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بروجاكس للتدريب والتطوير  
Projacs Training and Development

# Transformer Operational Principles, Selection and Troubleshooting

المحولات الكهربائية اختيارها وتشغيلها وصيانتها

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Dubai / United Arab Emirates

A Member of:



PROJACS ACADEMY



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## Introduction

Power and distribution transformers are essential devices in electricity supply. Their ratings can vary from small size distribution transformers of a few kVA up to very large power transformers of 1000 MVA or more. In terms of voltage ratings transformers can have operating voltages up to several hundreds of kilovolts. They represent a major asset of the power utility and any industrial plant.

Failure of a transformer can be very costly and dangerous for other major equipment and personnel alike. The design and operation of any transformer must fulfill certain requirements in order to withstand the electric, thermal and mechanical stresses during its service life. Tests and maintenance of transformers according to the relevant standards are intended to ensure that a transformer passing them will give trouble-free service for many years under the conditions it is likely to experience after its installation.

## Objectives

### At the end of the course participants will able to:

- Refresh the knowledge of the basic theory of transformers
- Understand the principles of operation of the transformer
- Identify the different features of power transformers, distribution transformers and instrument transformers
- Appreciate the principles of transformer design, ratings, windings, core structure and materials, insulation and cooling methods, selection, insulation, and lifetime
- Be familiar with construction of the transformer, transformer winding connections
- Recognize the effects of transformer load changes and off-load and on-load tap changers
- Understand transformer troubleshooting

### Who Should Attend?

- Engineers and Technicians from electricity supply industry
- Technical Management Professionals and Department Leaders
- Engineering Professionals from companies manufacturing and operating power and distribution transformers
- Engineers and Technical Personnel in power utilities, petrochemical plants, service professionals of large infrastructure projects.
- Participants need no specific requirements other than basic understanding of electricity and magnetism and circuit theory and general knowledge of nature and operation of power and distribution transformers.

## Course Outline

### **Day 1:**

#### **Introduction, General Principles and Classification**

- General Classification of Transformers: Transformer Construction, Core-Type, Shell-Type, Dry-type Transformers, Oil-filled Transformers, Cooling Techniques
- Transformer Windings, Interconnection of Windings, Advantages and Disadvantages of Principal Connections. Tertiary Windings, Autotransformers
- Harmonics in Transformers, Parallel Operation of Transformers, Loadings of Transformers in Parallel, Paralleling Requirements, Polarity
- Standards for Transformers, Types and Requirements
- Transformer Tapping and Connections
- Ability to withstand Short Circuit, Sound Level
- Case studies and workshop discussion

### **Day 2:**

#### **Transformer Constructional Details**

- Transformer Oil, Characteristics, Oil Oxidation, Breakdown Voltage, Water Content, Acidity, Oil Testing, Field Oil Testing, Dissolved Gas Analysis, Treatment and Filtering of Oil
- Effect of Oil Expansion, Breathing Action, Buchholz Relay, Explosion Vents
- Instrument Transformers
- Transformers for Industrial Applications: Electro-chemical, Arc and Induction Furnaces, Rectifier Transformers, High Voltage Testing Transformers, Precipitator Transformers, Dry Type Transformers
- Construction And Details, Transformer Cooling, Natural Cooling, Forced Cooling
- Case studies and Workshop Discussion

### **Day 3:**

#### **Transformer Operation, Selection, and Maintenance**

- Distribution Voltage Adjustment, Off-Load Tap Changing, On-Load Tap Changing
- Switching of high voltage underground cables supplying Distribution Transformers
- Earthing and Over-Current Protection of Distribution Transformers
- Transformer Maintenance: Oil preservation, Deterioration of oil, Breathers, Condition Monitoring, Faults in Transformers, Tapping and Windings
- Advanced Transformer Maintenance
- Guidelines on how to care for your Distribution Transformer
- Case studies and Workshop Discussion

### **Day 4:**

#### **Transformer Connections**

- Single Phase Circuits
- Two-Phase Circuits
- Three-Phase Circuits
- Transformer Maintenance and Troubleshooting
- Insulation Testing
- High Potential Testing
- Turns Ratio Testing
- Polarity Testing
- Power Factor
- Excitation Current
- DC Winding Resistance
- Polarization Recovery
- Insulating Fluid Dielectric
- Dissolved Gas Analysis

### **Day 5:**

#### **Transformer Protection, and Relaying**

- Transformer Faults and Troubleshooting
- Differential Relaying
- Normal Load
- External Faults
- Internal Faults
- Case studies and Workshop Discussion

## Training Method

- Pre-assessment
- Live group instruction
- Use of real-world examples, case studies and exercises
- Interactive participation and discussion
- Power point presentation, LCD and flip chart
- Group activities and tests
- Each participant receives a binder containing a copy of the presentation slides and handouts
- Post-assessment

## Program Support

This program is supported by interactive discussions, role-play, case studies and highlight the techniques available to the participants.

## Schedule

**The course agenda will be as follows:**

- |                     |                  |
|---------------------|------------------|
| • Technical Session | 08.30-10.00 am   |
| • Coffee Break      | 10.00-10.15 am   |
| • Technical Session | 10.15-12.15 noon |
| • Coffee Break      | 12.15-12.45 pm   |
| • Technical Session | 12.45-02.30 pm   |
| • Course Ends       | 02.30 pm         |

## Course Fees\*

- **2,950USD**  
*\*VAT is Excluded If Applicable*

## مقدمة

الطاقة الكهربائية ومحولات التوزيع هي من الأجهزة الأساسية في إمدادات الكهرباء. لذلك تصنيفاتها تختلف من محولات التوزيع الصغيرة الحجم من كيلو فولت حتى محولات الكهرباء الكبيرة جدا التي تصل ل 1000 MVA أو أكثر. فتقييمات محولات الفولتية من حيث الجهد والتي تعمل حتى عدة مئات من الكيلو فولت تمثل الأصول الرئيسية لتوليد الكهرباء في المنشآت الصناعية.

عند فشل عمل محول من محولات الكهرباء تكون مكلفة جدا وخطيرة للمعدات الرئيسية الأخرى والأفراد على حد سواء. فيجب عند تصميم وتشغيل أي محول الوفاء بمتطلبات معينة من أجل الصمود في وجه الضغوط الكهربائية، الحرارية والميكانيكية التي تخدمه. وتهدف الاختبارات وصيانة المحولات وفقا للمعايير ذات الصلة لضمان أن محول تمريرها سيعطي نتيجة خالية من المتاعب وخدمة تمتد لسنوات عديدة.

## الاهداف

في نهاية هذا البرنامج التدريبي سيكون المشاركون قادرين على:

- تحديث المعرفة النظرية الأساسية للمحولات
- فهم مبادئ تشغيل المحول
- التعرف على ميزات مختلفة من محولات الكهرباء، محولات التوزيع
- نقدر مبادئ تصميم المحولات، التصنيف، اللغات وبناء المواد الأساسية، والعزل وأساليب التبريد، والاختيار، والعزل، وعمرها
- كن على دراية ببناء المحولات
- التعرف على آثار التغيرات وتحميل المحولات وإيقاف التحميل
- فهم المحولات واستكشاف الأخطاء وإصلاحها

## الحضور

- المهندسين والفنيين المهتمين بصناعة إمدادات الكهرباء
- محترفي الإدارة الفنية
- محترفي الهندسة في شركات تصنيع وتشغيل الكهرباء ومحولات التوزيع
- المهندسين والكوادر الفنية في مرافق الطاقة ومصانع البتروكيماويات والمهنيين في خدمة مشاريع البنية التحتية الكبيرة