



Course Title: Introduction to Noise, Vibration, and Harshness Aspects of Hybrid and Electric Vehicles

Course Length: 2 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: \$1,195.00

Location: Oakland County *or* Company Site

Course Description:

The influx of different hybrid and electric vehicle configurations has brought about unique NVH challenges from a variety of sources. NVH refinement is an important aspect of powertrain development and the vehicle integration process. While developing the NVH behavior of the vehicle is critical to satisfy customer expectations, it is also important to consider the influence of reduced exterior noise levels on pedestrian safety. This seminar introduces participants to basic NVH principles and unique NVH challenges encountered in the development of HEV, ReEV, and EV including engine start/stop behavior, electric motor whine, driveline NVH, body structure, influence of noise from accessories, and sound quality development, as well as potential countermeasures.

Course Learning Objectives:

Upon completion of this course participants will be able to:

- Articulate the basic principles of NVH
- Describe the relative importance of powertrain noise, wind noise, and road noise in the vehicle's interior
- Identify the key sub-components of powertrain noise and means to control them
- Explain the key NVH issues specific to electrified vehicles and means to develop appropriate countermeasures
- Identify key metrics available to assess the NVH performance of electrified vehicles
- Develop an awareness of advanced NVH methodologies available to design the sound character of electrified vehicle

Course Content/Syllabus:

Automotive NVH Fundamentals

- Fundamentals of noise, vibration, and sound quality
- Vehicle NVH



- Powertrain-induced interior noise
- Engine noise
- Transmission noise
- Driveline noise
- Intake noise
- Exhaust noise
- Road-induced noise
- Wind noise
- Vehicle interior noise simulation for powertrain-induced noise
- Vehicle interior noise simulation for road-induced noise
- Vehicle sound quality
- Vehicle exterior noise simulation

HEV, ReEV, PHEV, and EV NVH

- HEV, ReEV, PHEV, and EV architecture definition
- “Road Map” for vehicle NVH development of HEV, ReEV, PHEV, and EV
- ICE start/stop noise using case study examples
- ICE start/stop vibration using case study examples
- Active control for start/stop refinement using case study examples
- Motor NVH using case study examples
- HEV/EV driveline NVH using case study examples
- Power electronics noise
- Accessory noise
- Application of powertrain-induced vehicle interior noise simulation
- Application of road-induced vehicle interior noise simulation
- Sound character of EV using case study examples
- Sound character of ReEV using case study examples
- Exterior noise considerations for EV and ReEV

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