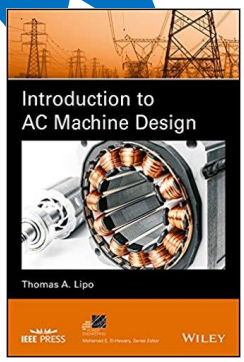
ADVANCED MOTORTECH LLC
5237 PARK STREET NORTH
SAINT PETERSBURG FL 33709-1011 USA
ADVANCEDMOTORTECH.COM
727-412-8200 ♦ SALES@ADVANCEDMOTORTECH.COM

Includes Book!
Tentative: Introduction to AC Machine Design
By Thomas A. Lipo



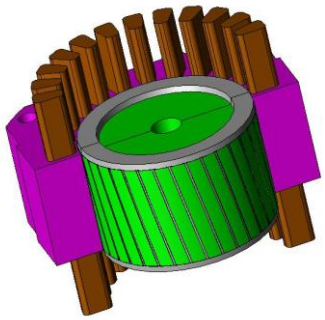
NEXT OFFERING!
JANUARY 28-29-30, 2020 IN ALBUQUERQUE NM

INDUCTION MACHINE DESIGN

--TAKING THEORY TO PRACTICE

Learn practical Induction Machine Design by applying motor characteristics, academic theory and manufacturing practices:

- **Induction Machine Design Methods, Unique Issues to IM's.**
- **Understand the Difference Between Analysis and Design**
- **Practical Non-Linear Magnetic Analysis Techniques**
- **Putting Flux & Windings to Work, Limitations**
- **Performance & Loss Calculations**
- **Realistic Practice & Expectations, Effect of Manufacturing**
- **How to Test for Parameters & Performance**



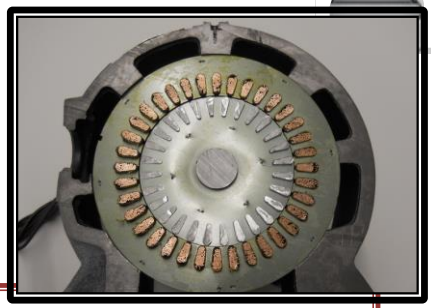
Objectives and Benefits:

This course provides practical, application-oriented design engineering methods for Induction Machines. Key motor principles are used to understand and choose options for Induction Machine design. Academic theory and practical experience is transformed to practical results with calculation 'How-to', considering manufacturing constraints. Emphasis is on quick decisions, performance differences, and new trends in induction motors. Included are new analysis techniques and new design options to achieve low cost, high efficiency, high power density, and maximum torque per amp. Similarities and differences of induction machines, compared to the latest PM machines, reluctance machines, and wound-field synchronous machines, is a common theme.

We specialize in engineering material that you can't find in a book, and you can't get from software training! It is presented using our acclaimed combination of motor design concepts and computer technology, with a heavy dose of many years of experience. Specifications, design steps, analysis approaches, useful rules of thumb and test methods are discussed for motors and drives for applications such as industrial systems, commercial HVAC, hybrid and electric vehicles, wind turbine generators, and home appliances. Most of the course focuses on three-phase squirrel-cage machines, both NEMA and non-NEMA types.

Those who will benefit:

- **Induction Motor & Generator Design Engineers**
- **Motor Engineering and R&D Managers, Professors & Grad Students**
- **Suppliers to Motor Manufacturers**
- **Control Engineers, Drive Systems Engineers**
- **Application Engineers, Sales Engineers**
- **Those Who Specify, Manufacture, Use or Service Induction Machines**



You should have some background in electric machine operation and construction such as the equivalent of a B.S. degree in engineering. Understanding of basic magnetic circuits is needed, but advanced motor theory and control techniques are not essential.

*** Course Schedule ***

Day 1:

7:30-8:00 Registration

8:15 Session Begins

1. Fundamentals of Induction Machines
- ☑ Comparison of Motor Types
- ☑ Rotor Configurations, & Why
- ☑ Create Torque in Induction Machines
- ☑ Equivalent Circuit of IM, DQ Model
- ☑ IM Models to Predict Performance
- ☑ IM Machine Design Steps, Using CAE

2. Control of Induction Motors
- ☑ Speed, Current, Torque, Loss Control
- ☑ VFD, 6-step, PWM, SVM, Vector Control
- ☑ Control for Torque/Amp or Efficiency
- ☑ Traction: Field Weakening, Peak Torque
- ☑ Peak Torque vs. High Speed, New Concepts
- ☑ Sensors for Control, Limits, Sensorless

3. Steel Core for Induction Machine
- ☑ Electrical Steels for IM, Making Lams
- ☑ Understanding Loss Data for Small Gap
- ☑ Coatings, Punching & Heat Treatment
- ☑ Segmented, Hinged Laminations for IM?
- ☑ Soft Magnetic Composites for IM?
- ☑ Sources of Good Data

4. Magnetic Analysis for IMs
- ☑ Non-linear Magnetic Circuits, MMF, Gap
- ☑ Air gap Flux, EMF Waveform
- ☑ Slot Leakage, Saturation, Inductances
- ☑ Intro to Motor Design Software & FEA
- ☑ Rules of Thumb, Good Practices

5. Squirrel Cage IM Rotor Design
- ☑ Materials, Construction, Principles
- ☑ Physics of Rotor Magnetization, Poles
- ☑ Rotor/Stator Slot Choice, Trade-offs
- ☑ Rotor Bar-shape, Options, Trade-offs
- ☑ Bar Shape for Peak Torque (Traction)
- ☑ Copper vs. Aluminum Cage

16:45 Session Ends

We'll keep you fresh!
Daily schedule includes:
Mid-morning break (10:00)
Lunch (12:00-13:15)
Afternoon break (15:30)

Day 2:

8:15 Session Begins

6. Winding Design Choices for IMs
- ☑ Coils, Poles, Slots, Phases
- ☑ Series, Parallel Circuits, Wye vs. Delta
- ☑ Lap vs. Concentric Winding
- ☑ Consequent Poles, Fractional Slots / Pole
- ☑ Design with Concentrated Coils
- ☑ Traction & Large Machine Coils
- ☑ Some Practical Info & Tricks of the Trade

7. Sizing & Scaling Laws
- ☑ Key Sizing Factors, Figures of Merit
- ☑ Current and Flux Density, MMF Drop
- ☑ Torque/Ampere, Maxwell Shear Stress
- ☑ Scaling: Vary Diameter, Vary Axial Length

8. Loss Calculations & Segregation
- ☑ Loss Components, Thermal Balance
- ☑ Causes, Core Loss, Prediction
- ☑ How to Determine Loss Coefficients
- ☑ Conductor & Eddy Current Losses
- ☑ Loss Segregation, Efficiency Map

9. How to Design Induction Motor
- ☑ Specification, Materials, Cooling
- ☑ Choosing Poles, Slots, Frequency
- ☑ Designing the Rotor Configuration
- ☑ Designing the Stator Slots & Winding
- ☑ Efficiency vs. Power Density
- ☑ Design Example: In-Class

10. Harmonics
- ☑ Winding MMF – Analysis, Models
- ☑ Winding Harmonics – Causes & Fixes
- ☑ Slot Harmonics, Minimizing the Effect
- ☑ Current Harmonics, Inverter Effect
- ☑ Effect of Rotor Design

11. Modeling & Simulation
- ☑ Analytic vs. Finite-Element Analysis
- ☑ Motor Design Software & Books
- ☑ FEA Software, Practical Perspective
- ☑ Linked CAE Simulation
- ☑ Ideas for Software & Hardware

16:45 Session Ends

2nd Day Extra FEA Demo!
Includes Refreshments

Day 3:

8:15 Session Begins

12. Thermal & Mechanical Design
- ☑ Mechanical Design, Fits, Tolerances, gap
- ☑ Losses, Heat, Cooling, Temperature, Rotor
- ☑ Cooling Tradeoffs – Self-Cool, Fan, Liquid
- ☑ Forces & Noise; Tips to Lower Noise
- ☑ Transients During Peak Torque
- ☑ Thermal, Mechanical Structural Data
- ☑ Practical Expectation, Limits

13. Testing: Losses & Model Parameters
- ☑ Electrical: R, L, Volts, Amps, PF
- ☑ Mechanical: Torque, RPM, Heat
- ☑ Locked Rotor, No-Load Tests, Equivalent Circuit Parameters
- ☑ Speed - Torque Curve
- ☑ Dynamometer Recommendations
- ☑ Test for Current Ripple, Ld, Lq
- ☑ Loss Tests, Efficiency Calculation

14. Efficiency for Industrial/HVAC
- ☑ Principles & Myths of Energy Savings
- ☑ Understanding Application Options
- ☑ Conversion System Configurations
- ☑ Design Example,: Copper Rotor

15. Power Density for Traction
- ☑ EV & HEV Applications
- ☑ Toyota Prius PM Motor
- ☑ Tesla Induction Motor
- ☑ Rail Traction Motor
- ☑ Design Example: Max Torque/AMP

16. New Trends & Technologies – What, Why, When
- ☑ Cast Copper Rotors
- ☑ Axial Flux IM Machines
- ☑ High Speed IM Machines
- ☑ New Materials
- ☑ Modular & Automated Mfg.
- ☑ PM Supply Uncertainty, Effect on IM

15:00 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

General Information

Tuition Fees Include:

- ☑ Extensive Training Manual (Full Color with Large Pictures)
- ☑ Hard Cover Book, Tentative:
  "**Introduction to AC Machine Design**" by Thomas A. Lipo
- ☑ Mid-Morning & Afternoon Break w/ Refreshments Each Day
- ☑ Lunch Each Day in Session
- ☑ Signed Certificate of Course Completion



Host Hotel Location:

Sheraton Albuquerque Airport Hotel
2910 Yale Boulevard SE
Albuquerque NM 87106 USA
Phone: +1-505-2843-7000, +1-800-277-1117

Accommodations:

A **great reduced-rate block** of rooms has been reserved at the beautiful, convenient **Sheraton Albuquerque Airport Hotel** for reservations made **before Dec 27, 2019**. Identify yourself as a participant in Advanced MotorTech training group to reserve a room at the reduced rate. Please make your own reservations.

Onsite training is available!
Send inquiries to
sales@advancedmotortech.com

Enrollment:

☐ Yes! Please enroll me in **Induction Machine Design, January 28-30, 2020**
Fee: $1925.00 (USD only) **Course No. IMD-2001**
Early Registration Fee: $1800.00 (USD only); Payment received by December 15, 2019
(We reserve the right to not enroll anyone considered to be a competitor or unsuitable, at our sole discretion.)

PAYMENT: (Deadline: *Payment must be received before start of course)

☐ MasterCard ☐ Visa ☐ AMEX

- Cardholder Name _____
- Card No. _____
- Exp ____/____ Billing Zip_____ Security Code: _____

☐ Check enclosed* (payable to Advanced MotorTech, LLC ☐ Purchase Order*

☐ Bill my company* ☐ Purchase Order*

* Please note payment deadline above; no exceptions; subject to approved credit.

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Title _____

Company _____

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* Cancellations received earlier than 14 days before the course are subject to a 15% late cancellation fee. Cancellations made within 7- 13 days before the course starts are subject to a 50% cancellation fee. Cancellations made 6 or less days before the course starts are subject to the full fee, or credit towards a later course

Phone: +1-727-412 – 8200 **Email: Training@AdvancedMotorTech.com**
Mail: Advanced MotorTech LLC, 5237 Park Street N, Saint Petersburg FL 33709 USA
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