Course Title: Automotive 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: Employer Site

Course Description:

This course is the lab component to the course "Automotive Systems", and as such, Automotive Systems is a pre-requisite for this course. Through hands-on experimentation, this course reinforces the concepts taught in Automotive 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 automotive 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. Automobiles Past, Present, and Future. An original 1930's era vehicle and multiple current production vehicles will be critically examined from the perspective of human factors, aerodynamics, powertrain architecture, safety, and others. Groups will summarize

*Price based on minimum enrollment, subject to change

and discuss what they found to be similar and different, how they think the end-customer drives automotive development decisions, and what they think an automobile of the future will be.

2. Application of systems, sub-systems, & components. Conventional and electrified vehicles will be placed on the ground and in the air, allowing participants to walk under, sit in, and examine the underhood areas of each. Participants will work in groups to identify, the functions and unique attributes of the major systems on the vehicles.
3. Measuring Propulsion System Efficiency and Performance. Several experiments will be run on the major sub-systems of an automotive propulsion system including: an Internal Combustion Engine, an Electric propulsion motor, and a battery pack in a dynamometer test cell. Groups will compute various performance metrics and energy efficiency, and relate their measurements and calculations to the concepts covered in the Automotive Systems course.
4. Human Factors. Participants will perform various tasks in several vehicles with differing levels of human to machine sophistication while their level of distraction is qualified. Participants will examine and discuss how the various Human / Machine interfaces have been designed relative to typical, and non-typical human abilities. Additionally, participants will evaluate blind spots in both LD automobiles and an 18-wheeler semi-truck, and examine how current advances in connectivity and autonomy are mitigating blind spot risk.
5. Road Load Losses. Participants will collect data following the SAE procedure for coast down testing, then compute the drag and rolling resistance coefficients, and losses. The experiments will be repeated with changes made to the vehicles that affect the drag and rolling resistance, and quantify how much these factors have been affected.
6. Vehicle Dynamics. Participants will experimentally determine the center of gravity of a vehicle, then quantify how changes to the center of gravity impact the handling performance of the vehicle, in particular understeer / oversteer.
7. Vehicle NVH. Participants will quantify how several vehicle design variables impact cabin noise and seat track vibration.
8. Safety Systems. Participants will identify and explain several key safety systems and features, and will observe a demonstration of an airbag deployment.
9. Controls, Diagnostics, & Cyber Security. Participants will communicate with the vehicle by sending, receiving, and interpret messages using the vehicles CAN bus.

Course Learning Objectives

- This course includes all the same learning objectives as Automotive Systems
- The learning objectives in Automotive 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 Automotive Systems Part 1
- Lab Project 1; Automobiles Past, Present, and Future

- In-Class Review of Automotive Systems Part 2
- Lab Project 2; Application of Systems, Sub-Systems, and Components
- Lab Project 3; Measuring Propulsion System Efficiency & Performance

Day 2

- Continuation of Lab Project 3; Measuring Propulsion System Efficiency & Performance
- Lab Project 4; Human Factors
- Lab Project 5; Road Load Losses
- Lab Project 6; Vehicle Dynamics
- In-Class Review of Automotive Systems Part 3

Day 3

- Lab Project 7; Vehicle NVH
- Lab Project 8; Safety Systems
- Lab Project 9; Controls, Diagnostics, & Cyber Security
- 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