The project spans two terms. (Permission of advisor required before registration.)
Restriction(s):
Can enroll if Level is Rackham or Graduate
Can enroll if College is Engineering and Computer Science
Can enroll if Major is , Automotive Systems Engineering

AENG 699 Master's Thesis 3 to 6 Credit Hours
Research for master's thesis under the direction of a faculty member. (Permission of advisor required.)
Restriction(s):
Can enroll if Level is Rackham or Graduate
Can enroll if College is Engineering and Computer Science
Can enroll if Major is , Automotive Systems Engineering

*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally