



Course Title: Advanced Vehicle Dynamics for Passenger Cars and Light Trucks

Course Length: 3 days, in-person

Time in Class per day (hours): 8 hours of in-person instruction

Delivery Options: Company site or at provider

Class Size: Minimum 8 / Maximum 25

Price Per Student: \$2,545.00

Location: Oakland County *or* Company Site

Course Description:

This interactive seminar will take you beyond the basics of passenger car and light truck vehicle dynamics by applying advanced theory, physical tests and CAE to the assessment of ride, braking, steering and handling performance. Governing state-space equations with transfer functions for primary ride and open loop handling will be developed & analyzed. Building on the analysis of the state space equations, common physical tests and their corresponding CAE solutions for steady state and transient vehicle events will be presented. The "state-of-the-art" of vehicle dynamics CAE will be discussed. Common lab and vehicle tests and corresponding metrics used to assess chassis system and vehicle performance will be discussed in great detail. Hands-on workshops using CARSIM™ vehicle dynamics simulation software will help reinforce the material. Significant time will also be dedicated to the use of design of experiments (DOE) as a tool to assist in the analysis and optimization of chassis systems for multiple vehicle responses.

Course Learning Objectives:

Upon completion of this course participants will be able to:

- Apply vehicle dynamics theory to practical evaluation and measurement
- Use governing state space equations and transfer functions to determine the effect of key parameters on primary ride and open loop handling
- Describe the current "state-of-the-art" of vehicle dynamics CAE
- Articulate various types of vehicle dynamics models
- Recognize kinematics and compliance (K&C) lab tests commonly used to quantify chassis system performance
- Identify and evaluate important K&C metrics used in vehicle dynamics development
- Identify and utilize important vehicle tests commonly used in industry to evaluate ride, steering and handling performance
- Relate chassis system characteristics to vehicle dynamic performance
- Utilize vehicle dynamics CAE software for the simulation of common physical lab and vehicle tests



- Apply design-of-experiments (DOE) to vehicle dynamics development

Course Content/Syllabus:

Day 1:

- Modeling Primary Ride Dynamics
 - 4-degree of freedom (DOF) primary ride model
 - 2-DOF primary ride model
- Modeling Vehicle Handling Dynamics
 - Developing the cornering compliance model
 - Developing the transfer function
- Introduction to Vehicle Dynamics CAE
 - Types of models
 - Strengths/Limitations
 - Commercial software packages
- Measurement and Simulation of Suspension Kinematics and Compliance (K&C)
 - Objectives of the K&C test
 - Definitions
 - Measurement equipment
 - Common tests
 - Simulation of the K&C test
- Measurement and Simulation of Primary Ride
 - Primary vs. Secondary Ride
 - Physical measurements
 - Common primary ride metrics
 - Olley Criteria for primary ride
 - Primary ride simulation
- CarSim™ Exercise - Primary Ride Simulation

Day 2:

- Measurement and Simulation of Acceleration and Braking
 - Steady state acceleration test and metrics
 - Steady state braking test and metrics
 - Simulation of steady state acceleration and braking
- Measurement and Simulation of Steering
 - On-center steering test and metrics
 - Low-g swept steer test and metrics
 - Simulation of steering tests
- CarSim™ Exercise - Steering
- Measurement and Simulation of Open Loop Handling



- Definition of open loop
- Steady state open loop tests -- High-g swept steer
- Transient open loop tests -- Step steer; Brake/throttle release in a turn; Fishhook; Sine with dwell
- Simulation of open loop handling tests
- CarSim TM Exercise - Open Loop Handling

Day 3:

- Measurement and Simulation of Closed Loop Handling
 - Definition of closed loop
 - Steady state closed loop tests -- Constant radius
 - Transient closed loop tests -- Lane change; Slalom
 - Simulation of closed loop handling tests
- CarSim TM Exercise - Closed Loop Handling
- Design of Experiments (DOE) Applied to Vehicle Dynamics Development
 - What is DOE
 - Why use DOE
 - Terminology
 - Types of DOE's
 - Example - Screening DOE for primary ride
 - Example - Response Surface Method (RSM) DOE for Transient Handling
- Vehicle Dynamics Summary

MAGMA short courses are held on a rolling basis, based on industry demand. Please complete this [short form](#) to express interest for yourself, or your organization.