ADVANCED MOTORTECH LLC
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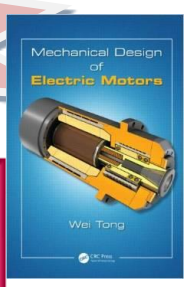
Includes Book!
"Mechanical Design of Electric Motors" by Dr. Wei Tong



Thermal Design of Motors & Generators
-Taking Theory to Practice

Join Us LIVE, ON-LINE: JULY 21-23, 2020

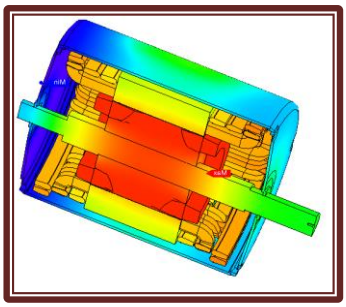
Live Interactive Classroom experience bro

Please Note: All Training courses are postponed until at least September 2021

Learn THERMAL DESIGN Principles and Methods for Induction Motors, PM Motors, Reluctance Motors, & DC Motors and Generators by applying practical experience, academic theory, material characteristics, manufacturing practices:

Thermal Design Principles and Methods for Electric Machines

- ☑ **Practical Thermal Principles and Analysis Techniques**
- ☑ **Deciding Which Materials, Frame Design, Cooling**
- ☑ **Temperature & Loss Calculations That Work**
- ☑ **Realistic Practice & Expectations; Options to improve**
- ☑ **How to Calculate & Test for Parameters & Performance**



Objectives & Benefits:

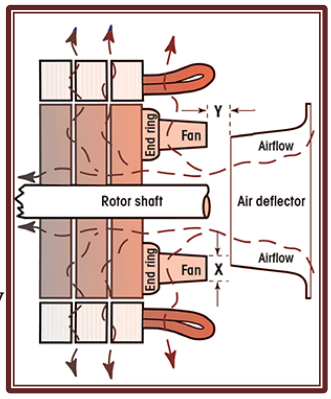
This is the FIRST true thermal design course anywhere in the world! Learn the calculations and "How-to" for application-oriented thermal design for all types of motors & generators. Learn thermal design techniques & decisions based on academic theory, years of practical experience, new designs and materials, all taking manufacturing and costs into account.

You will learn about practical Thermal Design Methods and the latest trends, including:

- **Understanding Heat Sources and Heat Sinks, Heat transfer, Temperature, Building your own Model**
- **When to choose Natural Convection versus Forced Convection Cooling versus Liquid Cooling**
- **New Analysis Techniques, Computer-Aided Engineering (CAE), Quick Approximations**
- **Thermal Design Trade-offs affecting Efficiency, Power Density, Thermal Target, Cost, Reliability**
- **Design using New Materials, New Manufacturing Methods, New CAE Tools**

The material in this course is Engineering practice you can't find in a book, & you can't get from software training! Presentations include specification requirements, design steps, balancing cost and thermal performance, good rules of thumb, analysis approaches & test methods. The course material applies to motors and generators used in industry, HVAC, hybrid electric drives, traction and propulsion systems, wind turbines, home appliances, aerospace applications. The material applies to radial flux, axial flux, transverse flux, and linear machines.

This **NEW, FAST-PACED COURSE** is packed with thermal design engineering concepts, with a heavy dose of experience. You will learn about the design calculations, similarities & differences of cooling systems, fabrication methods, choices of materials, and analysis tools. The MotorCAD® software will be used to illustrate and help understanding; but this is NOT software training.



Those who will benefit:

- **Motor & Generator Design Engineers and Manufacturers**
- **Drive & Control Engineers**
- **Application Engineers, for Industrial, HVAC EV/HEV/UAV, Wind, High Efficiency**
- **Suppliers to Motor Manufacturers**
- **Engineering & R&D Managers, Electric Machine Professors & Graduate Students**
- **Others Who Specify, Design, Manufacture or Service Motors and Generators**

You should know basic electric motor and generator principles, operation & construction. Understanding of basic thermal behavior in machines is very helpful, but advanced thermodynamic theory & motor theory is not essential.

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

Day 1:

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

1. Fundamentals of Electrical Machines
- ☑ Comparison of Motor Types
- ☑ Design Envelope,
- ☑ Key Characteristics, Figures of Merit
- ☑ Rotor Configurations, & Why
- ☑ Key Thermal Considerations

2. Multi-Discipline Models and Simulation of Electrical Machines
- ☑ Equivalent Circuits—Electrical & Thermal, Simple to Complex
- ☑ Using Models to Predict Performance
- ☑ Machine Design Steps, Thermal Impact
- ☑ Using CAE—Choose your difficulty wisely

3. Fundamentals of Thermal Design
- ☑ Cooling Method: Type, Air, Water, Oil
- ☑ Cooling Hardware
- ☑ Characteristics of Cooling Systems
- ☑ Building Equivalent Thermal Circuit
- ☑ Thermal Models, Temperature, Heat Flow
- ☑ Thermal Design Software

4. Heat Sources, Temperature Effects
- ☑ Heat Sources Overview, Location & Effect
- ☑ Joule Losses, AKA I^2R Losses
- ☑ Core Iron Losses
- ☑ Windage & Friction Losses
- ☑ Stray Load Losses
- ☑ Core Loss Prediction & Loss Coefficients

5. Material Considerations for Thermal Design
- ☑ Stator Materials, Impregnation
- ☑ Rotor Materials
- ☑ Magnet Materials
- ☑ Motor Housing Materials & Configuration
- ☑ Potting Materials, Composite, Processes

6. Thermal Estimation and Analysis
- ☑ Thermal Analysis Principle
- ☑ Thermal Analysis – Design Example
- ☑ Fan Cooling System
- ☑ Water Cooling Calculation
- ☑ IPM Motor Thermal Modeling

18:00 Sessions End

Please Note:

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

Day 2:

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

7. Thermal Considerations, Winding & Stator Design
- ☑ Current Density of Wire, Slot Fill Factor
- ☑ Wire Stranding, AC Losses
- ☑ Coating Configuration
- ☑ Slot Insulation
- ☑ Concentrated Winding Tradeoffs
- ☑ End Turn, Axial Heat Flow
- ☑ Laminations; Vent Ducts

8. Thermal Consideration, Rotor Design
- ☑ Induction Motor Rotor Bars
- ☑ PM Motor Magnet Segmentation
- ☑ Rotor Core; Vent Ducts
- ☑ Rotor Coils and DC Armature
- ☑ Rotor Cage Fins and Internal Fan

9. Thermal Considerations, Housing & EndBell Design
- ☑ Frame Types, Materials and Heat Flow
- ☑ Core and Housing Orientation
- ☑ Forced Air Cooling Design; Fin Design
- ☑ Liquid Cooling Systems in Housing
- ☑ Aggressive Cooling Methods: Oil Mist, Shaft Cooling, Blower Ventilation, Compressed Air

10. Sizing & Scaling Laws
- ☑ Key Sizing Factors, Figures of Merit
- ☑ Current Density & Electric Loading
- ☑ Flux Density, MMF Drop
- ☑ Ke, Kt, Maxwell Shear Stress
- ☑ Scaling: Varying Diameter, Length

11. Thermal Design of Electric Motors
- ☑ Typical Heat Transfer
- ☑ Improving Heat Transfer by Design
- ☑ Induction Motor Thermal Simulation
- ☑ Thermal Parameter Calculation
- ☑ Induction Motor FEA Modeling

12. Advanced Analysis (Transients)
- ☑ Analytic vs Transient Thermal Analysis in MotorCAD
- ☑ Transient Thermal Analysis – 3HP Induction Motor with FEA

18:00 Sessions End

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

Day 3:

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

13. Integrating Motor Design, Thermal Modeling & Simulation
- ☑ Analytic vs. Finite-Element Methods
- ☑ Motor Design Software & Books
- ☑ One Way Thermal Simulation
- ☑ Coupled Magnetic-Thermal Simulation
- ☑ Overview of CFD Analysis

14. Practical Thermal Design
- ☑ Methods to Reduce Losses
- ☑ Methods to Improve Internal Heat Transfer
- ☑ Methods to Improve External Heat Transfer

15. Testing: Losses & Modeling Thermal Parameters
- ☑ Testing Core Loss and Mechanical Loss
- ☑ Harmonic Effect on Loss Prediction
- ☑ Calibrating Models to Experimental Data
- ☑ Thermal Evaluation of Materials and Processes

16. New Trends & Technologies – What, Why, When
- ☑ EV Copper Rotor
- ☑ Super Conductor
- ☑ High Thermally Conductive Materials
  - ○ Slot insulations
  - ○ Wire insulations
  - ○ Encapsulation compounds
- ☑ New Manufacturing Methods

16:00 Closing & Adjourn

Practical design you can't get from books or software training

** Session breaks will not be coincident with topic breaks*

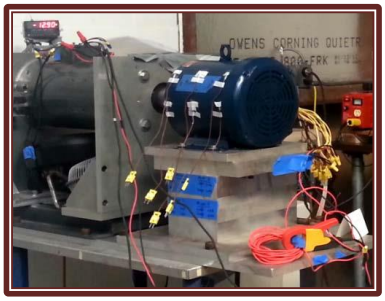
** Course content and schedule is subject to change. All listed material may not be covered in class, contingent on time used for extended discussion, questions.*

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 10 Watts to 50 MW, with speeds ranging from torque-motors to 90,000 rpm. Recent work includes design of very high efficiency PM and induction motors, very high power density machines, permanent magnet alternators, brushless d.c. traction motors, and low cost manufacturing.

Registration Fee Include:

- ☑ 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
- ☑ Hardcover Book "**Mechanical Design of Electric Motors**" by Dr. Wei Tong
- ☑ 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**
(Exceptions are not likely, but possible, on a case by-case only, at our sole discretion)

***Enrollment:** ☐ **Yes! Please enroll me in the 3-day course: Course ID: THRM–2007**

Thermal Design of Motors and Generators, July 21-23, 2020
Fee: $2125.00 for USA shipping addresse
$2325.00 for all International shippi

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Early Registration Discount!
ment by July 3, 2020

Early Registration 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.)

Payment (USD$ only): *(Payment Deadline: Payment must be received 2 weeks before the course; Early Registration payment must be received by July 3, 2020 (extended), no exceptions; †Invoiced and †PO payments not eligible for early discount)*

☐ MasterCard ☐ VISA ☐ AMEX

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

☐ Check (payable **to Advanced MotorTech, LLC**); ☐ †Invoice me; ☐ †Purchase Order; *Subject to approved credit*.

Name _____Title _____

Company _____

Shipping Address _____

City _____ State _____Zip _____

Phone ( ) _____ Email_____

Unique Course! One-of-a-Kind in the World!

***By registering 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 more than 14 days 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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