

# AUTOMOTIVE ENGINEERING (AENG)

## **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

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):**

Can enroll if Class is Graduate

## **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):**

Can enroll if Class is Graduate

Can enroll if Level is Rackham or Graduate

## **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).

**Prerequisite(s):** ME 265

### **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 551 FEM in Auto Structure Design 3 Credit Hours**

This course is designed to introduce the applications of finite element method in automotive structure design. It includes specific design examples of vehicle NVH and durability with commercial pre-processor and FEA solver. The course also provides theoretical knowledge of FEA and vehicle design.

**Restriction(s):**

Can enroll if Class is Graduate

Can enroll if Level is Rackham or Graduate

Can enroll if Major is Automotive Systems Engineering

**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):**

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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):**

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**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 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 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):**

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**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

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**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 Doctorate or Rackham or Graduate 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):**

Can enroll if Class is Graduate

**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 structures are discussed. Design for manufacturing, assembly, disassembly and recycling are emphasized. (YR).

**Prerequisite(s):** AENG 581 and AENG 587

**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):**

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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 Doctorate or Rackham or Graduate 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.) (OC).

**Prerequisite(s):** ME 330 or ME 325

**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