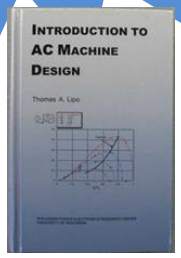
ADVANCED MOTORTECH LLC
4951 71ST AVENUE NORTH
PINELLAS PARK, FL 33781-4428 USA
ADVANCEDMOTORTECH.COM
727-412-8200 ♦ SALES@ADVANCEDMOTORTECH.COM

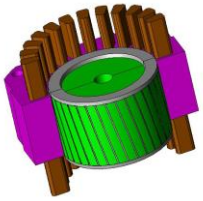
Includes Classic Book!
Introduction to AC Machine Design
By Thomas A. Lipo



Next Course Offering!
November, 17th, 18th & 19th 2015 in Dayton, Ohio
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
- Practical Magnetic Analysis Techniques
- Putting Flux & Windings to Work
- Performance & Loss Calculations
- Realistic Practice & Expectations
- 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.

<u>This course is the engineering material that you can't find in a book, and you can't get from software use or training!</u> It is presented using a 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:

- Motor & Generator Design Engineers
- Application Engineers
- Suppliers to Motor Manufacturers
- Control Engineers
- Engineering and R&D Managers
- 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: Tues, November 17th
7:30-8:00 Registration

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

2. Control of Induction Motors
- ☑ Current, Torque, Speed, Loss Control
- ☑ VFD, 6-step, PWM, SVM, Vector Control
- ☑ Control for Torque/Amp or Efficiency
- ☑ Traction: Field Weakening, Peak Torque
- ☑ Impact on Machine Design, 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

Day 2: Wed, November 18th
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
- ☑ Manufacturing Issues, Concentrated Coils
- ☑ Traction & Large Machine Coils
- ☑ Some Practical Info & Tricks of the Trade

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

8. Loss Calculations & Segregation
- ☑ Loss Components, Thermal Balance
- ☑ Problem of Core Loss Prediction
- ☑ How to Determine Core 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 Choice

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

Day 3: Thus, November 19th
8:15 Session Begins

12. Thermal & Mechanical Design
- ☑ Mechanical Design, Fits, Tolerances, IM 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 for IM
- ☑ Practical Expectation, Limits

13. Testing: Losses & Model Parameters
- ☑ Electrical: R, L, Volts, Amps, PF
- ☑ Mechanical: Torque, RPM, Heat
- ☑ Locked Rotor, No-Load Tests
- ☑ Speed - Torque Curve
- ☑ Dynamometer Recommendations
- ☑ Inductance 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

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

2nd Day Extra FEA Demo!
Includes Refreshments

Course content is subject to change. All issued material may not be covered contingent on time used for Questions & Answers.

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 in electric machine design and has over 45 years hands-on experience with electric machine applications and design engineering, from concept to performance to failure analysis. He has been involved in the research, development, testing and training of very high performance machines from 10 Watts to 50 MW, with speeds ranging from angle positioning torque-motors to 60,000 rpm machines. Recent work includes design of permanent magnet alternators, brushless d.c. motors, brush d.c. motors, high efficiency induction motors, very high power density machines, and low cost manufacturing.

General Information

Tuition Fees Include:

- ☑ Extensive Training Manual (Full Color with Large Pictures)
- ☑ Hard Cover Book "Introduction to AC 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:

Marriott at the University of Dayton
1414 South Patterson Boulevard
Dayton, Ohio 45409 USA
Phone: 800-450-8625

Accommodations:

A **reduced-rate block** of rooms has been reserved at the convenient **Dayton Marriott** for reservations made **before November 2nd**. Identify yourself as a participant in this course with code "ADV" to reserve a room at the reduced rate. Additional directions and information will be sent with your enrollment confirmation. Please make your own reservations

Enrollment:

☐ Yes! Please enroll me in **Course No. IMD-1115**
Induction Machine Design, November 17-19, 2015
Fee: $1725.00 (USD only)
We reserve the right to not enroll anyone considered to be a competitor, at our sole discretion.

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

☐ MasterCard ☐ VISA ☐ AMEX

- Cardholder Name _____
- Card No. _____
- Exp ___/___/___ Billing Zip_____Security Code: ____

This course begins where academics and software training stop!

☐ Check enclosed (payable to Advanced MotorTech, LLC)

☐ Bill my company ☐ Purchase Order

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

Name _____
Title _____
Company _____
Address _____
City _____ State _____Zip _____
Phone ( ) _____ Email_____

* Cancellations received 14-30 days before the course are subject to a 15% late cancellation fee. Cancellations made 7-13 days before the course starts are subject to a 50% cancellation fee. Cancellations made less than 7 days of the course beginning are subject to the full fee.

Phone: (727) 412-8200
Fax: (727) 412-8299
Email: Training@AdvancedMotorTech.com
Mail: 4951 71st Ave. North, Pinellas Park, FL 33781 USA