

## **Certificate: Automotive Systems Engineering**

The automotive system of the twenty-first century is poised to advance at a rapid pace with greater emphasis on lightweight structures, high efficiency powertrains, intelligent control systems, lower emissions, robust design and manufacturing, as well as improved comfort and safety. The profession requires that engineers make connections among different areas of knowledge, integrating them in ways that benefit the automotive industry, society, and the environment. (12 credit hours)

### *Automotive Systems Engineering Certificate Area #1: Automotive Energy Systems*

#### **AENG 596 Internal Combustion Engines I**

##### **3 credits**

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.

#### **AENG 598 Energy Systems for Automotive Vehicles**

##### **3 credits**

This course will discuss the current or future energy systems for automotive vehicles. Topics include liquid and gaseous fuels, direct energy conversion systems and fuel cells. Characteristics of various energy systems are discussed with respect to their performance, cost reliability, and environmental concerns. Fuel cell analysis and design is covered in detail.

#### **ME 597 Internal Combustion Engines II**

##### **3 credits**

Fuel flow and air flow measurements and techniques; engine maps, fuel and ignition control and control strategies; combustion and burn rate considerations in engine design, intake and exhaust systems, emissions and control strategies, emission test procedures.

#### **ME 598 Engine Emissions**

##### **3 credits**

This course introduces students to the fundamentals of engine exhaust emissions, including their formation mechanisms and abatement techniques. The students will be familiarized with the present emission control technologies and future challenges. The topics covered include: engine emissions and air pollution, review of emission regulations, catalyst fundamentals, catalyst-based engine after treatment techniques for gasoline, diesel, and lean-burn engines, discussion of cold-start emission control and breakthrough catalytic technologies.

Updated 3/05

\*Other courses are available for all certificate topic areas with approval of department advisor.

**ECE 546      Electric Vehicles**

**3 credits**

Fundamental concepts and specifications; energy sources, motors for electric vehicles, controllers and power electronics; engineering impact of electric vehicles.

*Automotive Systems Engineering Certificate Area #2: Automotive Materials*

**AENG 581      Materials Selection in Automotive Design**

**3 credits**

This course develops the 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 in the selection of alternate materials is discussed.

**AENG 584      Lightweight Automotive Alloys**

**3 credits**

This course introduces structure-processing-property relationships in 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.

**AENG 585      Ceramics for Automotive Applications**

**3 credits**

This course will present physical, thermal and mechanical properties of structural ceramics, ceramic coatings and ceramic matrix composites. Design and processing issues for these materials are emphasized. Automotive applications of ceramics are discussed. Thermoelectric and other propulsion materials are also discussed.

**AENG 586      Design and Manufacturing: Lightweight Automotive Materials**

**3 credits**

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.

**ME 584          Mechanical Behavior of Polymers**

**3 credits**

Mechanical behavior of polymers and ceramics are considered in relation to their structures, processing and applications. Emphasis is given to their deformation, fatigue and fracture characteristics. Strengthening mechanisms for both materials are discussed.

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**ME 587 Automotive Composites**

**3 credits**

The emphasis in this course is on automotive composites, such as SMC, SRIM and RTM. In addition to properties and applications of these materials, this course covers manufacturing processes, design considerations, test methods and quality control techniques used for automotive composites. The use of continuous fiber composites in automotive applications, such as leaf springs, drive shafts and energy absorbing structures are also discussed.

*Automotive Systems Engineering Certificate Area #3: Vehicle Design*

**AENG 545 Vehicle Ergonomics I**

**3 credits**

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.

**AENG 546 Vehicle Ergonomics II**

**3 credits**

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 lighting and driver vision systems, models to predict and evaluate field of view, target detection, disability and discomfort glare, legibility, etc.

**AENG 550 Design of Automotive Chassis and Body Systems**

**3 credits**

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.

**AENG 565 Vehicle Acoustic Interior System Design**

**3 credits**

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This course presents the technology and methodology of vehicle acoustic interior system design. Design of five main interior subsystems, namely dash panel, floor panel, roof, door aperture, and trunk, as well as the whole vehicle will be covered. Both analytical and experimental methods for transmission loss analysis and validation testing will be discussed in detail. Statistical Energy Analysis (SEA) will be used to calculate the power distribution within the subsystems. Determination of damping loss factors and coupling loss factors will be covered. Acoustical material property and material testing will be discussed. Case studies of optimizing acoustic packages of subsystem and the whole vehicle will be presented. The course also includes computer simulation using commercial software and experimental demonstrations.

**ME 543      Vehicle Dynamics**

**3 credits**

A treatment of the response, ride and maneuvering of motor vehicles. Road loads, suspension systems, mechanics of pneumatic tires.

**ME 558      Fracture & Fatigue Considerations in Design**

**3 credits**

A comprehensive review of fracture and fatigue processes in engineering materials with emphasis on mechanisms instead of failure. Design methodology based upon fracture toughness and fatigue crack propagation is presented.

**IMSE 593      Vehicle Package Engineering**

**3 credits**

Vehicle package specifications related to exterior and interior design reference points, dimensions and curb loadings. Benchmarking package studies, ergonomic tools and design practices used in the automobile industry. Driver positioning considerations, seat height, heel points, hip points, steering wheel location, seat pan and back angles. Pedal design issues, tear shaft positioning. Visibility of instrument panel space. Armrest and console design considerations. Principles and considerations in selecting and location types and characteristics of controls and displays on instrument panels, doors, consoles, and headers. Engine compartment packaging issues. Perception of interior spaciousness and visibility of the road over cowl and hood.

*Automotive Systems Engineering Certificate Area #4: Automotive Electronics & Controls*

**AENG 505    Digital Systems and Microprocessors**

**3 credits**

Introduction to modern digital computer logic. Numbers and coding systems, Boolean algebra with applications to logic systems, combination and sequential logic design, examples of digital logic circuits, simple machine language programming; macro processor-programming, input/output, interrupts, and system design.

**AENG 510    Vehicle Electronics I**

**3 credits**

Semiconductor diodes, junction transistors, FETS, rectifiers and power supplies, small signal amplifiers, biasing considerations, gain-bandwidth limitations, circuits models, automotive applications and case studies.

**ECE 515      Vehicle Electronics II**

**3 credits**

CD ignition, high speed switching, motor drive control, inverters, PWM controllers, active filters, signal conditioners, power electronics, voltage regulators. Selected topics, ASICS, RF amplifiers, battery chargers, solar cells.

**ECE 531      Intelligent Vehicle Systems**

**3 credits**

The course covers important technologies relevant to intelligent vehicle systems including: systems architecture, in-vehicle electronic sensors, traffic modeling and simulation. Students will design and implement algorithms and simulate driver-highway interactions.

**ECE 532      Automotive Sensors and Actuators**

**3 credits**

Study of automotive sensory requirements, types of sensors, available sensors and future needs. Study of functions and types of actuators in automotive systems. Dynamic models of sensors and actuators. Integrated smart sensors and actuators. Term project.

**ECE 565      Digital Control Systems**

**3 credits**

Mathematical representation of digital control systems; z-transform and differential equations, classical and state space methods of analysis and design, direct digital control of industrial processes.

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