



WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

**Department of Engineering
Professional Development**

The University of Wisconsin–Madison offers courses at your location focusing on engine performance and controls 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.

Fundamentals of Engine System Controls				
Topic <i>(Each session is approximately 1 hour)</i>	Five-day course	Four-day course	Three-day course	Two-day course
<u>Introduction to Engine Management Systems</u>	NA	NA	X	NA
<u>Control Theory Basics</u> <ul style="list-style-type: none"> • Feedback (PID) • Feed-forward (model) • Performance Considerations 	NA	NA	X	NA
<u>Engine Management Basics</u> System Architecture <ul style="list-style-type: none"> • Sensors/ Actuators • Controller [ECU] • Manufacturing Plant 	NA	NA	X	NA
Control Design Philosophies <ul style="list-style-type: none"> • Feed-forward vs. Black-box Modeling Techniques • Feedback and Adaptive Techniques • Robust Control 	NA	NA	X	NA
Combustion System Control Management <ul style="list-style-type: none"> • Air-led • Fuel-led • Torque-based 	NA	NA	X	NA
<u>Engine Control Functional Subsystems</u> Air System Flow Control <ul style="list-style-type: none"> • Governing Equations • Air Flow Control • Diluent (EGR) 	NA	NA	X	NA
Fuel System Flow Control <ul style="list-style-type: none"> • Single/Multi Point Injection • Direct Injection • Multiple injection 	NA	NA	X	NA
Spark/Injection Timing Control <ul style="list-style-type: none"> • Steady-state • Transient • Knock Mitigation 	NA	NA	X	NA
Torque Control <ul style="list-style-type: none"> • Brake to Indicated Transformation • Throttle Position/Fuel Mass Determination • Spark/Injection Timing Modulation 	NA	NA	X	NA



Fundamentals of Engine System Controls *continued*

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Engine Speed Control <ul style="list-style-type: none"> Idle/Max/All Speed Governing Torque-based Implications Crank/Warm-up Mode Control 	NA	NA	X	NA
Engine Protection <ul style="list-style-type: none"> Knock Rev Limiter Power Control 	NA	NA	X	NA
<u>Vehicle Control Subsystems</u> Communications (TCM, HCM, BCM, etc) <ul style="list-style-type: none"> Driver interface (intent, pedal, shifting, brakes, etc.) Transmissions Speed control 	NA	NA	X	NA
After-treatment Control <ul style="list-style-type: none"> Homogeneous Stoichiometric Combustion Systems Homogeneous Lean Combustion Systems Stratified Combustion Systems 	NA	NA	X	NA
Ancillary System Control <ul style="list-style-type: none"> Canister purge management Cooling system management Engine brakes 	NA	NA	X	NA
<u>Control Components</u> Hardware <ul style="list-style-type: none"> Embedded Systems Control electronics, drivers and devices, Sensor/Actuator Characterization A/D and D/A converters 	NA	NA	X	NA
Software <ul style="list-style-type: none"> System model Digital Signal Conditioning PLCs, CAN, communications 	NA	NA	X	NA
<u>The Development Process</u> Hardware/Software <ul style="list-style-type: none"> Development Phases Calibration Validation 	NA	NA	X	NA
Validation <ul style="list-style-type: none"> V-Model Manual Testing Automated Testing 	NA	NA	X	NA
OBDII Diagnostics/Prognostics <ul style="list-style-type: none"> Hardware vs Threshold Condition Based Multi-input Rationality Based OBD Regulatory Requirements Prognostics 	NA	NA	X	NA



Fundamentals of Engine System Controls *continued*

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Tools <ul style="list-style-type: none">• Validation• Calibration• Service	NA		X	NA
The Future <ul style="list-style-type: none">• Advanced/Low Temperature Combustion• Model based prediction and beyond• Cylinder Pressure Feedback• Emissions Sensing	NA	NA	X	NA

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

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