CME 3043
Fundamentals of Automotive NVH Analysis, Measurements & Controls
(3.2 non-credit/CEUs)

Objective
The objective of CME 3043 is to provide the participant with intensive training in the fundamental concepts of noise, vibration, and harshness (NVH) analysis and measurement, as well as the principles of vibration and noise controls. Rather than focusing on in-depth mathematical derivations, the principles of NVH are introduced so that the participant has a clear understanding of the basic issues related to NVH.

Description
Not only is NVH one of the key factors involved in a vehicle's design, dynamics, and performance, but also in influencing a customer's purchasing decision. This course is designed for engineers and other technical professionals who have little formal background in noise and vibration, but whose work is closely associated with NVH issues. This course will feature technical presentations and hands-on laboratory sessions.

Topics Covered

Technical Presentations

1. Mechanical Vibration and Modal Analysis
- Basic Concepts of Vibration
- Time and Frequency Analysis – Fourier Series and Fourier Transform
- Free and Forced Vibration of Single Degree of Freedom System
- Free and Forced Vibration of Two and Mul-degree Freedom Systems
- Vibration Absorber (Tune Damper)
- Analytical and Experimental Modal Analysis
- Calculation of Frequency Response Functions
- Coherence Function
- Modal Assurance Coefficient (MAC)

2. Principles of Digital Signal Processing
- ADC-Analog-To-Digital Conversions
- Sampling Frequency (Shannon's Sampling Theorem)
- Time Record and Bandwidth, BT Product Requirement
- Frequency Resolution
- Sampling Parameters
- Alaising and Leakage Errors
- Time Window Techniques
- Overlapping and Time Delay Measurements
- Auto and Cross Correlations
- Auto and Cross Power Spectra
- Cepstrum Power Spectrum
- Joint Time-Frequency Analysis –Order Tracking Analysis

3. Sound and Noise

- Generation and Propagation of Sound
- Wave Nature of Sound
- Acoustic Boundary (absorption and transmission coefficients)
- Acoustic Material
- Levels and Decibles
- Addition and Subtraction of Sound Sources
- Human Hearing Mechanism
- Critical Bands and Articulation Index
- Human Perceived Sound and Noise (Frequency weighting A, B, C, and D)
- Loudness Level – Phons
- Subjective Loudness – Sones
- Annoyance – Perceived Noisiness
- Description of Sound Fields (Near, Far, Free and Reverberant Fields)
- Sound Source Models (Monopole, Dipole, and Quadrupole)
- Standing Waves
- Acoustic Modes of Enclosures
- Helmholtz Resonators
- Sound Intensity Analysis
- Sound Quality Evolutions
- Measurement and Analysis of Sound
- Octave and Constant Band Spectra

4. Principles of Vibration and Noise Controls
- Damping Treatments
- Tuned Dampers
- Vibration Isolation
- Identify Sources of Noise and Their Relative Importance
- Source-Path-Receiver Relationship
- Contribution from Direct and Reflected Noises
- Absorption and Attenuation
- Noise Leakage and Flanking Paths
- Structure-Borne and Air-Borne Noises

5. Lab Sessions
- Frequency Response Function Measurement
- Experimental Modal analysis
- Noise measurement using sound pressure level meters and octave filter
- Sound spectral analysis with FFT and real time analyzers
- Sound power and sound intensity measurement (2003)
- Order Tracking Analysis (2003)
- Sound Absorption Coefficient Measurement using Impedance Tube (2003)
- Sound Quality Evaluations (2003)

6. Invited Guest Speaker Lectures

- Sound Quality Overview – Norman Otto (Retiree of Ford Motor Company)
- PowerTrain NVH – Bruce Bonhard (Ford Motor Company)
- Vehicle NVH Problems and Approaches – Mark French (Bosch Corporation)
- Order Tracking Analysis – Doug Kopp (A1 Systems, Inc.)

Prerequisite
Knowledge of engineering dynamics and linear algebra is preferred.

Course Material
Course notes will be provided by the instructor

Instructor
J. Cherng, Ph.D., Professor of Mechanical Engineering

Target Audience
This course is designed for engineers and other technical personnel who have little formal background in NVH, but whose daily work is closely associated with NVH issues.

CEU
A total of 3.2 Continuing Education Units (CEU's) will be awarded to each participant who completes the program. The CEU is a nationally recognized means of tracking non-credit continuing education development. It confirms participation in a structured professional development activity or course work.

One CEU is awarded for 10 hours of completed activity or course work. A permanent record of each attendee's participation is maintained in the Office of the Registrar at the University of Michigan-Dearborn.

Register

Engineering Professional Development
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