Michigan Alliance for Greater Mobility Advancement

Course Title: Electrified Propulsion Systems Lab

Course Length: 2.5 days

Time Online: N/A

Time in Class: 5 hours

Time in Lab: 15 hours

Class Size: Minimum 6 / Maximum 20

Price Per Student: $2,310.00*

Location: Company Site

Course Description:
This course is the lab component to the course "Electrified Propulsion Systems", and as such, Electrified Propulsion Systems is a pre-requisite for this course. Through hands-on experimentation, this course reinforces the concepts taught in Electrified Propulsion Systems, thus significantly improving student knowledge and retention.

The hands-on activities are delivered at the customers location using the Michigan Tech Mobile Lab. The Mobile Lab includes a heated and air-conditioned classroom, lab benches for component level experimentation and teardowns, two fully functional propulsion system testcells for testing electric drive motors and power electronics, battery packs, and engines. The test properties are controlled with embedded control systems with rapid prototyping capability and the testcells utilize AC dynamometers, emissions analysis instrumentation, combustion analysis instrumentation, and a wide range of measurements for voltage, current, torque, mass flow rates, etc. The Mobile Lab also includes a vehicle chassis dynamometer and a fleet of up to 30 vehicles including convention, hybrid electric, and full Battery Electric. Vehicles are instrumented and used for data collection and analysis on the chassis dynamometer and local real-world drive cycles near the customers location. Approximately 5 hours of classroom time (delivered from the Mobile Lab) is spent reviewing concepts taught in Electrified Propulsion Systems prior to each lab activity, and for the students to take their final knowledge assessment (exam) at the end of the course.

This course is well suited to engineers, managers, technicians, and other staff including those with primary roles in marketing, service, etc.

Lab Projects Description:

1. *Inspection & Discussion of Electrified Vehicles & Components.* A wide range of electrified vehicles are provided. Vehicles range from simple P0 / P1 architecture through powersplit hybrids and BEV's. Students identify electrification specific components and features while identifying architectures and energy flow.
2. *Assessing Driving Characteristics.* Students execute specific driving maneuvers and evaluate the impact that the different electrification architectures have on those driving maneuvers.

* Price based on minimum enrollment, subject to change

3. *Hybrid Drive Unit Teardown & Analysis.* Students disassemble multiple drive units including front wheel drive and rear wheel drive configurations. Students must not only identify major components, but conduct an engineering analysis along the way.
4. *Electrified Propulsion System Testing.* A parallel hybrid propulsion system is tested in the testcell, and the performance and efficiency of the system is evaluated at several conditions representing different vehicle speed / load points.
5. *Systems Level Effects & Energy Consumption.* Students log vehicle data through the CAN bus over a city and highway drive cycle. The data is analyzed to determine gasoline utilization, electric energy utilization, energy consumption in miles per gallon and miles per gallon equivalent, and to solidify their understanding of how the propulsion system operates, and how various architectures impact operational characteristics.
6. *Systems Level Effects & Energy Consumption with CAV.* Students repeat Lab 5, but with changes that are made possible with Connected and Autonomous Vehicle technologies. Data is analyzed and the improvements due to CAV features are quantified.

Course Learning Objectives:

- This course includes all the same learning objectives as Electrified Propulsion Systems
- The learning objectives in Electrified Propulsion Systems are reinforced through actual hands-on experimentation and data analysis using sophisticated state of the art test cells and a fleet of modern vehicles.

Course Content / Syllabus:

Day 1

- Course Overview (Learning Objectives, Introductions, Outline, etc.)
- In-Class Review of Electrified Propulsion Systems
- Lab Project 1; Inspection & Discussion of Electrified Vehicles & Components
- Lab Project 2; Assessing Driving Characteristics
- Lab Project 3; Hybrid Drive Unit Teardown & Analysis
- Lab Project 4; Electrified Propulsion System Testing

Day 2

- Continued In-Class Review of Electrified Propulsion Systems
- Lab Project 5; System Level Effects & Energy Consumption
- Lab Project 6; System Level Effects & Energy Consumption w/ CAV
- Student Assessment (Exam). This is graded.
- Students turn in written summary of each lab project including answers to questions on worksheets. This is graded.
- Course Evaluations