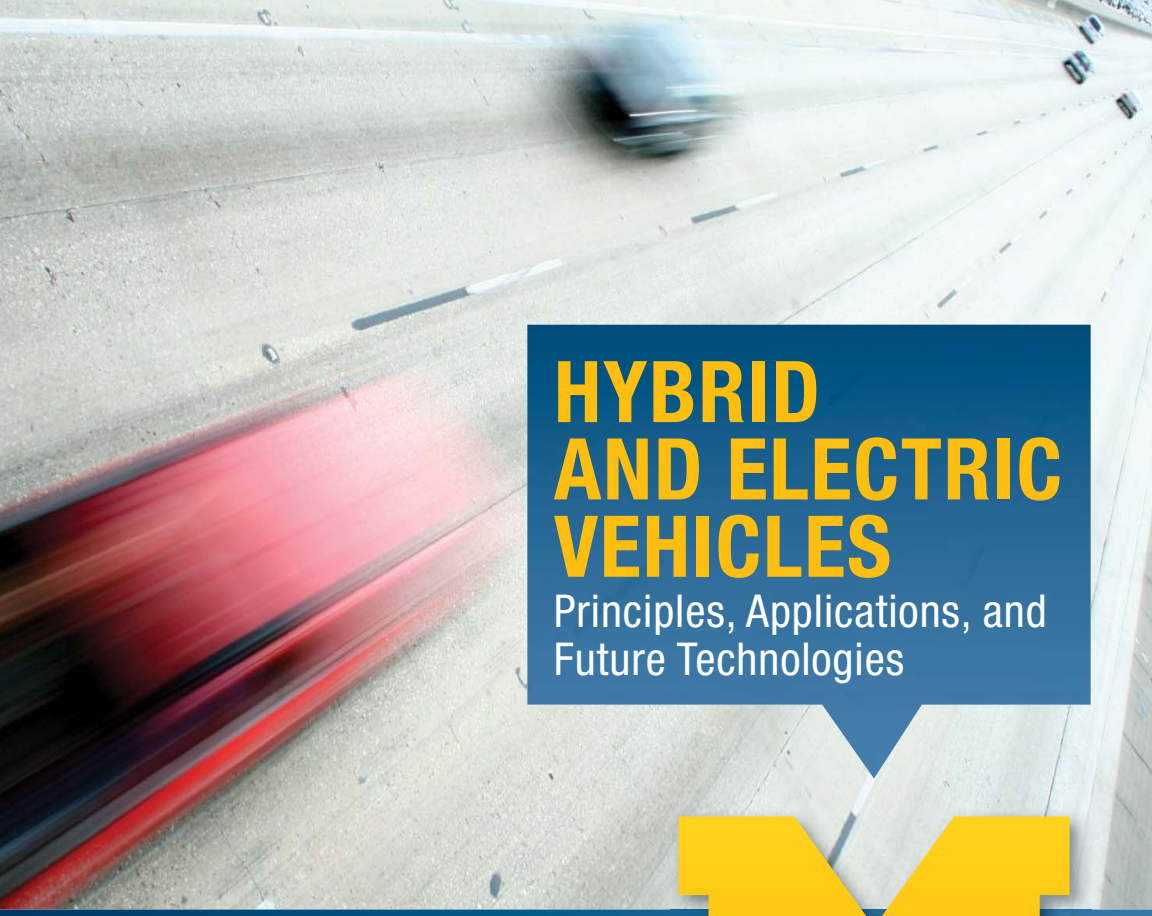

HYBRID AND ELECTRIC VEHICLES

Principles, Applications, and Future Technologies

UNIVERSITY OF MICHIGAN
COLLEGE OF ENGINEERING

HIGHLIGHTING THE LATEST RESEARCH-BASED FINDINGS ON CLEAN VEHICLE TECHNOLGIES

This short course covers all key topics in hybrid vehicles including modeling and control, batteries, battery management systems, motors and power electronics, and EMC.

Scan here
to learn more

2011 PROGRAM DATES

Ann Arbor, Michigan

ENTIRE FIVE-DAY SHORT COURSE

October 3–7 All six modules included

INDIVIDUAL MODULES

October 3	Model-Based Approach for Hybrid Vehicle Design and Analysis
October 4	Battery Fundamentals
October 5	Power Electronics for Electric Drive Vehicles
October 6 (AM)	Military and Non-Automotive Applications, Diagnosis, Prognosis, Reliability, and NVH of HEVs
October 6 (PM)	Battery Management Systems for Electric Drive Vehicles
October 7	EMC of Hybrid and Electric Vehicles

Learn More: **InterPro.engin.umich.edu/HybridVehicles**

HYBRID AND ELECTRIC VEHICLES

Course Content that's More Than Theory

This short course emphasizes the delivery of concepts and examples that have been successfully implemented in laboratories and/or on prototype vehicles. Students will be provided with case studies and examples derived from research-grade simulations that have been used and validated experimentally.

OVERVIEW

This five-day short course consists of six modules that can be taken as a whole or individually:

- Model-Based Approach for Hybrid Vehicle Design and Analysis (7 hours)
- Battery Fundamentals (7 hours)
- Battery Management Systems for Electric Drive Vehicles (3.5 hours)
- Power Electronics for Electric Drive Vehicles (7 hours)
- Military and Non-Automotive Applications, Diagnosis, Prognosis, Reliability and NVH of HEVs (3.5 hours)
- EMC of Hybrid and Electric Vehicles (7 hours)

WHO SHOULD ATTEND

Engineers and managers who are involved in the design and development of hybrid vehicles, and/or their key components.

PROGRAM DETAILS

$2,495* COVERS THE ENTIRE FIVE-DAY PROGRAM
ONE-DAY MODULE: $600
HALF-DAY MODULE: $350

Fee includes tuition, instructional materials, continental breakfast, lunch and breaks each day. Fee is payable in advance. Upon registration, you will receive an email confirmation including directions to the program site and recommended lodging.

GROUP DISCOUNT

Registration of five or more individuals qualifies an organization for a group discount on the cost of the full five-day program. Call **(734) 647-7200** or email **MEonline@umich.edu** to learn more.

PROGRAM INSTRUCTORS

DR. HUEI PENG is a professor of Mechanical Engineering at the University of Michigan–Ann Arbor. His research interests include modeling and control of hybrid vehicles, fuel cell vehicles, and advanced power-train techniques.

DR. CHRIS MI is an associate professor of Electrical and Computer Engineering and director of DTE Power Electronics Laboratory at the University of Michigan–Dearborn. His research interests are in power electronics, electric machines, and their applications in HEVs and renewable energy systems.

DR. DON SIEGEL is an assistant professor of Mechanical Engineering at the University of Michigan. His research interests include development of high-capacity materials and systems for energy storage applications, computational materials science, multi-scale modeling and more.

JAMES MUCCIOLLI has extensive experience in EMC design, analysis, and testing. His background includes over twenty years of specialized EMC systems experience at X2Y Attenuators, DaimlerChrysler, and United Technologies.

DR. M. ABUL MASRUR is presently with the US Army RDECOM-TARDEC (R&D)* where he has been involved in research related to hybrid electric vehicles, vehicular electric power system architecture concept design and development, electric power management, and artificial intelligence based fault diagnostics in electric drives. He is also an Adjunct Professor in the University of Detroit Mercy where he has been teaching courses related to Advanced Electric and Hybrid Vehicles.

* This course instruction is presented by Dr. M. Abul Masrur in a personal/individual capacity, and nothing presented in this course should be construed as an endorsement of any of the statements, or of any products or other materials discussed or mentioned in this course, in one way or the other, by any of the organizations indicated above with which the author is or has been affiliated. The materials discussed and presented are merely for factual information.

PROGRAM AGENDA

MODEL-BASED APPROACH FOR HYBRID VEHICLE DESIGN AND ANALYSIS

Professor Huei Peng, University of Michigan

Duration: 7 hours

- Introduction, background
- Modeling of hybrid electric vehicles
- Integration and analysis of hybrid vehicles
- Modeling and control of a split hybrid electric

INTRODUCTION TO ELECTRICAL ENERGY STORAGE (OR BATTERY FUNDAMENTALS)

Professor Don Siegel, University of Michigan

Duration: 7 hours

- Introductory material
- Key components of batteries and their properties
- Thermodynamics and kinetics of battery operation
- Overview of various battery chemistries
- Li-ion batteries
- Models of battery operation
- Degradation mechanisms in Li-ion batteries
- Advanced batteries
- Ultra-capacitors

POWER ELECTRONICS FOR ELECTRIC DRIVE VEHICLES

Professor Chris Mi, University of Michigan

Duration: 7 hours

- Electrification of the Automobile
- Introduction to Power Electronics
- Modeling of Power Electronics
- Rectifiers (AC-DC)
- Unidirectional DC-DC Converters
- Bidirectional DC-DC Converter
- Power Electronics Building Blocks
- Thermal Issues in Power Electronics
- Hardware in the Loop
- Isolated DC-DC Converter
- Inverters
- Introduction to Motor Drive
- Battery Chargers
- Vehicle to Grid (V2G)
- Emerging and Future Technologies
- Learning Assessment

BATTERY MANAGEMENT SYSTEMS FOR ELECTRIC DRIVE VEHICLES

Professor Chris Mi, University of Michigan

Duration: 3.5 hours

- Batteries for EV, HEV, and PHEV
- Functions of BMS
- Current, voltage, temperature monitoring circuit
- SOC calculation and calibration
- Cell balancing
- Battery sizing and pack design example
- Thermal management
- SOH—Concepts, method, impedance measurements
- Power supply for BMS
- Battery chargers—Contact, inductive, and wireless charger
- V2G scenarios and V2G charger
- Relay and contact control circuit
- Battery charge algorithms
- Battery safety
- Future Technologies in BMS

HYBRID AND ELECTRIC VEHICLE SPECIAL TOPICS

Abul Masrur

Duration: 3.5 hours

Off Road HEV, Hydraulic Hybrid, and Non-Automotive Applications

- Off Road HEV overview
- Hydraulic versus electric HV
- Non-automotive applications
- Deployment decision making process for HEV for different types of vehicles

Military Applications of HEV

- Benefits
- Ground vehicle applications
- Architecture—Series, parallel, complex
- Non-automotive applications in military
- Ruggedness issues
- Vehicles which are most benefitted

Diagnostics, Prognostics, Reliability, and NVH of HEV

- What is involved
- System health quantification
- Reliability of HEV
- EMC issues
- Noise vibration harshness issues (NVH) —Electromechanical and others
- End of life issues

EMC SYSTEM ENGINEERING APPROACH TO HYBRID AND ELECTRIC VEHICLES

James Muccioli

Duration: 7 hours

- EMC System Engineering of a Vehicle Architecture
- Challenges of Testing Battery Systems for Hybrid and Electric Vehicles
- Grounding Principles for Hybrid and Electric Vehicle Systems Shielding
- EMC System Engineering Verification and Validation Model

Visit **InterPro.engin.umich.edu/HybridVehicles** for more detailed program content.

HOW TO REGISTER*

Visit the Hybrid Vehicles website at **InterPro.engin.umich.edu/HybridVehicles** or send an email to **MEonline@umich.edu** or call **(734) 647-7200.**

*Program fee at time of brochure printing. Check our current program fee schedule at **InterPro.engin.umich.edu/HybridVehicles**. Fee is subject to change.

ABOUT INTERPRO

Michigan Interdisciplinary and Professional Engineering (InterPro) develops and delivers programs and services that enable engineers, managers, and technical professionals to be more effective, productive, and competitive. InterPro extends and enhances the programs, capabilities, and relationships of the faculty and affiliates of the College of Engineering by offering graduate degree programs, distance learning, non-credit public short courses, professional certification programs, and conferences.

Professional development short courses and certification programs include:

- Six Sigma Certification
  - Transactional
  - Manufacturing
  - Healthcare
- Design for Six Sigma Certification
- Toyota Kata
- Lean-Six Sigma Certification
- Lean Manufacturing Certification
- Lean Product Development Certification
- Lean Office Certification
- Lean Healthcare Certification
- Lean Supply Chain for Healthcare Certification
- Lean Supply Chain & Warehouse Management Certification
- Lean Pharmaceutical Certification
- Michigan Human Factors Engineering Short Course
- Financial Management for Engineers
- Dynamics of Heavy Duty Trucks

Graduate degree programs currently offered include:

- Automotive Engineering online
- Design Science
- Energy Systems Engineering online
- Engineering Sustainable Systems
- Financial Engineering
- Global Automotive and Manufacturing Engineering online
- Integrated Microsystems
- Manufacturing Engineering online
- Pharmaceutical Engineering
- Robotics and Autonomous Vehicles

online Indicates programs with an online delivery option.

Graduate Certificates of Advanced Studies in Engineering (CASE) are also available in some of the programs.

Visit InterPro.engin.umich.edu

to learn more about InterPro programs.

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