



WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

Department of Engineering
Professional Development

The University of Wisconsin–Madison offers courses at your location focusing on spark-ignition thermodynamics and combustion system 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.

Spark-Ignition Thermodynamics and Combustion System Development				
Topic <i>(Each session is approximately 1 hour 10 minutes)</i>	Five-day course	Four-day course	Three-day course	Two-day course
Applying Thermodynamics to Engines <ul style="list-style-type: none"> ▪ Heat engines and internal combustion engines ▪ Maximum work ▪ Property and state determination 	X	X	X	
Pressure-Volume Analysis, Work, and Power <ul style="list-style-type: none"> ▪ Calculating and measuring pressure-volume work ▪ Boosted engines ▪ The roles of the crankcase 	X	X	X	X
Thermodynamics in Compression, Expansion <ul style="list-style-type: none"> ▪ Heat release placement and compression ratio ▪ Roles of heat transfer ▪ Specific heat ratio 	X			
The Torque Curve and Engine Application <ul style="list-style-type: none"> ▪ Torque curve shaping ▪ Gear ratio selection ▪ Turbocharged or supercharged engines 	X	X	X	X
Air Handling Considerations in Spark-Ignition Engines <ul style="list-style-type: none"> ▪ Valve event optimization ▪ Variable valve events ▪ Swirl, squish, and tumble 	X	X	X	X
Pulse Dynamics and System Tuning <ul style="list-style-type: none"> ▪ Reviewing the physics ▪ Intake and exhaust tuning ▪ Multi-cylinder engine considerations 	X	X	X	
System Development through Analysis and Experiment <ul style="list-style-type: none"> ▪ Discharge coefficients ▪ Standard and optical measurements ▪ CFD in air handling development 	X	X		
Turbocharging and Supercharging <ul style="list-style-type: none"> ▪ Compressor maps and optimization ▪ Engine matching ▪ Approaches to boost control ▪ Charge air cooling 	X			
Fuel Chemistry and Energy <ul style="list-style-type: none"> ▪ Hydrocarbon fuel chemistry ▪ Bio-fuels ▪ Enthalpies and heating values 	X	X	X	X
Combustion and Stoichiometry <ul style="list-style-type: none"> ▪ Global combustion reactions ▪ Stoichiometry, mass and volume ▪ Lean and rich mixtures 	X	X	X	X



Spark-Ignition Thermodynamics and Combustion System Development *continued*

Topic (Each session is approximately 1 hour 10 minutes)	Five-day course	Four-day course	Three-day course	Two-day course
Combustion Equilibrium Calculations <ul style="list-style-type: none"> ▪ Equilibrium concentrations ▪ Adiabatic flame temperature ▪ Practical significance of equilibrium 	X	X		
Kinetics and Combustion Reactions <ul style="list-style-type: none"> ▪ Forward and reverse reactions ▪ Reaction time and activation energy ▪ Types of reactions 	X	X		
Combustion in Spark-Ignition Engines <ul style="list-style-type: none"> ▪ Flame front progression ▪ Spark energy and turbulence ▪ Length scales and propagation 	X	X	X	X
Knock and the Engine Variables <ul style="list-style-type: none"> ▪ Mechanisms of knock onset ▪ Critical variables and measures ▪ Knock modeling and recent findings 	X	X		
Heat Release Analysis <ul style="list-style-type: none"> ▪ Governing equations ▪ Critical variables ▪ Measurement and the use of filters 	X			
Exhaust Emission Considerations and Regulation <ul style="list-style-type: none"> ▪ Atmospheric reactions ▪ Overview of measurement techniques ▪ Overview of regulation approaches 	X	X	X	
Exhaust Emission Mechanisms <ul style="list-style-type: none"> ▪ Carbon monoxide ▪ Hydrocarbon mechanisms and control ▪ Nitric oxide mechanisms and control 	X	X	X	X
Emission Control, In-Cylinder, and Aftertreatment <ul style="list-style-type: none"> ▪ System development for efficiency, emissions ▪ Spark timing maps ▪ Aftertreatment system development 	X	X	X	X
Combustion System Development <ul style="list-style-type: none"> ▪ Combustion chamber development ▪ Direct-injection engines ▪ Boosting and downsizing 	X			
Big Picture Perspectives <ul style="list-style-type: none"> ▪ Well-to-wheels assessments ▪ Customer and societal perspectives ▪ Alternative powertrains 	X	X	X	

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

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