Introduction to Electric Machines and Drives
June 4–6, 2013
Madison, Wisconsin

A special three-day course on the theory, design, and application of electric machines and drives

- Principles of rotating electrical machines
- Power electronics converter basics
- Drives and the fundamentals of their controls
- In-class demonstrations

Learn the basics of electromechanical energy conversion, machine theory, power electronic drives, and elementary AC drive controls. In-class demonstrations included!
Increase Your Knowledge

Industry relies critically on the ability to move systems and control power. The conversion of electrical energy to torque and motion has been the purview of motors for more than a century. In the last 30 years, the introduction of power electronic drives with motors has led to new design opportunities; indeed, the increased integration of drives and machines in recent years has created a quantum leap in productivity, efficiency, and system performance.

During this course, you will learn from recognized machines and drives experts. You will gain a solid introduction to the rapidly expanding field with well-founded fundamentals, practical application examples, and in-class demonstrations.

Who Should Attend

Anyone new to the field of electrical rotating machines and drives and those desiring a refresher from the perspective of actual designs from actual practitioners will benefit by attending this state-of-the-art course. You will find this course valuable if you work in the fields of:

- Appliance drives
- Cranes and elevators
- Precision motion control
- Renewable/alternative energy
- Electric/hybrid-electric vehicles
- Autonomous vehicle control
- Aerospace, marine, and military vehicles

Course Faculty

**Thomas M. Jahns, PhD**, Professor, Department of Electrical and Computer Engineering, University of Wisconsin–Madison. Previously with GE Corporate R&D and Massachusetts Institute of Technology, Professor Jahns has research interests in electric machines, drive system analysis and control, and power electronic modules.

**Robert D. Lorenz, PhD**, Professor, Department of Mechanical Engineering, University of Wisconsin–Madison. Professor Lorenz spent 10 years with Gleason Works, Rochester, New York, where he was R&D staff group leader in product development and automation systems. His research interests include high-precision and high-performance real-time controls, drive system design, and advanced sensor technologies.

**Michael Ryan, PhD**, President, Ryan Consulting, Los Angeles, California. Dr. Ryan is involved in the application of power electronics and controls, particularly for alternative energy systems. He has had a wide range of industrial experience with positions at Raytheon Space and Airborne Systems, Capstone Turbine, General Electric Corporate R&D and Defense Systems Divisions, Automated Dynamics, Otis Elevator, and Hamilton Standard.

Wisconsin Electric Machines and Power Electronics Consortium (WEMPEC)

WEMPEC is a consortium of more than 80 sponsoring companies and organizations that supports pre-competitive research in the fields of electric machines, power electronics, controls, and their applications. The consortium organizes seminars, campus technology roadmapping visits, student internships, and an annual review meeting to maximize interaction between students, faculty, and sponsors.

For more information contact:

Professor Thomas M. Jahns
608-262-5702 or jahns@engr.wisc.edu

Professor Robert D. Lorenz
608-262-5343 or lorenz@engr.wisc.edu

Or visit wempec.wisc.edu

ENROLL ONLINE TODAY! Or visit our Web site
**Introduction to Electric Machines and Drives**

**June 4–6, 2013 in Madison, Wisconsin**

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### Course Topics

**Introduction**
- Welcoming remarks
- What you can expect to learn

**Review: Electromagnetics and Energy Conversion**
- Ampere's law
- Faraday's law
- Gauss's magnet law
- Magnetic circuits: electrical-magnetic analogy
- Magnetic flux
- Soft magnetic materials
- Inductors and transformers
- Forces: Lorentz and Reluctance
- DC machine

**Review: AC Systems and Three-Phase Circuits**
- AC voltages and currents
- Complex numbers and phasor concepts
- Why three-phase?
- Harmonics
- Per-unit system

**Basics of AC Machines**
- Elementary AC machines
  - air-gap MMF
  - flux
  - voltage waveforms
  - Distributed stator windings
  - Elementary rotor-stator coupling
  - Three-phase operation

**Synchronous Machines: Steady State**
- Synchronous machine types
  - smooth rotor
  - salient pole
  - permanent magnet
- Circuit models and vector diagrams
- Capability curves

**Induction Motors: Steady State**
- Induction machine types
  - wound rotor
  - "squirrel cage" rotor
- Circuit models
- Concept of slip
- Torque-speed curves

**Converter Power Electronics: Basic Theory, Devices**
- Review of circuit fundamentals
- Basic converters: AC-DC, DC-DC, DC-AC, AC-AC
- Device characteristics and capabilities

**AC Inverter Basics: VSI, CSI, Modulation**
- Basic inverter system
- Voltage source inverter (VSI)
- Current source inverter (CSI)
- Modulation techniques
- Pulse width modulation (PWM)
- Practical considerations

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**Adjustable Speed Drives: Basics**
- Basic adjustable speed drive systems
- Review: DC machine speed control
- Varying voltage
- Varying frequency
- Motor and drive selection

**Adjustable Speed Drives: Volts/Hz Control**
- Concepts of constant flux and torque
- Operation at constant torque or power
- Low speed operation
- Basic Volts-per-Hertz system
- Drive limitations

**Adjustable Torque Drives: Basics**
- Ideal adjustable torque systems
- Review: DC machine torque control
- Key elements of torque control
- Synchronous machine torque
- Induction machine torque-slip control

**Induction Motor Field Orientation**
- Revisit IM model
- Physical representation of induction machine fields
- Basic IM vector drive
- Rotor flux orientation

**Application-Specific Selection of Machine-and-Drive Systems**
- Load types and characteristics
- Specific drives to suit application
- Practical issues of machine and drive selection
- Case study

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**Daily Schedule**

Registration will be at 8:00 a.m. on the first day of the course at Engineering Hall, 1415 Engineering Drive, Room 1610, Madison, Wisconsin 53706. Class will begin at 8:30 a.m. on all three days of the course and continue until 4:30 p.m. on the first two days of the course, with final adjournment at 3:00 p.m. on the final day of the course. The daily schedule will include refreshments prior to the start of the course, morning and afternoon refreshment breaks, and lunch served at noon.

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**Earn Your Master’s Degree in Power Electronics While Working Full Time**

Take your skills to the highest level when you earn your University of Wisconsin–Madison Master of Science in Electrical and Computer Engineering (Power Electronics) Degree. This world-class program, delivered at a distance via online lectures or DVDs, allows you to complete courses from anywhere and makes it easy for busy engineers to follow the semester schedule.

For more information, contact Helene Demont at 608-262-5516, or demont@engr.wisc.edu, or visit distancedegrees.engr.wisc.edu.

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**Valuable Take-home References**

As an attendee you’ll receive a binder of valuable take-home materials plus a copy of the excellent text, *Introduction to Electric Machines and Drives*, by University of Wisconsin professors T. M. Jahns, T. A. Lipo, and D. W. Novotny. This information will be useful during the course and once you are back on the job.

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**Earn Continuing Education Credit**

By participating in this course, you will earn 20 Professional Development Hours (PDH) or 2.0 Continuing Education Units (CEU).
Four Easy Ways to Enroll

Internet: http://epd.engr.wisc.edu/webP036

Phone: 800-462-0876 or 608-262-1299 (TDD 265-2370)

Fax: 800-442-4214 or 608-265-3448

Mail to: The Pyle Center
ATTN: Engineering Registration
702 Langdon Street
Madison, Wisconsin 53706

Course Information

- Please enroll me in Introduction to Electric Machines and Drives Course #P036
  June 4–6, 2013 in Madison, Wisconsin Fee: $1595
- Team Discount: $1395 each when three of more people from the same organization enroll in this course
- WEMPEC Discount: $1395 each for members of WEMPEC Sponsor Companies
- I cannot attend at this time. Please send me brochures on future courses.

Personal Information (Please print clearly.)

Name ____________________________
Title _____________________________
Company __________________________
Address __________________________
City/State/Zip ______________________
Phone (__________) Fax (__________)
E-mail ____________________________

Additional Enrollees

Name ____________________________
Title _____________________________
E-mail ____________________________

Billing Information

- Bill my company
- P.O. or check enclosed (Payable in U.S. funds to UW - Madison)

Card No. __________________________
Cardholder’s Name __________________
Date Issued _________________________
Expire _____________________________

General Information

Fee Covers Course materials, textbook, break refreshments, lunches, and certificate. WEMPEC member companies and groups of three or more save $200 per person.

Cancellation If you cannot attend please notify us at least seven days prior to the course start, and we will refund your fee. Cancellations received after that date and no-shows are subject to a $150 administrative fee per course. You may enroll a substitute at any time before the course starts.

Location The course will be held in Room 1610, Engineering Hall, 1415 Engineering Drive, Madison, WI. Phone messages may be left for you with the program director, Mitch Bradt, at 608-263-1085.

Parking Limited pay-as-you-go parking is available at Lot 17 adjacent to Engineering Hall. We recommend making your room reservation at one of the hotels providing shuttle service.

Accommodations We have reserved a block of guest rooms (rates starting at $119, including parking) at Doubletree Hotel, 525 West Johnson Street, Madison, WI. Reserve a room online at epdweb.engr.wisc.edu/lodgingP036 or call 608-262-1583 and indicate that you will be attending this course under group code IEMD. Room requests after May 3 will be subject to availability. Other fees and restrictions may apply.

We have reserved a second block of guest rooms (rates starting at $129, including parking and shuttle) at DoublesTree Hotel, 525 West Johnson Street, Madison, WI. Reserve a room online at epdweb.engr.wisc.edu/lodgingBP036 or call 1-800-222-8733 or 608-251-5511 and indicate that you will be attending this course under group code UWE. Room requests after May 4 will be subject to availability. Other fees and restrictions may apply.

Need to Know More?

Call toll free 800-462-0876 and ask for
Program Director: Mitch Bradt, PE
bradt@wisc.edu
608-263-1085

Program Associate: Helene Demont
demont@engr.wisc.edu
608-262-5516

Or e-mail custserv@epd.engr.wisc.edu

Other Course Opportunities

The Department of Engineering Professional Development conducts a variety of courses that provide current, practical information and approaches. Other courses in the power electronics and electrical machinery series include:

- Permanent Magnet Machines and Drives: Principles, Design and Applications
- Dynamics and Control of AC Drives
- Introduction to Power Electronics
- Introduction to Electric Machines and Drives
- Electromagnetic and Electromechanical Engineering Principles

For information about these courses or to make a suggestion for a course we do not presently offer, call program director Mitch Bradt at 800-462-0876 or e-mail bradt@wisc.edu.