Engine Design & Mechanical Development
Draft Agenda proposal for custom courses

Day One, AM

Reliability
- Engine life regimes
- Mathematical reliability characterization
- The Weibull model
- Accelerated testing

Fatigue in Engine Development
- Fatigue mechanisms and material data
- EFR stress models
- Design for infinite life
- Cumulative damage models

Wear in Engine Development
- Mechanisms of wear in the engine
- Adhesive wear and friction
- Wear characterization and validation

Day One, PM

Displacement and Configuration
- Volumetric efficiency
- Identifying displacement needs
- Number and configuration of cylinders

Engine balance
- Rotational balance and couples
- Counterweight design
- Reciprocating balance
- Application to multi-cylinder configurations
Parameters in Engine Layout
- Package size and critical dimensions
- Bore-to-Stroke ratio
- Deck height
- Bore spacing

Day Two, AM

Block and Head Materials & Casting
- Gray, ductile, and CG iron
- Aluminum alloys
- Magnesium
- Casting processes

Cylinder block layout
- Key features and design approaches
- Crankcase design
- Deck and cylinder design

Cylinder head layout
- Firedeck and combustion chamber
- Port design
- Cooling jackets
- Oil deck design

Day Two, PM

Block loading and development
- Cylinder block load paths
- Rig test development
- Cylinder block analysis
- Modal Analysis & NVH

Cylinder head development
- Cylinder head fatigue analysis
- Fatigue analysis and test techniques
- Clamping load and the bolt column

Head gaskets and sealing
- Head gasket and bolt loading
- Gasket construction
- Development and validation
Day Three, AM

Manifold development
- Material selection and design features
- Loading and durability development
- Sealing

Camshafts and Valvetrain
- Valvetrain types and systems
- Component design details
- Lash compensation
- Cam drive systems

Crankshaft Development
- Crankshaft design and materials
- Single throw development
- System development and torsionals
- Rig testing and analysis
- Flywheel sizing

Day Three, PM

Torsional Analysis
- System characteristics
- The forcing function
- Torsional analysis
- Damping approaches

Connecting Rods
- Materials and design options
- The rod and cap joint
- Connecting rod loading
- Rig testing and analysis

Piston Design and Development
- Design and materials
- Crown Development
- Temperature control
- Pin and boss durability
- Skirt development and clearance
Day Four, AM

Ring Pack
- Ring pack operation
- Compression and oil ring design
- Ring dynamics
- Measurement and analysis

The Cylinder Wall
- Objectives and surface characteristics
- Honing processes
- Bore distortion and control

Thermal Loading and Engine Cooling
- Critical temperatures and control
- Thermal mapping and measurement techniques
- Transients and deep thermal cycles
- Oil temperature control

Coolants
- Chemical formulation and mixtures
- Coolant performance characteristics
- Additives and filtration
- Cooling Circuits

Day Four, PM

Cooling jacket development
- Coolant velocity control
- Cylinder balance
- Cooling jacket venting
- Experimental and computational methods

Cooling system components
- Water pump design and performance
- Thermostats and control
- Heat exchanger selection

Cooling Circuit Layout and Analysis
- Cooling circuits and vehicle considerations
- Cooling system sizing
- Circuit analysis and testing
- Deaeration
Day Five, AM

Lubrication Systems
- Splash and pressurized lubrication systems
- Lubrication layout considerations
- Sump design and dry sump systems
- Drain-back

Engine lubricants
- Conventional and synthetic lubricants
- Additive packages
- Lubricant performance measures
- Deposit mechanisms

Lube system components
- Pump and regulator design and performance
- Filtration
- Oil cooler use and design

Day Five, PM

Lube system layout and analysis
- Pressure and flow requirements, and pump sizing
- The crankcase environment and oil aeration
- Windage and bay-to-bay breathing
- Breathers and positive ventilation systems

Bearings
- Hydrodynamic bearing operation
- Film pressure and oil film thickness
- Oil supply drillings, location, and the use of bearing grooves
- Split-shell bearing design
- Hydrodynamic bearing analysis – Sommerfeld number, computational and experimental techniques
- Bearing materials and development

Gaskets and Seals
- Bolted joint and flange characteristics
- Gasket materials
- Bolt load and sealing
- Pressure and temperature effects on sealing load
- Shaft seals
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