

TUTORIAL: Fundamentals of Transformer Design.

The tutorial objective is to present the fundamentals of “core-type” power transformers design, detailing all stages, the compliance with international standards and customer specifications, and description of the calculation tools necessary for design and evaluation.

The tutorial is aimed at professionals working in electrical utilities and are responsible for the specification, acquisition, design review, factory acceptance, installation, operation, maintenance and repair of power transformers.

The tutorial begins with a brief description of the constructional details of core and windings used in power transformers and the materials used in his manufacture (silicon steel, conductor materials and insulating materials).

During the tutorial we will present the design of transformers from the following points of view:

- calculation of electrical characteristics (losses, impedances, etc.).
- dielectric dimensioning.
- short-circuit dimensioning.
- thermal dimensioning.
- mechanical dimensioning.

The transformer design is multidisciplinary and requires in-depth knowledge of the basics of:

- Electromagnetism (Maxwell Equations).
- Heat Transfer (Conduction, Convection and Radiation).
- Hydraulics.
- Strength of Materials.
- Numerical Analysis.
- Calculation Software Development.

The design and calculation of transformers require to have sophisticated calculation tools, i.e. specific-use software. Some can be purchased in the market, like finite element packages, and others are developed by the manufacturers themselves for their exclusive use.

Among the numerical design tools to be presented in the tutorial are included:

- the Rabins Method applied to calculate the radial and axial components of the leakage magnetic flux.
- the Finite Element Method (FEM) applied to the dielectric, short-circuit, thermal and mechanical design.
- the minimizing of functions of several variables with nonlinear constrains using Genetic Algorithms for transformer optimization.

LECTURER: Álvaro Portillo

(IEEE Member 1984 - IEEE Senior Member 2001) He was born in Uruguay in 1954, and has an extensive experience in transformers, for almost 40 years. He graduated in Electrical Engineering in the Uruguayan Republic University in 1979.

He worked in the Uruguayan electrical utility (UTE) up to 1985 in activities related with transformers acceptance, installation and maintenance. From 1985 to 1999 he worked in MAK S.A. (Uruguayan manufacturer of transformers up to 20 MVA, 69 kV), from 2000 to 2007 as consultant in TRAF0 (Brazilian manufacturer of transformers up to 230 kV, 150 MVA) and from 2007 up today as consultant with development of software tools for transformer design at WEG (Brazilian manufacturer of transformers up to 500 kV, 500 MVA). He works also as consultant of electric utilities in the elaboration of technical specifications and design review of power transformers.



He is member of many CIGRE and IEC working groups. He is a professor at the Uruguayan Republic University since 1977, now responsible for post-graduation courses about transformers (specification, design, operation, maintenance, etc.).