Michigan Alliance for Greater Mobility Advancement

Course Title: Vehicle Dynamics for Passenger Cars and Light Trucks

Course Length: 3 days

Time Online: N/A

Time in Class: 24 hours

Time in Lab: N/A

Class Size: Minimum 5 / Maximum 24

Price Per Student: $2,685.00*

Location: Company Site

Course Description:

This seminar will present an introduction to Vehicle Dynamics from a vehicle system perspective. The theory and applications are associated with the interaction and performance balance between the powertrain, brakes, steering, suspensions and wheel and tire vehicle subsystems. The role that vehicle dynamics can and should play in effective automotive chassis development and the information and technology flow from vehicle system to subsystem to piece-part is integrated into the presentation. Governing equations of motion are developed and solved for both steady and transient conditions. Manual and computer techniques for analysis and evaluation are presented. Vehicle system dynamic performance in the areas of drive-off, braking, directional control and rollover is emphasized. The dynamics of the powertrain, brakes, steering, suspension and wheel and tire subsystems and their interactions are examined along with the important role of structure and structural parameters related to vehicle dynamics. Physical experiments, applicable to vehicle dynamics are also introduced.

Attendees will receive the Bosch Automotive Handbook and The Automotive Chassis: Engineering Principles by Reimpell, Stoll and Betzler.

This course has been approved by the Accreditation Commission for Traffic Accident Reconstruction (ACTAR) for 18 Continuing Education Units (CEUs). Upon completion of this seminar, accredited reconstructionists should mail a copy of their course certificate and the $5 student CEU fee to ACTAR, PO Box 1493, North Platte, NE 69103.

Course Learning Objectives
By attending this course, participants will be able to:

- Summarize how vehicle dynamics is related to the voice of the customer
- Identify important vehicle system parameters useful for effective application of vehicle dynamics to chassis development
- List and explain parameters that effect vehicle performance relative to drive-off, braking, directional control and rollover

* Price based on minimum enrollment, subject to change

- Identify physical measurements needed to effectively apply vehicle dynamics to passenger cars and light trucks
- Define the value of vehicle dynamics simulation in the development and evaluation of vehicles
- Explain the balance required between ride, directional control and rollover and the essential process for this balance to be obtained for marketplace vehicles

Course Syllabus

Day One

- The Role of Vehicle Dynamics in Passenger Car and Light Truck Product Development
- Vehicle Dynamics and the Voice of the Customer
    - Use of QFD to manage vehicle dynamics performance in drive-off, braking, ride and handling
    - Thinking systemically about automotive chassis design and development through the logic of vehicle dynamics
- Effective Metrics for Vehicle Dynamics
    - Vehicle system, subsystem and piece-part metrics used to link vehicle dynamics to vehicle system design and development: bounce frequencies, lateral acceleration gain, understeer gradient, roll gradient, roll stiffness, etc.
- Tire Fundamentals: Tire Wheel System Anatomy and Architecture, Tire Axis Systems, Parameters and Characteristics
- Elementary Tire Patch Forces and Moments: Forces and Moments at the Tire Contact Patch During Steady Braking, Steady Cornering and Steady Drive-Off Maneuvers
- Acceleration (Drive-Off) Performance
    - Basic powertrain system anatomy and architecture
    - Power limited and traction limited drive-off including powertrain system dynamics required to produce vehicle motive force at the tire patch
    - Road load considerations: aerodynamic resistance, rolling resistance, grade resistance
    - Performance prediction in acceleration and fuel economy

Day Two

- Braking Performance
    - Basic brake system anatomy and architecture
    - Braking dynamics: braking forces, weight transfer, center of weight, brake force distribution, stability
    - Pedal force gain, brake proportioning, braking efficiency, anti-lock braking systems
    - Tire - road limitations
    - Federal requirements for braking performance
    - Brake system performance prediction
- Ride Fundamentals
    - Input excitation signals: road roughness, vehicle sources (tire/wheel system, driveline and engine)
    - Vehicle response properties: suspension isolation, tire vertical stiffness, spring rate ratio, suspension stiffness, ride rate, suspension damping, pitch and bounce frequencies
    - Quarter vehicle and pitch plane ride simulations
    - Ride performance prediction based on flat ride criteria

Day Three

- Cornering Fundamentals
  - Low speed turning
  - High speed cornering: tire forces, Bundorf bicycle model, understeer gradient, characteristic speed, lateral acceleration gain, yaw velocity gain, side-slip
  - Suspension effects on cornering: tire cornering stiffness, camber thrust, roll steer, lateral force compliance steer, aligning torque, lateral load transfer, steering system
  - Experimental methods for vehicle handling development
- Suspension Systems
  - Suspension system anatomy and suspension system performance requirements relative to drive-off, braking, ride and handling
  - Solid live axles, twist beam suspensions and independent suspensions
  - Side view pitch poles and pitch axis considerations: anti-squat and anti-dive suspension geometry, wheel travel and caster geometry
  - Role axis considerations: roll center location, roll axis geometry and location, wheel travel and toe geometry, wheel travel and camber geometry
- Steering Systems
  - Steering system anatomy, architecture and performance requirements
  - Steering geometry, wheel geometry, steering system forces and moments, steering ratio, steering compliance
  - Experimental methods for steering system performance evaluation and development
- Roll-Over Fundamentals
  - Vehicle system roll-over prevention requirements
  - Elementary and suspended vehicle simulations
  - Suspension system and steering system considerations
- Introduction to CAE Applications for Vehicle Dynamics: CarSim and sSNAP and Manual Analysis Methods