ADVANCED MOTORTECH LLC
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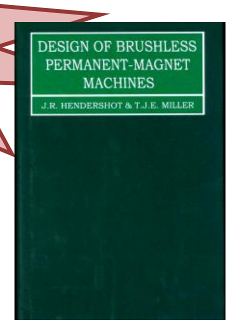
Includes 882 pg Book!
Design of Brushless Permanent Magnet Machines
by Hendershot & Miller



3-DAY SHORT COURSE

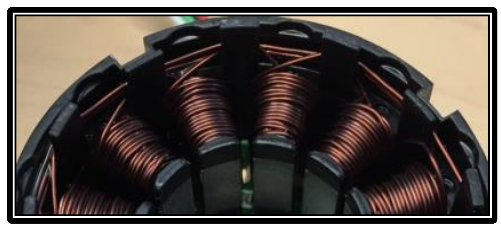
ADVANCED MOTOR DESIGN

--TAKING THEORY TO PRACTICE

Join Us LIVE, On-Line: September 22-23-24, 2020

Learn Advanced Topics in Motor and Generator Machine Design Engineering by understanding the issues, solution choices and procedures, and practical use of the results--all based on academic theory, design experience, and manufacturing practice.
6 of the Key Challenging Topics in 3 days:

- **Core Loss — Advanced Analysis, Prediction, Minimization, & Testing**
- **Advanced Winding Design—Fractional SPP, Layout, Harmonics**
- **Advanced Thermal Design for Motors**
- **Motor Design Optimization**
- **Advanced Induction Machine Design**
- **Advanced IPM Motor Design**



Objectives and Benefits:

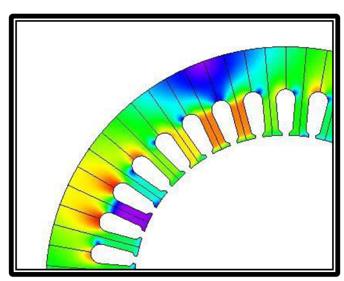
This course provides advanced, but practical, design engineering methods for all types of ac motors and generators. Key motor design difficulties are addressed in six fast-paced, half-day sessions. You will learn to understand the problem, choose solution methods, and interpret the analysis and test data.

We will apply academic theory, computer-aided engineering tools and practical experience to solve difficult motor design issues. The Works-Shop structure will provide 'How-to', with emphasis on quick answers, deep analysis where warranted, expectations & benefits, parameter sewnsitivity, performance differences. Included are new analysis techniques, new design methods, and the latest concepts and practice being used by design engineers and research labs. Similarities and differences of induction, PM machines, reluctance machines, and wound-field synchronous machines, is a common theme.

More-so than ever, this Advanced Course is the engineering material that you can't find in any book, and you can't get from software training! Our acclaimed trainng is a combination of motor design theory and computer tools, inlcuding a heavy dose of many years of practical experience. Each topic area includes design steps, analysis goals and limits, useful rules of thumb and reality checks, interpretation of data, and test methods. The topics apply to the design of all types of machines, especially traction drives, high speed machines, high efficiency, and high power density, as well as cost reduction.

Those who will benefit:

- **Design Engineers of Motors and Generators**
- **Electrical, Mechanical, and Manufacturing & Managers**
- **Research Engineers, Professors, Test Technicians**
- **Control & Drive System Engineers**
- **Inventors, Marketing & Business Development Senior Staff & Managers**
- **Motor Manufacturing Equipment Sales Staff and Engineers**



*Course Schedule (*All times are Eastern Time Zone, USA*)*

9:45-10:10 On-Line Entry; AV check
10:15 Sessions Begin

Day 1 AM: ADVANCED CORE LOSS PREDICTION

1. Concepts of Magnetic Materials, Lamination Model

- ☑ Understanding Magnetic Materials: domains, walls, inclusions, orientation, manufacture
- ☑ Material Chemistry: why BH curves are different, oriented and non-oriented electrical steels
- ☑ Understanding Epstein test and Toroid test to get BH curve and loss data
- ☑ Strength of materials; high speed rotors, magnetostriction & noise

2. Hysteresis & Eddy Currents, and Loss Calculation

- ☑ Hysteresis & Eddy Currents for different materials; what matters for motor cores
- ☑ Basic and advanced methods to model and calculate saturation
- ☑ Basic and advanced methods to model and calculate hysteresis, & eddy currents losses
- ☑ Understanding the effects of frequency, saturation and non-sinusoidal excitation

☑ 3. Effects of Manufacture for Laminations and Core Stack; Testing and Correlation

- ☑ Making Cores: burrs, sheet coatings, Franklin Test, anneal process, grinding
- ☑ Effect of core stack: clamping pressure, bonding methods, radial pressure
- ☑ Special laminations: Segmented laminations, hinged laminations
- ☑ Testing for losses, Correlation to determine Ke and Kh coefficients

Day 1 PM: ADVANCED WINDING DESIGN

4. Winding MMF – Analysis & Model

- ☑ MMF of windings, winding factors
- ☑ Winding harmonics, differential leakage field
- ☑ Influence of saturable teeth on gap flux
- ☑ Fractional Slots/Pole/Phase (SPP) , how to lay out winding

☑ 5. Variations in Winding Design

- ☑ Lap vs. Concentric windings Effect of consequent poles
- ☑ Wye vs. Delta, short & long jumper, leads – impact on performance
- ☑ Random vs. bobbin vs. form coils

6. Concentrated Coil Winding Design

- ☑ Harmonics & performance for SPP =1
- ☑ Harmonics & performance of Fractional SPP
- ☑ How to minimize harmonics, maximize torque for Fractional SPP
- ☑ Using harmonics to predict torque ripple and noise

18:00 Session Ends

Please Note -- *Daily schedule includes:*

- *Three AM & Three PM sessions, approximately 1 hour, each*
- *10 minute breaks between sessions*
- *30 minute Lunch Break*

9:45-10:10 On-Line Entry; AV check
10:15 Sessions Begin

Day 2 AM: ADVANCED MOTOR THERMAL DESIGN

7. Thermal Analysis Issues for Motors Construction

- ☑ Distributed heat sources and cooling System
- ☑ Understanding thermal result of manufacturing processes
- ☑ Improved heat transfer by design
- ☑ Cooling in TEFC (IP55) Frame
- ☑ Water and Oil cooling calculations

8. Realistic Thermal Modeling

- ☑ Thermal modeling in lumped circuit, mixed-mode quasi 2D/3D
- ☑ Thermal modeling in FEA
- ☑ Calibrating Models to test data
- ☑ Forced cooling calculations In-slot winding methods

9. Advanced Thermal Analysis

- ☑ Steady state thermal analysis – 3 hp Induction Motor
- ☑ Transient thermal analysis – 3 hp Induction motor
- ☑ Methods & tricks to improve internal heat transfer
- ☑ Methods & tricks to improve external heat transfer

Day 2 PM: MOTOR DESIGN OPTIMIZATION

10. Concept & Goal of Motor Design Optimization

- ☑ Understanding the specifications and objectives
- ☑ Understanding limitation due to manufacturing processes
- ☑ Initial scaling and figures of merit
- ☑ Optimization Procedure, Sensitivity Analysis
- ☑ Interpreting results, practical limits

11. Optimization Methods and Practice

- ☑ Optimized batch calculations and demonstrations
- ☑ Perform optimization in FEA
- ☑ Design for maximum torque
- ☑ Design for minimum magnet material

12. FEA Demonstration

- ☑ Surface Magnet Motor Design
- ☑ Motor Design –Cogging torque
- ☑ Motor Design – Harmonics
- ☑ Trends for more advanced analysis

18:00 Session Ends

Day 2 – PM
Tentative Special Extra:
FEA Design Capabilities Demo

9:45-10:10 On-Line Entry; AV check
10:15 Sessions Begin

Day 3 AM: ADVANCED INDUCTION MOTOR DESIGN

13. Advanced Induction Motor Design Choices & Models

- ☑ Unique principles of induction motor design; magnetization issue
- ☑ Equivalent Circuit & DQ Analysis in non-sinusoidal environment
- ☑ Understanding the stator slots/ rotor bars choice, harmonic torques
- ☑ FEA Analysis, including core losses and motor controller

14. High Performance Induction Motor Design

- ☑ High frequency, high speed rotor design
- ☑ Problem of proximity effect losses
- ☑ Design for traction drive
- ☑ Design for concentrated coil winding
- ☑ Rotor bar design to lower losses

15. Key Efficiency and Thermal Issues for Induction Motors

- ☑ Reducing stray load loss, Achieving flat efficiency curve
- ☑ Efficiency map calculation
- ☑ Thermal design of Induction Rotors
- ☑ Trends in induction motor design

☑

Day 3 PM: ADVANCED IPM MOTOR DESIGN

16. Advanced IPM Motor Design Choices & Models

- ☑ Unique design and operation principles of the IPM motor
- ☑ Equivalent Circuit and DQ Analysis, DQ current vectors; demagnetization
- ☑ Understanding the bridge, magnet layer & barrier choices
- ☑ FEA Analysis, torque ripple

17. IPM Rotor Design

- ☑ V-Shape Magnet vs. Straight Magnet
- ☑ Design for Reluctance Torque/ Magnet Torque ratio
- ☑ Alternative Magnet Layers, Bridges and spokes in Rotor Design
- ☑ Rotor Structural Analysis
- ☑ The Line-Start IPM motor

18. IPM Motor Design Issues

- ☑ Efficiency map calculation
- ☑ Thermal designs of IPM rotor
- ☑ Maximum torque/ampere vs. maximum efficiency
- ☑ Trends in IPM Motor Design

18:00 Closing & Adjourn

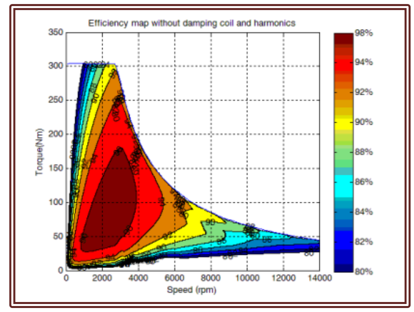
**Course content is subject to change. All issued material may not be covered.*

Instructor:

Dr. Keith W. Klontz is President and CEO of Advanced MotorTech LLC, an engineering services company with emphasis on electric machine design. He holds BS & MS degrees in Electrical Engineering from the University of Illinois, Champaign-Urbana, and a PhD in Electrical Engineering from the University of Wisconsin-Madison. Dr. Klontz is a world-recognized expert and instructor in electric machine design and has over 50 years of hands-on experience with electric machine applications and design engineering, from concept to performance to repair and failure analysis. He has been involved in the research, development, prototyping, testing and training of very high performance machines from 5 Watts to 50 MW, with speeds ranging from angle positioning torque-motors to 90,000 rpm machines. Recent work includes design of extremely high efficiency PM and induction motors, very high power density machines, permanent magnet alternators, brushless d.c. traction motors, brush d.c. motors, and design for low cost

Enrollment Fee Includes:

- ☑ Extensive 400+ page Training Manual (Full Color), materials shipped about 2-3 weeks before the course starts
- ☑ Access to the Live HD Broadcast, with two-way interaction capability
- ☑ Book "**Design of Brushless Permanent Magnet Machines"** by Hendershot & Miller
- ☑ Signed Certificate of Course Completion



Broadcast Information:

Hours: Live 9:45am to 18:15pm, Eastern Time Zone USA

Type: Classroom Setting; Live Instructor at Large-View Screen *(Not voice-over-slides)*

(Just like a live classroom, session recordings will not be available for later viewing)

Platform: Custom 1080p WEBEX; Entry Credentials with Password Required

To Attend This Course:

- **We will send a WEBEX Link and Entry credentials; please confirm receipt**
- **Recommended connection & bandwidth: Ethernet, 50MBs download** (5 MBs minimum); Wireless quality is not assured
- **Recommended viewing: 15 inch or larger monitor;** (1280 × 800 minimum**;** viewing ability, streaming quality, and compatibility with mobile devices, smaller screens and lower resolution, cannot be assured**)**
- **For now, we can accept only attendees located in: North America, UK/Europe, Japan, Korea, Australia, New Zealand**

***Enrollment:** ☐ **Yes! Please enroll me in the 3-day course: Course ID: AMD–2009**

Advanced Motor Design, September 22-23-24, 2020

Fee: $2125.00 for USA shipping address

$2325.00 for all International shipping addresses

Early Enrollment Fee†: $1975.00 for USA shipping address

$2175.00 for International shipping addresses

(We reserve the right to not enroll anyone, for any reason, at our sole discretion.)

Early Enrollment Discount!
Payment by August 1, 2020

Payment (USD$ only): *(Payment Deadline: Payment must be received 2 weeks before the course; Early Enrollment payment must be received by August 1, 2020, no exceptions; †Invoiced and †PO payments not eligible for early discount)*

☐ MasterCard ☐ Visa ☐ AMEX

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- Card No. ____
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Name ____________________________________ Title ____

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City ___________________________ State _______Zip _____

Phone ( ) _________ Email_________________________

Next Offering of our One-Of-A-Kind Course!

***By enrolling for our course, you agree:**

(1) To provide us a verifiable address with this enrollment for trackable shipment of training materials
Sorry, a PO Box is not acceptable for this. Delivery without signature required will be used
(2) To not allow any unpaid individuals to view any of the training content with intent to learn from our broadcast
(3) To screen-capture only handwritten white-board/flipchart writing, and visual samples shown.
(4) With exception of (3) screen-captures, to not allow any recording of the broadcast without permission in writing and prior payment of a recording fee. All training material and broadcast content is copyright protected.
(5) To not hold us responsible for poor connection, poor audio, or poor visual quality due to issues with your hardware, software, ISP, or facility. *(If in doubt, please contact us in advance for an Audio/Visual check.)*

Cancellations made 15 days or more before the course starts, AND before shipment of the training materials, are subject to a 15% cancellation fee.
Cancellations made 14 days or less before the course starts, OR after shipment of training materials, are subject to a 50% cancellation fee.

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