1D Powertrain Modeling - Remote training

5 days | **MS1D-EN-D**

Overview

LEVEL

Expert

PURPOSE

This course provides design engineers and technicians an overview of 1D modeling applied to the engine (fluids, combustion, thermal and mechanical) in order to obtain representative results and to reduce design times.

It is also a prerequisite for powertrain and vehicle investigations.

This course provides a global overview of 1D modeling and simulation uses for powertrain design.

LEARNING OBJECTIVES

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

understand the principles of 1D modeling,

know the basics of 1D modeling in the area of compressible and incompressible fluids, combustion, mechanics and thermals,

know the components of a 1D powertrain model: modeling agencies, components, circuits and fluid systems,

design and develop a 1D model of an engine,

implement and configure the components of a 1D model,

learn the principles of different 1D simulation tools, such as GT-Power and AMESIM,

use 1D models and 1D simulations to develop powertrains: large choices of architectures (displacement, compression ratio, bore, volumes and lengths of pipes, …), parts dimensioning and design impacts on powertrain performance.

WAYS AND MEANS

This training course is based on continuous balancing between theory and practice, knowledge and expertise.

Design of complete 1D models of engine parts or engines on “GT-Power”.

Concrete case studies of 1D simulation.

Simulation and exploitation of 1D models for system designs: air system, combustion chamber, cooling system, fuel system, mechanical engine parts.

Agenda

1D FLUID MODELING & SIMULATION — 1.5 d

Basics of 1D modeling and numerical simulation. 1D simulation compared to 0D and 3D simulation in the design process of a powertrain system.
Fundamentals of fluid modeling: Eulerian approach, Lagrangian Navier-Stokes equations, conservation of mass, momentum and energy, nature of the flow, boundary layer concept, the notion of compressibility, definition of viscosity, equation Barré Saint-Venant bar, flow coefficients, pressure wave propagation.
Average flow and instantaneous flow turbulence.
Solvers and comparison software (GT-Power and AMESIM), operating principles and properties of the software.
Modeling components of compressible fluids: modeling pipes and volumes, modeling valves, modeling boosts components.

Modeling components of incompressible fluids: modeling of hydraulic circuits, modeling pumps, taking into account the deformation of the flexible.
Determination of calibration models and components.
Application of modeling based on simulation tools GT-Power: construction of a supercharged engine with EGR and CAC model, modeling air loop, correlation, calculations and tests and registration of the model, analyzing performance.
Design and architecture: modeling and simulation of a fuel system, calculation of the pressure waves, parametric study. Injector modeling.

1D COMBUSTION & EMISSIONS MODELING & SIMULATION

1.5 d

Introduction to the modeling of combustion, heat, burning rate, creation of chemical species, chemical kinetics, the concept of self-ignition delay, knocking engine, premixed flame and diffusion flame, laminar velocity and turbulent aerodynamic, coupling combustion cycle to cycle variation, statistical aspects related to combustion models, …
1 zone model, 2-zone model, 3-zone and multi-zone model. 1D combustion model, influential parameters modeling.
1D Diesel combustion model, influential parameters modeling.
Predictive modeling of emissions (NOx, particles, HC, CO and CO_2), statistical modeling programs: mapping and neural networks.
1D modeling combustion CFD models, model heat transfer, aerodynamics, combustion model, chemical models.
Operating principles and properties of the simulation software.
Modeling components: injector, cylinder, chamber geometry, piston position; heat transfer model, aerodynamics (swirl, tumble, turbulence), combustion model.
Model calibration, recalibration of combustion models.
Application to Diesel: cylinder pressure analysis and correlation from the cylinder pressure measurement only; example of predictive Diesel combustion models (multizone and 3 zones).
Application to Gasoline: analysis and correlation of cylinder pressures TPA three pressure analysis (Pcyl, Pexhaust and Pintake) for determining the rate of RBG; parametric study: influence of the rate depending on the RBG Camshaft law; examples of predictive models of combustion gas (1D, 2 zones).

1D MODELING & THERMAL SIMULATION

1 d

Fundamentals of thermal modeling, conduction, natural and forced convection, radiation, thermal inertia, heat balance equations, dimensionless numbers in heat: Prandtl, Nusselt.
Modeling components: fluid and combustion components incorporating thermal models (lines and volumes, heat roller), heat exchangers, thermostats, loss models for walls.
Characterization of components, building materials, masses, specific heat, thickness, …
Application: construction of a predictive model exchanger: EGR or CAC; characterization of virtual component bench; parametric study on bench or on integrated cooling system.

1D MECHANICAL MODELING & SIMULATION

1 d

Fundamentals of mechanical modeling: inertia, stiffness and damping torsional deformations.
Frequency approach and temporal approach.
Modeling components: masses, springs, dampers, motion conversion, reducers, trees, strength, speed, time, macro components (valves, wastegate, components of a gearbox).
Examples of 1D modeling engine design, part modeling and studies of mechanical systems: piston shafts, engine block, manifolds, cylinder heads.
Applications: mass spring system: modeling approaches; examples of crankshaft torsional analysis; examples of gearbox: modeling approaches; interaction and fluid mechanics (opening a wastegate under the forces of aero pressure).