Course Syllabus

AUTO-2920 - Introduction to Electric Vehicle Propulsion Systems

3.00 credits

Course Fee: $105.00

Prerequisite: None

This course provides practical training in the theory and basic design aspects of battery powered electric vehicle propulsion systems. Primary subjects to be covered will include rationale for EV, safety, battery technologies, basic battery testing, electric machine (motor) types, electric machine operation, power management, power inverters, DC to DC converters, accessory systems, and potential future technologies. (4 contact hours) South Campus.

Macomb Community College

Official Course Syllabus

Outcomes and Objectives

OUTCOME 1: Upon completion of this course, students will be able to explain the global environmental and social impact of the internal combustion engine, compare technologies, and defend why electric propulsion systems represent a practical short term replacement.

OBJECTIVES: While participating in this unit, students will:

1. Compare long term implications of using carbon-based and non-carbon-based energy sources.
2. Complete a personal / household carbon footprint assessment.
3. Assess beliefs and motivation regarding personal / household carbon footprint reduction.
4. Compare transportation technologies needed to reduce the carbon footprint.

OUTCOME: 2 Upon completion of this course, students will be able to practice recommended safety procedures relating to diagnosis and servicing of EV / HEV.

OBJECTIVES: While participating in this unit, students will:

1. Correctly use appropriate personal protective equipment (PPE).
2. Make comparisons and recommendations for different classes of electrical-safety gloves.
3. Make comparisons between the capabilities of different category (CAT) electrical meters.
4. Safely de-power an electric vehicle and/or a hybrid electric vehicle.

OUTCOME 3: Upon completion of this course, students will be able to compare different manufacturers design strategies associated with the total battery pack and related components integration into the total vehicular power delivery, safety, and communications systems.

OBJECTIVES: While participating in this unit, students will:

1. Compare common types of high voltage interlock and safety systems.
2. Describe the operation of the battery-pack contactor system.

3. Compare characteristics of active and passive thermal management systems.
4. Describe the operation of current and voltage sensing devices and their role in energy management.

OUTCOME 4: Upon completion of this course, students will be able to compare the theory, operation, construction, design features, unique characteristics, and servicing protocol of electric machines currently being used in EV / HEV applications. (Including, DC, AC Induction, Permanent Magnet, and Switched Reluctor designs.)

OBJECTIVES: While participating in this unit, students will:

1. Build and test brush and brushless motors from scientific experimenter's kits.
2. Evaluate strengths and weaknesses of electric machines used in EV / HEV applications.
3. Compare common speed (rpm) and position sensors used with electric machines.
4. Compare common thermal management systems used in EV / HEV motor applications.

OUTCOME 5: Upon completion of this course, students will be able to compare different manufacturers design approach relating to operation, construction, architecture, and servicing protocol of power inverters used in EV application.

OBJECTIVES: While participating in this unit, students will:

1. Compare the limitations of common switching transistors used in EV power inverters.
2. Compare types of current sensors used in power inverters.
3. Evaluate waveforms strategies used to control electric machine torque and speed.
4. Compare thermal management strategies used by various manufacturers for power inverters.

OUTCOME 6: Upon completion of this course, students will be able to compare different manufacturers design approach relating to operation, construction, architecture, and servicing protocol of DC to DC converters used in EV application.

OBJECTIVES: While participating in this unit, students will:

1. Describe the basic components and operating cycles of DC-DC converters.
2. Compare advantages and disadvantages to common DC to DC converter locations.
3. Compare operational characteristics of step-down (buck) and step-up (boost) converters.
4. Compare thermal management strategies used by various manufacturers for DC to DC converters.

OUTCOME 7: Upon completion of this course, students will be able to compare different manufacturers design approach relating to operation, construction, architecture, and servicing protocol of vehicle accessory systems used in EV application.

OBJECTIVES: While participating in this unit, students will:

1. Compare manufacturers' strategies relating to transition between regenerative and hydraulic braking systems.
2. Compare manufacturers' strategies relating to vehicular HVAC systems operation and service protocol on EV /HEV.

3. Compare basic systems operation between electric steering assist and hydraulic steering assist.
4. Compare various manufacturers' strategies relating to service protocol for electric steering assist.

OUTCOME 8: Upon completion of this course, students will be able to discuss societal options relating to alternative vehicle propulsion, compare technologies that may be utilized in the future, and defend their position on the most likely future propulsion technology.

OBJECTIVES: While participating in this unit, students will:

1. Discuss the advantages and disadvantages of fuel cells as a viable propulsion technology.
2. Evaluate alternative energy storage and delivery technologies currently being considered for future vehicle propulsion.

Common Degree Outcomes

X 1. The graduate can integrate the knowledge and technological skills necessary to be a successful learner.
X 2. The graduate can demonstrate how to think competently.
X 3. The graduate can demonstrate how to employ mathematical knowledge.
4. The graduate can demonstrate how to communicate competently.
X 5. The graduate is sensitive to issues relating to a diverse, global society.

Course Assessments

Course assessments include administration of a pre-test and a post-test to evaluate course effectiveness. Laboratory performance and written test scores will be utilized to assess the degree to which course objective are being met.

Course Content Outline

I. The Need for EV
   A. Environment
   B. Emissions
   C. Society
   D. Energy Costs
   E. Politics

II. EV Safety
   A. HV Concerns
   B. Cable ID
   C. Proper Tools
   D. Personal Protection Equipment

E. Service Disconnect
F. Environment
G. Battery Hazards

III. Introduction to Battery Chemistry
A. Battery Theory
B. Types
1. Flooded Lead/Acid Battery Technology
2. AGM Battery Technology
3. Nickel-Metal Hydride battery technology
4. Lithium-Ion Battery Technology
C. History
D. Construction
E. Chemical energy to electrical energy
F. Safety precautions
G. Ratings
H. Comparison between Battery Technologies
I. Testing and Servicing
J. Environmental Concerns
K. Cylindrical vs. Prismatic Design
L. Prismatic Design
M. What's New – Potential Future Battery Technologies

IV. Battery Pack Integration with Vehicle Systems
A. Energy Management
B. Contractor Circuit Operation
C. High Voltage Circuitry
D. Thermal Management
E. State of Charge
F. Communications/Network
G. DTCs/OBD/Diagnostic Overview

V. Electric Machines
A. Potential EV applications
B. Advantages/Disadvantages of EM's in Electric Vehicle
C. Magneto-Motive Force and Voltage Induction
D. Types of Electric Machines Used in EV Applications
1. DC Motors
2. AD Induction Asynchronous Motors
3. Permanent Magnet Synchronous Motor
4. Switched Reluctance Motors
E. Components
F. Operation
G. Pros/Cons of Various Motor technologies
H. Thermal Management
I. Motor Position Sensing
J. Testing
K. Service Limitations

VI. Power Inverter/Electronic Motor Controls
A. Definition
B. Operation
C. Thermal Management
D. Electronic Feedback
E. Integration into Vehicle Systems/Communications
F. System Diagnostic Overview

VII. DC to DC Converters
- A. Definition
- B. Operation
- C. Location
- D. Components
- E. Thermal Management
- F. Integration into Vehicle Systems/Communications
- G. System diagnostic Overview

VIII. Vehicle Systems
- A. HVAC
- B. Regenerative Braking
- C. Suspension and Steering

IX. Introduction to Advancing Technology (Overview)
- A. Hydrogen/Fuel Cells
- B. Ultra Capacitors
- C. Hydraulic Propulsion

Department Contacts

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09/20/11 – Experimental Course Reference Number 11-12-EX02