TRANSFORMER ACADEMY

INTRODUCTION TO TRANSFORMERS

COURSE AUTHOR: ORLANDO GIRALDO

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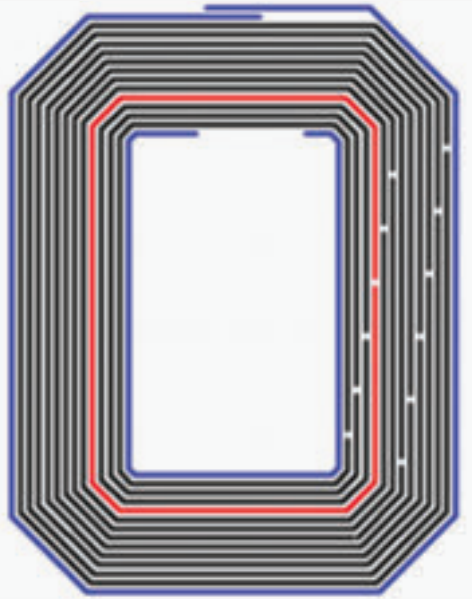
Orlando Giraldo has acquired the title of electrical engineer from the Technological University of Pereira, Colombia, and finance specialist from the EAFIT University. He has worked for over 46 years of at different positions in the transformer-related areas in ABB (13 years), SIEMENS (14 years) and THE HJ FAMILY OF COMPANIES (the last 24+ years) on: design, production, tests, sales, etc., of transformers and components. He has also completed multiple training visits to transformer and component plants around the world. Eng. Giraldo is a specialist in transformer production, components and protection. For the last five years, he has been working as senior consulting engineer of THE H-J FAMILY OF COMPANIES and teacher of Transformer course in the Technological University of Pereira.

WHAT MAKES THIS COURSE UNIQUE?



This is a transformers course based on 50+ years of experience in transformers design, production, tests, protection, manufacturing machines, components marketing, and factory management.

The program contains state-of-the-art information about the core and coil manufacturing media, renewable energy transformer applications, digital and smart transformer characteristics, monitoring and control, fuse protection of oil-immersed transformers, high temperature solid and liquid insulations, including ester oils.

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TARGET AUDIENCE

The course is intended for:

1. Transformer manufacturers
2. Repair shops
3. Utility engineers
4. People involved in transformer monitoring and control
5. People producing transformer components who want to understand transformer operation

TRANSFORMER ACADEMY

INTRODUCTORY / BASIC LEVEL

LESSON 1

History of transformers and introduction to the content of the course

- The journey of a young transformer designer - the future of the industry
- Transformers in the 2020's decade
- Digitalization of transformers
- Transformers for renewable applications

LESSON 2

The basics of transformers

- The need of transformers – Transmitting electric energy at high voltages.
- Old radial systems and new microgrids and smart grids concept. Distributed generation.
- Basic concepts of the electromagnetic theory applied to transformers: magnetic field, magnetic flux, magnetomotive force, permeability of magnetic materials. Basic problems of applications. Exercises.
- Definition of a transformer (the basics of):
  - Principles of operation
  - Constructive characteristics
  - Magnetic circuit and hysteresis cycle
  - Windings and electrical circuit
- The insulating structure cooling methods and cooling system working characteristics of a transformer.
- No-load operation: losses and excitation current
- Under load operation: the war of the fluxes. Load losses and transformer ratios.
- Phenomena that occur in an energized transformer
- Forces between windings
- Magnetostriction
- Leakage flux
- Transformer heating
- Standards and regulations: IEEE, IEC, national standards, etc.
- Classification of transformers: review of 22 different of transformer types according to:
  - Localization in the electric power system
  - Type of Insulation
  - Voltage and power ranges

INTERMEDIATE LEVEL

LESSON 1

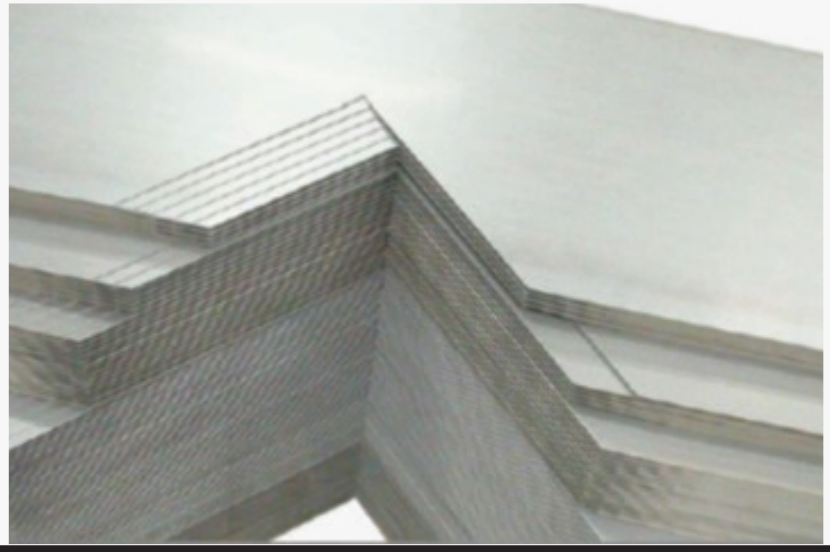
The magnetic circuit

- The magnetic core
- Ferromagnetic materials used in transformer core manufacturing
- Magnetization and hysteresis curve
- Fundamental equation of transformers. Considerations.
- Design and construction of the transformer core
- Types of cores for distribution and power transformers
- Machinery to manufacture cores for distribution and power transformers
- Noise, magnetostriction, resonance
- Core losses (eddy losses and hysteresis losses) and separation method. Numerical examples.
- No load losses test in transformers. Test circuit considerations.
- Procedure to calculate core losses for wound cores and for stacked cores. Numerical examples.

LESSON 2

Equivalent circuit of a transformer

- Ideal transformer model
- Polarity marks in windings
- Basic equations of a transformer
- Phasor representation of the equivalent circuit
- Determination of the parameters of the equivalent circuit
- Load loss test. Examples.
- No Load loss test. Examples.
- Winding resistance measurements. Examples per IEEE Std.



MASTER'S LEVEL

LESSON 1

Operating characteristics of transformers

- Short circuit tension and current (symmetrical and asymmetrical)
- Thermal and dynamic effects of short circuit currents
- Inrush current
- Voltage regulation
- Transformer efficiency
- Per unit system

LESSON 2

Windings and insulation system in the transformers

- Basic concepts about insulations
- Solid, liquid, and gaseous insulations for transformers
- Transformer bushings
- Thermal classification of transformer insulations
- Winding construction and machinery
- Winding types
- Geometrical calculation of a winding. Losses and weight calculations.
- Winding tests: applied voltages, induced tension, impulse tests

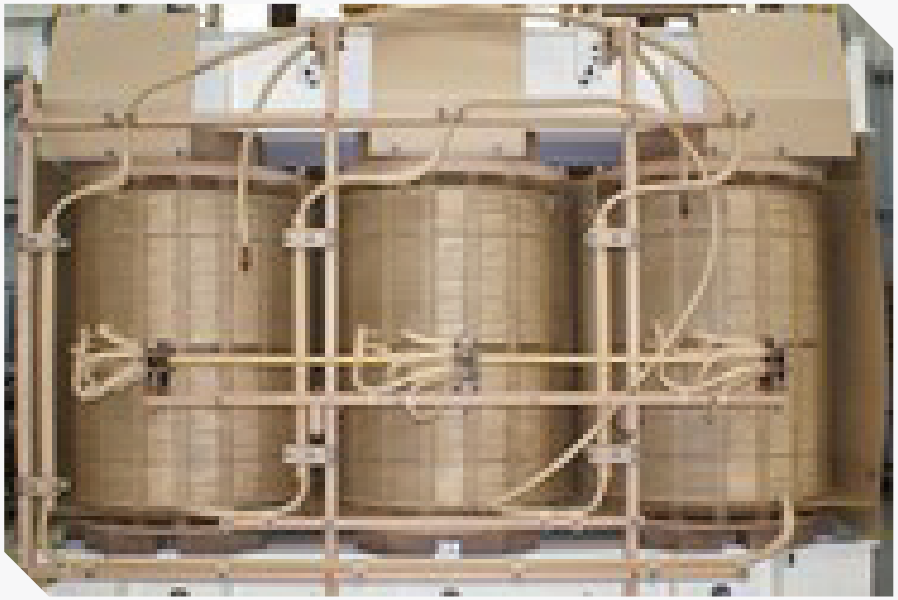
LESSON 3

Temperature and load-ability of transformers

- Expected life of a transformer
- Insulation aging
- Heat transfer in a transformer
- Temperature limits in a transformer
- Cooling limits in a transformer
- Cooling systems in a transformer
- Guide for loading transformers and temperature model of a transformer
- Heat run test and loss of life calculation

ADDITIONAL POTENTIAL LESSONS:

- Other constructive forms of transformers: 3-winding transformers, autotransformers
- Tap changers and dual voltage switches
- 3-phase transformers and connecting groups
- Characteristics of transformer connecting groups and performance under overloads
- Zig-zag connection characteristics and applications
- 3-phase cores characteristics and applications
- Operation of transformers in parallel
- Transformer accessories and transformer digitalization
- Transformer test standards and specifications



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The entire course is fully endor-agnostic, but it is sponsored by The H-J Family of Companies.

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