Michigan Alliance for Greater Mobility Advancement

Course Title: Fundamentals of Vehicle Dynamics

Course Length: 17 hours

Time Online: 17 hours

Time in Class: N/A

Time in Lab: N/A

Class Size: N/A

Price Per Student: $945.00* (for SAE International Members)

$1,100.00* (for non-members)

Location: On-Demand Online

Course Description:

Vehicle design always involves conflicting goals. A suspension system that's optimized for ride is not always the best for handling. The powertrain that gives best acceleration is not likely to be the most fuel-efficient.

This course addresses the motor vehicle as a system. By increasing your knowledge of the primary mechanics for all modes of performance, you'll better appreciate how to optimize the overall vehicle. This will allow you to predict performance of a given design early in the design process, identify the conflicts in designing for optimal performance in different modes, and set directions for design changes that will improve performance of a given mode.

This on-demand course featuring vehicle dynamics expert and best-selling author, Thomas D. Gillespie, provides a broad overview of vehicle performance, including engineering analyses and formulas that will allow you to calculate useful performance metrics. The goal of this course is to provide you with the tools to predict the performance of a car or truck in accelerating/braking, ride, and handling/rollover. In the process, you'll come to understand the basic mechanisms and engineering principles that govern steering and suspension system design, as well as develop familiarity with the terminology.

This course has been approved by the Accreditation Commission for Traffic Accident Reconstruction (ACTAR) for 16 Continuing Education Units (CEUs)

Course Learning Objectives

By attending this course, participants will be able to:

- Determine how wheel loads on a vehicle relate to center of gravity location loading, aerodynamic forces, road grade, trailer towing forces, and acceleration, braking and cornering

* Price based on minimum enrollment, subject to change

- Describe how the powertrain and brake systems work to produce longitudinal acceleration and deceleration, and how these are influenced by powertrain type and traction limits
- Explain the basic mechanics of road load resistance forces arising from aerodynamics and tire rolling resistance
- Explain the basics of ride and how to design a vehicle and tune suspensions for good ride
- Examine the physics of turning to understand low speed maneuverability and the mechanics of high-speed cornering quantified by the understeer gradient
- Explain the tire, suspension, and steering system properties that account for understeer
- Review the principle types of suspensions, their attributes, and how each functions
- Describe the primary architectural features of a steering system
- Explain the primary mechanisms involved in the vehicle rollover process

Course Syllabus

Module I: Introduction
[Total Run Time: 24 minutes]

- Coordinate systems used to describe vehicle behavior
- Calculating wheel loads based on vehicle load, acceleration, road grades, aerodynamics and trailer towing forces

Module II: Acceleration
[Total Run Time: 1 hour, 10 minutes]

- Typical engine performance characteristics
- Functional model of the drive train
- Mapping the tractive force as a function of speed and gear
- Calculating tractive force at drive wheels for traction-limited performance
- Modeling traction limits on solid axles due to lateral load transfer

Module III: Braking
[Total Run Time: 1 hour, 35 minutes]
Basic equations for calculating deceleration and stopping distance

- Advantages and disadvantages of disc and drum brakes
- Overview of global braking regulations
- A process for designing and proportioning a brake system for optimal performance
- Anti-lock brake (ABS) systems
- A means for evaluating the efficiency of the brake system under diverse conditions

Module IV: Road Loads
[Total Run Time: 1 hour, 30 minutes]

- Aerodynamics
- Mechanics of air flow over the car
- Governing equations for forces and moments acting on the vehicle and typical values
- Practical consequences of aerodynamics acting on the car
- Sources of tire rolling resistance and sensitivity to operating conditions
- Typical values of rolling resistance
- Overview of the primary sources of energy losses on the vehicle affecting fuel consumption

Module V: Ride

[Total Run Time: 2 hours, 45 minutes]

- Ride performance
- Basic mechanisms responsible for ride excitation
- Rigid-body ride models and metrics
- Suspension design factors influencing ride
- Measurement and evaluation of ride

Module VI: Cornering
[Total Run Time: 2 hours, 45 minutes

- Basics of handling
- Low speed turning, off-tracking and maneuverability
- Ackerman steering and relationship to turning behavior
- Cornering properties of the tires in high speed turning
- Steer angle relationship to radius of turn and lateral acceleration
- Concept of understeer gradient
- Understeer gradient relationship to the yaw rate and lateral acceleration gains
- Critical speed, characteristic speed, sideslip angle, and static margin

Module VII: Suspensions
[Total Run Time: 1 hour, 50 minutes]

- Suspension effects on handling
- Influences on handling arising from roll moment distribution, camber change, roll steer, lateral force compliance steer, aligning moment and steering compliance
- Constant radius and constant speed methods for measurement of understeer gradient
- Suspension design and analysis
- Performance requirements for suspensions
- Principle types of suspensions and how each functions
- Solid axle suspensions Independent suspension types
- Roll center concept and roll center influence on vehicle behavior
- Mechanics of anti-dive and anti-squat

Module VIII: Steering
[Total Run Time: 2 hours, 10 minutes

- Steering systems
- Typical architecture of the gearbox and rack and pinion steering systems
- Geometry of the steering linkages acting in combination with the suspension
- Different types of steering geometry errors affecting drift, wander, pulls and roll steer
- Geometry of the steering axis at the road wheels relating to caster, kingpin inclination, and offset at the ground
- Forces and moments acting on tires
- Influence of front wheel drive on steering behavior
- Advantages of four-wheel steer systems

Module IX: Rollover
[Total Run Time: 1 hour, 20 minutes]

- Mechanics of the rollover process
- Rollover metrics – static stability factor, tilt table ratio
- Principles for rollover mitigation by electronic stability and roll stability controls

- Rollover test procedures -- the Fishhook, FMVSS 126 and UN/EXE 13 regulations
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