# Electrical Equipment Maintenance, Testing And Troubleshooting

## Course general description:

This course is designed to provide a comprehensive understanding of the various types of motors, variable-speed drives, transformers, generators, rectifiers and inverters, uninterruptable power systems (UPS), circuit breakers, and fuses. Upon the successful completion of this course, participants will be able to specify select, commission, and maintain this equipment for their applications. Further, participants will have enough knowledge to achieve reduced capital, operating, and maintenance costs along with an increase inefficiency.

## Audience:

This course is intended for:

1- Electrical Engineers
2- Technical staff, who are involved in the selection, installation, operation, testing, troubleshooting or maintenance of electrical equipment.
3- Maintenance personnel
4- Electrical supervisors

## Course objectives:

The participants will be able to:

1- Specify, select, install, operate, test, troubleshoot, and maintain various types of electrical equipment such as transformers, motors, variable speed drives, generators, circuit breakers, switchgear, and protective systems
2- Carry out diagnostic testing and inspection, advanced fault detection techniques, critical components, and common failure modes for electrical equipment
3- Apply selection criteria, commissioning requirements, predictive and preventive maintenance, reliability, testing, and cost estimation for electrical equipment
4- Implement the maintenance techniques required to minimize the operating cost and maximize the efficiency, reliability, and longevity of electrical equipment

## Course duration:

5 days

## Course location:

Cairo-Dubai-Istanbul

## Course contents:

**Day-1**

- Capacitors
- Current and Resistance
- The Magnetic Field
- Three-Phase System
- Electric Machines and Transformers
- Common Terms and Principles
- The Magnetic Field
- Magnetic Behavior of Ferromagnetic Materials
- Importance of Transformers
- Types and Construction of Transformers
- The Ideal Transformer
- Impedance Transformation Through a Transformer

- Analysis of Circuits Containing Ideal Transformers
- Theory of Operation of Real Single-Phase Transformers
- The Voltage Ratio Across a Transformer
- The Magnetizing Current in a Real Transformer
- The Equivalent Circuit of a Transformer
- The Transformer Voltage Regulation and Efficiency
- The Autotransformer
- Three-Phase Transformers
- Cause of Transformer Failures
- Transformer Oil
- Gas Relay and Collection Systems
- Relief Devices
- Interconnection with the Grid

**Day-2**

- The Rotating Magnetic Field
- The Induced Voltage in AC Machines
- the Induced Torque in a Three-Phase Machine
- Winding Insulation in AC Machines
- AC Machine Power Flow and Losses
- Induction Motor Construction
- Basic Induction Motor Concepts
- The Equivalent Circuit of an Induction Motor
- Losses and The Power-Flow Diagram
- Induction Motor Torque-Speed Characteristics
- Control of Motor Characteristics by Squirrel-Cage Rotor Design
- Starting Induction Motors
- Speed Control by Changing the Line Frequency
- Speed Control by Changing the Line Voltage
- Speed Control by Changing the Rotor Resistance
- Solid-State Induction Motor Drives
- Motor Protection
- The Induction Generator

**Day-3**

- Characteristics of Motors
- Enclosures and Cooling Methods
- Application Data
- Design Characteristics
- Insulation of AC Motors
- Failures in Three-Phase Stator Windings
- Predictive Maintenance
- Motor Troubleshooting Diagnostic Testing for Motors
- Repair and Re
- Furbishment of AC Induction Motors
- Failures in Three-Phase Stator Windings

- Introduction to Power Electronics
- Power Electronics Components
- Power and Speed Comparison of Power Electronic Components
- Basic Rectifier Circuits
- Filtering Rectifier Output
- Pulse Circuits
- A Relaxation Oscillator Using a PNPN Diode
- Pulse Synchronization
- Voltage Variation by AC Phase Control
- The Effect of Inductive Loads on Phase Angle Control
- Inverters
- Motor Application Guidelines

**Day-4**

- On-Load Maintenance and Monitoring
- Off-Load Maintenance
- Generator Testing
- Typical Generator Operational Problems
- Generator Rotor Reliability and Life Expectancy
- Generator Rotor Refurbishment
- Types of Insulation
- Generator Rotor Modifications
- Upgrades and Updates
- High-Speed Balancing
- Flux Probe Test
- Theory of Circuit Interruption
- Physics of Arc Phenomena
- Circuit Breaker Rating
- Conventional Circuit Breakers
- Methods for Increasing Arc Resistance
- Plain Break Type
- Magnetic Blow-out Type
- Arc Splitter Type
- Application
- Oil Circuit Breakers
- Recent Developments in Circuit Breakers
- FUSES
- Types of Fuses
- Features of Current Limiting Fuses
- Advantages of Fuses Over Circuit Breakers

**Day-5**

- Proper Lube Oil Sampling Technique
- Test Description and Significance
- Visual and Sensory Inspection
- Chemical and Physical tests

- The Application of Sine Waves to Vibration
- Multi-mass Systems
- Resonance
- Logarithms and Decibels (DB)
- The Use of Filtering
- Vibration Instrumentation
- Time Domain
- Frequency Domain
- Machinery Example
- Vibration Analysis
- Resonant Frequency
- Vibration Severity

**Methodology:**

- 50% lectures & concepts
- 10% Videos
- 10% Case studies
- 10% Exercises
- 10% Discussions
- 10% Software (if applicable or examples)

**Course code: (TEEI008)**