

# PROGRAMS OFFERED BY THE JAMES AND PATRICIA ANDERSON COLLEGE OF ENGINEERING

## Electric-drive Vehicle Engineering

The Electric-drive Vehicle Engineering (EVE) programs are interdisciplinary, involving faculty from the Departments of Chemical Engineering and Materials Science, Electrical and Computer Engineering, Industrial and Systems Engineering, and Mechanical Engineering. These programs were established in 2009, and developed in close cooperation with governmental agencies, industry, and the U.S. Department of Energy. The mission of the EVE program is to educate and prepare the technical and scientific workforce for the emerging electric-drive vehicle industry; to promote and mobilize/align available resources to develop interdisciplinary research programs; and to disseminate technical information and raise public awareness on the emerging electric-drive vehicle technology.

Programs offered:

- Electric-drive Vehicle Engineering (M.S.) (<http://bulletins.wayne.edu/graduate/college-engineering/programs-offered/electric-drive-vehicle-engineering-ms/>)
- Electric-drive Vehicle Engineering (Graduate Certificate) (<http://bulletins.wayne.edu/graduate/college-engineering/programs-offered/electric-drive-vehicle-engineering-graduate-certificate/>)

## Mobility

People require mobility, because it empowers them to conquer the distance that separates their homes from the locations where they study, work, shop, seek medical treatment, do business, or visit friends. In the meanwhile, Wayne State University is demonstrating a commitment to improve quality of life for individuals and communities through excellence in mobility-related research, teaching, and service. This certificate program is the first of its kind in Michigan, focusing on mechanisms known as mobility, which is the ability to meet the needs of society to move freely, gain access, communicate, commute, and establish connectivity with the advanced mobility technologies today or in the future.

Programs offered:

- Mobility (Graduate Certificate) (<http://bulletins.wayne.edu/graduate/college-engineering/programs-offered/mobility-graduate-certificate/>)

## Sustainable Engineering

Students will learn the fundamentals of sustainable engineering, extend their knowledge in the application of sustainable engineering principles, and maintain their technical competitiveness by broadening their sustainability expertise.

Programs offered:

- Sustainable Engineering (Graduate Certificate) (<http://bulletins.wayne.edu/graduate/college-engineering/programs-offered/sustainable-engineering-graduate-certificate/>)

## Alternative Engineering Technology

### AET 5110 Fundamental Fuel Cell Systems Cr. 4

Introduce various types of fuel cells, materials properties of electrodes and polymeric membranes, and electrochemical mechanisms. Reforming of various types of hydrocarbon fuel to hydrogen, and reforming technology. Offered Fall.

**Restriction(s):** Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

**Equivalent:** CHE 5110, EVE 5130, ME 5110

### AET 5120 Fundamentals of Alternative Energy Technology Cr. 3

Provide an overview/review of thermodynamics. Cover advanced thermodynamics topics of energy and chemical reacting systems. Introduce general areas of alternative energy technology, engineering analysis and design of solar angle/time/radiation, solar heating, solar photovoltaic, and wind power. Offered Winter.

**Restriction(s):** Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

### AET 5250 Alternative Energy Technology System and Design Cr. 4

Topics such as: batteries, flywheels, capacitors, motors, controllers, power management, heat dissipation, systems containment, manufacturing processes, systems dynamics. Lectures and design projects. Offered Fall.

**Prerequisites:** AET 5120

**Restriction(s):** Enrollment is limited to Graduate or Undergraduate level students; enrollment limited to students in the College of Engineering.

### AET 5310 Fundamentals of Battery Systems for Electric and Hybrid Vehicles Cr. 4

Fundamental electrochemistry and engineering aspects for electric propulsion batteries, including lead acid, nickel metal hydride, and lithium ion technologies. Offered Intermittently.

**Equivalent:** CHE 5120, EVE 5120, ME 5215

### AET 5410 Energy, Emissions, Environment (E3) Design Cr. 3

Provides students the tools to uncover the relation between energy consumption and energy generation and optimize processes to take most advantage of low emitting energy options. Exposes students to design tools and methodologies from a diverse group of sources including US EPA, DOE, EIA, and the latest in emerging research. Offered Fall.

**Equivalent:** CE 5410, STE 5410

### AET 5600 Integrated Product Development Cr. 3

Product development process: product architectures, concurrent engineering. Integration of marketing, design, and manufacturing functions for product development. How such processes are designed to account for various manufacturing and other business constraints to ensure that customer needs are met. Offered Fall.

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**Equivalent:** EVE 5600, IE 6405

### AET 5800 Charging Infrastructures for Electric Vehicles Cr. 3

This course provides the students with technical knowledge into concept development, product design, and manufacturing of charging infrastructures for electric vehicles. Students will also get to explore recent developments and future plans on global EV charging technologies. Offered Spring/Summer.

**AET 5810 Power Management for Advanced Energy Storage Systems and its Applications Cr. 4**

Operating principles and modeling of energy storage techniques; control and power management, power electronic converters, electric machines, and power systems; power management strategies of hybrid energy systems including HEV and alternative energy systems. Offered Fall, Winter.

**Prerequisites:** ECE 4470

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**Equivalent:** EVE 5810

**AET 7990 Directed Study Cr. 1-4**

Independent projects on subjects of interest in advanced energy technology. Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Repeatable for 4 Credits**

**AET 7991 Internship in Industry Cr. 1-4**

Industrial internship in alternative energy technology. Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**AET 8996 Directed Research Cr. 1-4**

Independent research projects. Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**AET 8999 Master's Thesis Research and Direction Cr. 1-8**

Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Repeatable for 8 Credits**

## Electric-drive Vehicle Engineering

**EVE 5110 Fundamentals of Electric-drive Vehicle Engineering Cr. 3**

Cover engineering fundamentals and basic design of electric-drive vehicle powertrains by understanding and analyzing the relevant multi-physics and applying the associated equations and simple models. Offered Fall.

**Restriction(s):** Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

**Equivalent:** ME 5115

**EVE 5115 Fundamentals of Electric-drive Vehicle Modeling Cr. 4**

Covers engineering and modeling fundamentals and basic design of electric-drive vehicle powertrains by understanding and analyzing the relevant multi-physics and applying the associated equations and simple models. MATLAB script m-file is required for all assignments. Offered Fall.

**Restriction(s):** Enrollment limited to students with a class of Senior; enrollment is limited to Graduate or Undergraduate level students; enrollment limited to students in the College of Engineering.

**Equivalent:** ME 5115

**EVE 5120 Fundamentals of Battery Systems for Electric and Hybrid Vehicles Cr. 4**

Fundamental electrochemistry and engineering aspects for electric propulsion batteries, including lead acid, nickel metal hydride, and lithium ion technologies. Offered Intermittently.

**Equivalent:** AET 5310, CHE 5120, ME 5215

**EVE 5130 Fundamental Fuel Cell Systems Cr. 4**

Introduce various types of fuel cells, materials properties of electrodes and polymeric membranes, and electrochemical mechanisms. Reforming of various types of hydrocarbon fuel to hydrogen, and reforming technology. Offered Fall.

**Restriction(s):** Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

**Equivalent:** AET 5110, CHE 5110, ME 5110

**EVE 5410 Power Electronics and Control Cr. 3**

Control of electrical energy using solid state devices, diodes, thyristors, IGBTs, and new WBG devices; mathematical analysis of circuits containing these devices; power converters and control; applications of power converters in alternative energy systems and electric vehicles. Offered Winter.

**Prerequisites:** ECE 4330 with a minimum grade of C-

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**Equivalent:** ECE 5410

**EVE 5450 Control and Optimization for Integrated Electric-drive Vehicle Systems Cr. 4**

Understanding of how to control a system using modern control theory, how to optimize the performance of a system using various optimization technologies, and how to apply the control and optimization technologies to EDV systems. Offered Winter.

**Prerequisite:** EVE 5430

**Restriction(s):** Enrollment limited to students with a class of Applicant Masters, Candidate Masters, Unranked Grad, Graduate Certificate or Senior; enrollment limited to students in the College of Engineering.

**EVE 5600 Integrated Product Development Cr. 3**

Product development process: product architectures, concurrent engineering. Integration of marketing, design, and manufacturing functions for product development. How such processes are designed to account for various manufacturing and other business constraints to ensure that customer needs are met. Offered Fall.

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**Equivalent:** AET 5600, IE 6405

**EVE 5700 Electric-drive Vehicle Capstone Design Cr. 4**

The class is divided into teams competing on same or similar Electric-Drive Vehicle (EDV) system design project on contemporary EDV issues with relevant vehicle powertrain and energy system contents, involving energy, environmental, safety and economic analyses. Offered Winter.

**Prerequisites:** EVE 5110 and (EVE 5310 or EVE 5430)

**Restriction(s):** Enrollment limited to students with a class of Applicant Masters, Candidate Masters, Unranked Grad, Graduate Certificate or Senior; enrollment limited to students in the College of Engineering.

**EVE 5810 Power Management for Advanced Energy Storage Systems and its Applications Cr. 4**

Operating principles and modeling of energy storage techniques; control and power management, power electronic converters, electric machines, and power systems; power management strategies of hybrid energy systems including HEV and alternative energy systems. Offered Fall, Winter.

**Prerequisites:** ECE 4470

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**Equivalent:** AET 5810

**EVE 7300 Advanced Battery Systems for Electric-drive Vehicles Cr. 3**

Aims to familiarize students with advanced battery technologies and their applications in hybrid and electric vehicles. Contents include: a descriptive overview of energy sources and conversions, HEV/PHEV/ EV technology, hybrid powertrain configuration and components, in-vehicle energy storage systems, electrochemistry fundamentals, battery power and capacity/energy, battery system design (cell, module and pack), Battery Management System (BMS), cell monitoring and balancing, thermal management, on-board diagnostics, battery charging schemes and systems. Offered Fall.

**Prerequisite:** EVE 5120 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Equivalent:** ET 7300

**EVE 7310 Electric-drive Vehicle Simulation and Control Cr. 4**

Cover modeling, simulation and control of electric-drive vehicle powertrain including plant modeling, controls model development, and in-the-loop controls testing. Proficiency in MATLAB/Simulink is required. Offered Winter.

**Prerequisites:** EVE 5115 with a minimum grade of B- or ME 5115 with a minimum grade of B-

**Restriction(s):** Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

**Equivalent:** ME 7315

**EVE 7990 Directed Study Cr. 1-4**

Independent projects on subjects of interest in electric-drive vehicle engineering. Offered Every Term.

**Restriction(s):** Enrollment limited to students with a class of Applicant Masters, Candidate Masters, Unranked Grad or Graduate Certificate; enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

**Repeatable for 4 Credits**

**EVE 7991 Internship in Industry Cr. 1**

Industrial internship in automotive vehicle-related technologies, particularly in vehicle electrification, and related components and/or systems. Internships are off-campus experiential learning activities designed to provide students with opportunities to make connections between the theory and practice of academic study and the practical application of that study in a professional work environment. Internships are completed under the guidance of an on-site supervisor and a faculty sponsor, who in combination with the student will create a framework for learning and reflection. Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Repeatable for 3 Credits**

**EVE 8999 Master's Thesis Research and Direction Cr. 1-8**

Offered Every Term.

**Restriction(s):** Enrollment limited to students with a class of Applicant Masters, Candidate Masters, Unranked Grad or Graduate Certificate; enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

**Repeatable for 8 Credits**

## Engineering: Special Topics

**EGR 5655 Innovation & Entrepreneurship I Cr. 3**

Provides education and hands-on experience in innovation and entrepreneurship applied to enterprise, product and service design and delivery. The first of a 2-semester sequence, this course teaches methods and tools to find, formulate, and develop engineering innovation and entrepreneurship, leading to practical, relevant, and productive new commercial and social enterprises. Offered Fall.

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**EGR 5656 Innovation & Entrepreneurship II Cr. 3**

Provides education and hands-on experience in innovation and entrepreneurship applied to enterprise, product and service design and delivery. This course is the second of a 2-semester sequence. This course teaches methods and tools to find, formulate and develop engineering innovation and entrepreneurship, leading to practical, relevant, and productive new commercial and social enterprises. Offered Winter.

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**EGR 5657 Innovation & Entrepreneurship Lab Cr. 1**

Provides hands-on application of Lean LaunchPad principles in innovation and entrepreneurship applied to enterprise, product and service and delivery. Offered Every Term.

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**Repeatable for 2 Credits**

**EGR 5658 Global Collaborative Projects Involving Sustainability, Innovation and Cultural Diversity Cr. 3**

Participate in an authentic, global project experience that replicates how you will work in your career. This course, is designed for senior and graduate engineering students from diverse backgrounds. It aims to foster global collaboration, emphasizing sustainability, innovation, and building cross-cultural awareness and diversity. Students will engage in collaborative engineering projects, case studies, presentations, and discussions while gaining insights into different cultures, sustainable engineering practices, innovation, and global sustainability challenges. Offered Spring/Summer.

**EGR 5990 Competition Team Cr. 2**

This course is based on the students' contribution to a team participating in reputed regional/national/international competitions. Participation in the competition gives students a unique, multifaceted learning opportunity entirely led and run by students under the supervision of faculty member. Project teams collaboratively solve the complex engineering problems while gaining real-world experience. Participation in the competition provides students with hands-on laboratory learning experience and gives opportunities to hone leadership and professional skills. The faculty advisor is expected to provide technical and administrative support to the team and the overall program. Offered Every Term.

**Repeatable for 4 Credits**

**EGR 5995 Special Topics in Engineering Cr. 1-4**

State of the art research, development and practice topics from across the fields of engineering; emphasis on interdisciplinary topics. Offered Every Term.

**Restriction(s):** Enrollment limited to students in the College of Engineering.

**Repeatable for 4 Credits**

## Sustainable Engineering

**STE 5410 Energy, Emissions, Environment (E3) Design Cr. 3**

Provides students the tools to uncover the relation between energy consumption and energy generation and optimize processes to take most advantage of low emitting energy options. Exposes students to design tools and methodologies from a diverse group of sources including US EPA, DOE, EIA, and the latest in emerging research. Offered Fall.

**Equivalent:** AET 5410, CE 5410

**STE 6270 Sustainability Assessment and Management Cr. 3**

Sustainability assessment and management for engineering design and development; theoretical, regulatory, and practical implications; Detroit and global applications. Offered Yearly.

**Equivalent:** CE 6270