



WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

Department of Engineering
Professional Development

The University of Wisconsin–Madison offers courses at your location focusing on engine design and mechanical development. Curriculum for course topics is designed by UW–Madison faculty and industry experts, and in cooperation with the Engine Research Center (ERC). The University's ERC has a long and distinguished record of research and education pertaining to internal combustion engines and advanced propulsion systems.

Our staff will work with you to tailor our programs to meet your development goals.

Engine Design and Mechanical Development				
Topic <i>(Each session is approximately 1 hour 10 minutes)</i>	Five-day course	Four-day course	Three-day course	Two-day course
Introduction to IC Engine Development	X	X	X	X
Vibration and Engine Forces <ul style="list-style-type: none"> • Forces, moments, and superposition • Rotational forces and dynamic couples • Crankshaft counterweight design 	X	X		
Reciprocating Forces <ul style="list-style-type: none"> • Reciprocating force calculation • First- and second-order balancing • Multi-cylinder engine balance 	X	X	X	X
Crankshaft System Design <ul style="list-style-type: none"> • Crankshaft layout • CG and mass distribution • Counterweight placement 	X			
Connecting Rods <ul style="list-style-type: none"> • Design approaches • Critical loads • Development methodology 	X	X	X	
Crankshaft System Analysis <ul style="list-style-type: none"> • Fillet stress and crank throw development • Oil drilling placement and optimization • Nose and flange design 	X	X	X	
Torsional Analysis <ul style="list-style-type: none"> • Forcing functions • System response • Approaches to damping 	X	X	X	
Valvetrain Design Overview <ul style="list-style-type: none"> • Component design, operation, and materials • Lash and compensation • Camshaft drive systems • Test and analysis techniques 	X	X	X	X
Valve Lobe Design <ul style="list-style-type: none"> • System dynamics and governing equations • Lobe design process • Lobe failures and designing for durability • Ball and socket joints and loads 	X	X		
Engine Architecture <ul style="list-style-type: none"> • Number and configuration of cylinders • Bore-to-stroke ratio optimization • Bore spacing and deck height • Cylinder block design trade-offs 	X	X	X	X



Engine Design and Mechanical Development *continued*

Topic (Each session is approximately 1 hour 10 minutes)	Five-day course	Four-day course	Three-day course	Two-day course
Fatigue in Engine System Development <ul style="list-style-type: none"> • Overview of high- and low-cycle fatigue analysis • Fatigue life determination • Application to engine components 	X	X		
Materials and Casting Processes <ul style="list-style-type: none"> ▪ Aluminum and grey iron alloys ▪ Alternative block and head materials and alloys ▪ Casting and machining processes 	X	X	X	
Structural Development <ul style="list-style-type: none"> ▪ Cylinder block load paths ▪ The head gasket seal ▪ Thermal loads and cylinder head development 	X	X	X	X
Design Patents, Trade Dress, and Industrial Design	X			
Noise, Vibration, and Harshness (NVH) <ul style="list-style-type: none"> ▪ Establish the fundamentals ▪ Target definition ▪ Radiated noise 	X			
NVH Analysis <ul style="list-style-type: none"> ▪ Identify NVH source mechanisms ▪ Define critical features ▪ Best practices 	X			
NVH Application <ul style="list-style-type: none"> ▪ Analytical prediction techniques ▪ Measurement techniques ▪ Root cause analysis 	X			
Heat Transfer and Engine Thermal Loading <ul style="list-style-type: none"> ▪ Heat transfer in engines ▪ Identifying and controlling critical temperatures ▪ Thermal mapping 	X	X		
Approaches to Cooling <ul style="list-style-type: none"> ▪ Engine coolant chemistry and performance ▪ Engine cooling circuits ▪ Air-cooled engines 	X	X	X	X
Cooling Jacket Development <ul style="list-style-type: none"> ▪ Boundary layers and nucleate boiling ▪ Cylinder block and head considerations ▪ Filling, venting, and de-aeration 	X	X	X	
Cooling System Considerations <ul style="list-style-type: none"> ▪ Water pump design and performance ▪ Heat exchangers ▪ Air-side considerations 	X	X	X	X
Lubrication System Design <ul style="list-style-type: none"> ▪ Lubricants and additives ▪ Layout and component considerations ▪ Dry sump systems 	X	X	X	X
Lubrication System Development <ul style="list-style-type: none"> ▪ Pressure and flow requirements ▪ Oil pump design and performance ▪ Windage and lubricant aeration 	X	X		



Engine Design and Mechanical Development *continued*

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Bearing Development <ul style="list-style-type: none">▪ Hydrodynamic bearing operation▪ Bearing sizing and analysis▪ Bearing requirements and materials	X	X	X	
Piston Development <ul style="list-style-type: none">▪ Design approaches, materials, and cooling▪ Crown loading▪ Pin boss loads and design approaches▪ Secondary motion and skirt loading	X	X	X	X
The Ring Pack and Cylinder Wall <ul style="list-style-type: none">▪ Ring design and operation▪ Ring dynamics and ring-pack development▪ Cylinder wall surface characteristics▪ Cylinder wall distortion and its control	X	X	X	X

For more information about courses available at your site, including optimal group size and costs, contact:

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