COURSE OVERVIEW EE0861
Fundamentals on Electrical Systems Operation, Maintenance, Testing & Troubleshooting (E-Learning Module)

Course Title
Fundamentals on Electrical Systems Operation, Maintenance, Testing & Troubleshooting (E-Learning Module)

Course Reference
EE0861

Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration
30 online contact hours
(3.0 CEUs/30 PDHs)

Course Description

This E-Learning course is designed to provide participants with a fundamental overview on electrical systems operation, maintenance, testing and troubleshooting. It covers the basic electrical theory and concepts including conductors, insulators, semiconductors, electromotive force and simple electrical circuit; the Ohm's law, resistance and resistivity, direct current (DC), alternating current (AC) and frequency (f, hertz); the power factor (pf) - real power/ apparent power, leading or lagging power factor, power factor and generator set KVA and the components of a substation; the power substation and layout; and the earthing and bonding, electrical separations and Earth fault compensation.

Further, the course will also discuss the transmission line parameters, resistance, temperature effects, inductance, capacitance, isolators, conductor systems and insulation; the principle of operation and transformer as well as transformer equations, power transformers, transformer parameters and transformer tap changer; the power system operating constraints, equipment constraints, stability constraints, harmonics and voltage distortion; the disturbances in the torque of induction motors; and the power system protection, faults and abnormal operating conditions.

During this course, participants will learn the sensitivity, selectivity, reliability and dependability; the insulation testing and maintenance, classification of insulation, testing and sampling insulating liquids and cleaning electrical insulation; the continuous monitoring; the protection components, protection relays, instrument transformers, current transformers and system transducers; the use and testing of voltage transformers; the lightning protection, transformer protection and switchgear maintenance; and the ten tips to optimize switchgear life and enhance reliability.

Course Objectives

Upon the successful completion of this course, participants will be able to:-

- Apply and gain a fundamental knowledge on electrical systems operation, maintenance, testing and troubleshooting
- Discuss the basic electrical theory and concepts including conductors, insulators, semiconductors, electromotive force and simple electrical circuit
- Explain Ohm's law, resistance and resistivity, direct current (DC), alternating current (AC) and frequency (f, hertz)
- Identify power factor (pf) - real power/ apparent power, leading or lagging power factor, power factor and generator set KVA and the components of a substation
- Design power substation and layout as well as describe earthing and bonding, electrical separations and Earth fault compensation
- Determine transmission line parameters, resistance, temperature effects, inductance, capacitance, isolators, conductor systems and insulation
- Discuss the principle of operation and transformer as well as transformer equations, power transformers, transformer parameters and transformer tap changer
- Explain power system operating constraints, equipment constraints, stability constraints, harmonics and voltage distortion
- Identify the disturbances in the torque of induction motors as well as apply power system protection, faults and abnormal operating conditions, sensitivity, selectivity, reliability and dependability
- Carryout insulation testing and maintenance, classification of insulation, testing and sampling insulating liquids and cleaning electrical insulation
- Implement continuous monitoring and recognize protection components, protection relays, instrument transformers, current transformers and system transducers
- Use and test voltage transformers as well as apply lightning protection, transformer protection and switchgear maintenance
- Recognize the ten tips to optimize switchgear life and enhance reliability

Who Should Attend

This course covers systematic techniques on electrical systems operation, maintenance, testing and troubleshooting for engineers, supervisors and other technical staff who work in transmission, distribution, maintenance, operation, control and analysis of utilities and industrial electrical networks.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Fee

As per proposal

Course Contents

- Basic Electrical Theory and Concepts
- Conductors
- Insulators
- Semiconductors
- Electromotive force (emf)
- Simple electrical circuit
- Ohm's Law
- Resistance and resistivity
- Direct current DC
- Alternating current (ac)
- Frequency (f, Hertz)
- Period T
- A period of a sine wave
- Units and abbreviations
- Reactance (X, Ohms)
- Impedance (Z, Ohms)
- Electrical Power/Energy
- Electrical Power P

- Electrical Power
- Electric Energy E
- Active Power (P Watts)
- Reactive Power (Q, Vars)
- Apparent Power (A, Volt-Amps, VA)
- Power Factor (PF) - Real power/ apparent power
- Leading or Lagging Power Factor
- Power Factor & Generator Set KVA
- Components of a Substation
- Designing of Power Substation and Layout
- Earthing and Bonding
- Electrical Separations
- Conductors (Cables and Bus Bars)
- Cables
- Cable Types
- Earth Fault Compensation
- Fault Current with Earth Fault Compensation
- Fault Current - Solid Earthing
- Low-impedance Neutral Earthing
- Fault Current - Low-impedance Neutral Earthing
- End of section
- Transmission Line Parameters
- Introduction
- Resistance
- Temperature effects
- Inductance
- Capacitance
- Three-Phase Capacitance
- Overhead Line Terminations
- Components of a Substation
- Isolators
- Conductor Systems

- Insulation
- Fuses & Disconnects
- Motors & Motor Control Centers
- Motor Control Centers (MCC)
- Transformers
- Function
- Principle of operation
- Principle of a transformer
- Transformer equations
- Power Transformers
- Transformer Parameters
- Values referred to the primary side
- Values referred to the secondary side
- Transformer Tap Changer
- Types of Tap Changers
- No-load tap changers
- Load tap changers
- End of section
- Power System Operating Constraints
- Equipment Constraints
- Stability Constraints
- Harmonics
- What are Harmonics?
- How Harmonics are Generated?
- Harmonics are Produced in an Electrical Network
- Six Pulse Rectifier
- Effects of Harmonics
- Overloading of Neutrals
- Increase of Losses in the Transformers
- Increase of Skin Effect
- Voltage Distortion
- Disturbances in the Torque of Induction Motors

- Power System Protection
- The need for Protection
- End of section
- Fundamentals of Power System Protection
- Faults and Abnormal Operating Conditions
- Shunt Faults (Short Circuits)
- Series Faults
- Protection System Attributes
- Sensitivity
- Selectivity
- Speed
- Reliability and Dependability
- Overcurrent Protection
- Directional Overcurrent Protection
- Insulation Testing and Maintenance
- Classification of Insulation
- Insulation Resistance
- Insulation Testing and Maintenance
- Insulation-Resistance Meters
- Insulating Liquids
- Testing and Sampling Insulating Liquids
- Cleaning Electrical Insulation
- Cleaning by spraying
- Cleaning with water
- Cleaning with abrasives
- Partial Discharge
- Short term PD monitoring (1 - 2 hours).
- Semi-permanent monitoring (1 -3 days).
- Continuous monitoring
- Protection Components
- Protection Relays
- Instrument Transformers

- Theory of Operation
- Current Transformers
- System Transducers - Current Transformer
- System Transducers - Voltage Transformer
- Current Transformers
- Current Transformer Types
- Wound Primary
- Bar Primary
- Safety when working with CT's
- Specifying CT's
- Future trends in C.T. Design using optics
- C.T. Ratio Test
- C.T. Polarity test
- Secondary winding resistance
- Voltage Transformers
- System Transducers - Voltage Transformer
- Voltage Transformers - Two types
- Electromagnetic Type Voltage Transformer
- Capacitor voltage transformer (CVT)
- Use of Voltage Transformers
- Testing of Voltage Transformers
- V.T. Ratio and polarity test
- Secondary winding resistance
- Insulation resistance of windings
- Circuit Breakers
- System Transducers - Circuit Breaker
- Lightning Protection
- Lightning Protection - Shield Wires
- Lightning Protection - Surge Arresters
- Transformer Protection
- Transformer Faults
- Types, Ratings and Uses

- Arrester Types
- Valve type arrester
- Equipment in areas subject to earthquakes or heavy pollution
- Static compensators
- Airport lighting systems
- Arresters
- Inspection, Maintenance and Testing
- Inspection and Tests - Visual and Mechanical Inspection
- Clean Unit
- Electrical Tests
- End of section
- Switchgear Maintenance
- Ten Tips to Optimize Switchgear Life and Enhance Reliability
- Introduction
- Tip 1: Perform Infrared Inspections
- Tip 2: Exercise Circuit Breakers Annually
- Tip 3: Don't Neglect Recommended Maintenance
- Tip 4: Recondition the Equipment
- Tip 5: Keep Good Records and Trend Performance
- Tip 6: Upgrade the Equipment
- Tip 7: Outsource Preventive Maintenance Via a Long-Term Maintenance Contract
- Tip 8: Comply with NFPA 70E
- Tip 9: Utilize Predictive Maintenance Tools
- Tip 10: Perform a Short Circuit Analysis and a Time Current Coordination Study
- Conclusion
- End of Course