This course can be adapted to virtual classroom mode

Powertrain NVH

Noise, Vibrations, Harshness

3 days **ACMOT-EN-A**

Overview

LEVEL

Expert

PURPOSE

This course provides a deeper knowledge and competencies of the nature and origin of noises and vibrations generated in the powertrains and the measurement and analysis methods used in the vibro-acoustic field. it aims at implementing technical solutions to reduce noise and vibration.

LEARNING OBJECTIVES

Upon completion of the course, participants will be able to:

know the parameters used to characterize noise and vibrations,

understand vibrating systems behaviors and control parameters,

know the signal processing instruments and methods,

master experimental techniques,

identify the acoustic signature of the powertrain's (PT) main sources,

interpret the sonograms corresponding to the main vibration sources of the powertrain,

carry out a validation test on vibration for engine-related parts.

WAYS AND MEANS

Real and concrete examples of powertrain vibro-acoustic problems discussed by experts from the automotive world.
Real and concrete solutions implemented in the industry.

Agenda

ACOUSTIC & VIBRATIONS IN THE INDUSTRIAL WORLD — 0.25 d

Acoustics: pressure, intensity, sound power; levels expressed in decibels, sound level structure; sound velocity.
Time and space variations of waves, plane and spherical waves, propagation law. Human ear, hearing properties, ear sensitivity, A-weighting decibel levels. Vibration parameters analysis: acceleration, velocity, displacement.
Free or forced response ringing oscillator, free-running frequency, role of damping.

SIGNAL ANALYSIS INSTRUMENTS & METHODS — 0.5 d

Signals classification and processing; fast Fourier transformation (FFT): sampling, weigh time space, spectrum.
Time analysis, spectral analysis, white noise, pink noise, order analysis.
Tri-dimensional representations, sonograms, time-frequency representations.
Acoustic phenomena measure instruments: microphones, displacement sensors, acceleration sensors, acoustic imaging, anechoic bench.
Modal analysis (experimentations): vibration mode of a metal plate; structure response to a dynamic stress (loudspeaker, vibrator, unbalanced electric engine); deformation display with a stroboscope.

POWERTRAIN NOISE VIBRATION & HARSHNESS

0.75 d

Powertrain dynamic behavior: internal forces of inertia and combustion, effect of parts deformation, deformation of powertrain structures, finite element modeling, main modes of resonance.
Powertrain acoustic radiation. Radiating envelopes. Excitations sources. Acoustic power. Powertrains vibration transfers. Structures and effects of housings of powertrain.
Efforts of inertia: single-cylinder, three and four cylinder in-line engines dynamics; use of balancer shafts; composition of the combustion and inertia efforts; effect of dual mass flywheel (DMA).
Combustion noise: cylinder pressure, dynamic pressure, spectral analysis of the cylinder pressure; technologies impact on the combustion noise; transfer and spread of combustion noise; measurement of combustion noise; combustion noise in transient operation.

POWERTRAIN MAIN NOISES & VIBRATIONS

0.75 d

Injection systems: technical description of the systems, acoustic phenomena related to the operation of the system, mechanisms of noise generation in medium and high frequency, fluid-structure interaction, effect of dispersion and drift, analysis of the measured signals.
Piston slap: play liaison of the moving parts, piston slap, noise analysis.
Sounds training distribution: the whining, scraping, rubbing belt, role of the housings; origins and solutions.
Whistle of the turbocharger: meow, sound of wind and sound of discharge; origins and solutions.
Noise of gearboxes: whining, hoarse sound; origins and solutions.
Aerodynamic noise: noise related to filling air and exhaust.

ACOUSTIC SIGNATURES OF THE POWERTRAIN (PT) MAIN SOURCES

0.25 d

Acoustic and vibratory process during design: reduction at source or vibration filtration.
PT primary and secondary sources, glossary of the engine’s main sources.
Examples of acoustic signatures (analysis from sonograms): diesel injector, supercharger, timing, belt-driven accessories, gearbox, starter, intake noise.
Demonstrator: analysis of the noise sources of an electrically-driven thermal engine model; spectral analysis during a speed increase, interpretation.

PARTS MECHANICAL RESISTANCE TO VIBRATIONS

0.5 d

Validation of engine parts with all the vibration types: identifying the frequencies and the rates of generation of overvoltage and resonances, quantification of vibratory levels during acceleration and displacement, determining the endurance conditions and durations.
Examples: validation of an intake P/T sensor, of an oil gauge guide, of an oil turbo pipe.