# COURSE OVERVIEW EE0776

## Electrical Equipment: TRANSFORMERS, MOTORS, VARIABLE SPEED DRIVES, GENERATORS, CIRCUIT BREAKERS, SWITCHGEARS & PROTECTIVE SYSTEMS: *Selection, Installation, Operation, Testing, Troubleshooting & Maintenance*

### Course Title

Electrical Equipment: TRANSFORMERS, MOTORS, VARIABLE SPEED DRIVES, GENERATORS, CIRCUIT BREAKERS, SWITCHGEARS & PROTECTIVE SYSTEMS: *Selection, Installation, Operation, Testing, Troubleshooting & Maintenance*

H-STK© INCLUDED

### Course Date/Venue

Session 1: June 07-11, 2026/Crowne Meeting Room, Crowne Plaza Al Khobar, KSA

Session 2: November 08-12, 2025/Tamra Meeting Room, Al Bandar Rotana Creek, Dubai UAE

### Course Reference

EE0776

3.0 CEUs (30 PDHs) AWARD

### Course Duration/Credits

Five days/3.0 CEUs/30 PDHs

### Course Description

***This practical and highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.***

Maximum efficiency, reliability, and longevity of electrical equipment such as the various types of motors, variable-speed drives, transformers, generators, rectifiers, inverters, uninterruptible power systems, circuit breakers, fuses, power station electrical and protective systems are of great concern to many industries. These objectives can only be achieved by understanding the characteristics, selection criteria, common problems and repair techniques, preventive and predictive maintenance.

This course is a MUST for anyone who is involved in the selection, applications, or maintenance of electrical equipment. It provides the latest in technology. The course covers how these equipments operate and provide guidelines and rules that must be followed for a successful operation. Their basic design, operating characteristics, specification, selection criteria, advanced fault detection techniques, critical components as well as all maintenance issues are covered in detail.

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 these equipment for their applications. Further, participants will have enough knowledge to achieve reduced capital, operating and maintenance costs along with increase in efficiency.

## Course Objectives

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

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

## Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials conveniently saved in a **Tablet PC**.*

## Who Should Attend

This course provides an overview of all significant aspects and considerations of electrical equipment including transformers, motors, variable speed drives, generators, circuit breakers, switchgears and protective systems for engineers and other technical staff who are involved in the selection, installation, operation, testing, troubleshooting or maintenance of such electrical equipment.

## Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

## Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

## Certificate Accreditations

Haward's certificates are accredited by the following international accreditation organizations:

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. Haward's certificates are internationally recognized and accredited by the British Accreditation Council (BAC). 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.

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors 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 2018-1 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 2018-1 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 Accreditors 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.

## Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking

## Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

**Mr. Pan Marave**, PE, MSc, BEng, is a **Senior Electrical & Instrumentation Engineer** with over **30 years** of extensive experience in **Generator Excitation Systems** & **AVR**, **Oil**, **Gas**, **Petrochemical**, **Refinery** & **Power** industries. His expertise includes **CEMS** Operations and Maintenance, **ABB 11KV Distribution Switchgear**, Operation & Maintenance of **Rotork make MOVS**, **Maintaining Instrument Air Compressors**, **Circuit Breaker**, **HV Switchgear Maintenance**, **HV/LV Electrical** Authorisation, Basic **Electricity**, **Electrical & Special Hazards**, **Personnel Protection**, **HV/LV Equipment**, **Motor Controllers**, **Electrical Switching** Practices, **Emergency Planning**, **Safety Management**, Safety Instrumented Systems (**SIS**), Safety Integrity Level (**SIL**), Emergency Shutdown (**ESD**); **DCS**, **SCADA** & **PLC**; **Measurement** (**Flow**, **Temperature**, **Pressure**); **Process Analyzers** & **Analytical Instrumentation**; **Process Control**, **Instrumentation** & **Safeguarding**; **Process Controller**, **Control Loop & Valve Tuning**; Industrial **Distribution Systems**; Industrial **Control & Control Systems**, Power Systems **Protection & Relaying**; **Earthing**, **Bonding**, **Grounding**, **Lightning & Surge Protection**; Electric Power **Substation** & **Systems**; Electrical Engineering Principles; **Motor Control Circuit**; **Electrical Fault Analysis**; Electrical Networks & Distribution **Cables**; **Circuit Breakers**, **Switchgears**, **Transformers**, **Hazardous Areas Classification** and **Detailed Engineering Drawings**, **Codes** & **Standards**. Furthermore, he is also well-versed in Microprocessors Structure, Lead Auditor (**ISO 9000:2000**), **ISO 9002**, Quality Assurance, and Projects & Contracts Management.

Presently, Mr. Marave is the **Technical Advisor** of **Chamber of Industry & Commerce** in Greece. Prior to this, he gained his thorough practical experience through several positions as the **Technical Instructor**, **Engineering Manager**, **Electronics & Instruments Head**, **Electrical**, **Electronics & Instruments Maintenance Superintendent**, **Assistant General Technical Manager** and **Engineering Supervisor** of various international companies such as the **Alumil** Mylonas, **Athens Papermill**, **Astropol** and the **Science Technical Education**.

Mr. Marave is a **Registered Professional Engineer** and has **Master's** and **Bachelor's** degrees in **Electrical Engineering** from the **Polytechnic Institute of New York** and **Pratt Institute of New York** (**USA**) respectively. Further, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management** (**ILM**) and an active member of the **Technical Chamber** and the Institute of Electrical and Electronics Engineer (**IEEE**) in Greece. He has presented and delivered **numerous international** courses, conferences, trainings and workshops worldwide.

## Course Fee

**US$ 5,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

## Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met\

***Day 1***

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| *0730 – 0800* | *Registration & Coffee* |
| *0800 – 0815* | *Welcome & Introduction* |
| *0815 – 0830* | ***PRE-TEST*** |
| *0830 – 0930* | ***Fundamentals of Electric Systems***<br>*Capacitors ● Current & Resistance ● The Magnetic Field ● Faraday's Law of Induction ● Lenz's Law ● Inductance ● Alternating Currents ● Three-Phase System* |
| *0930 – 0945* | *Break* |
| *0945 – 1030* | ***Introduction to Machinery Principles***<br>*Electric Machines & Transformers ● Common Terms & Principles ● The Magnetic Field ● Magnetic Behavior of Ferromagnetic Materials ● Faraday's Law – Induced Voltage From a Magnetic Field Changing with Time ● Core Loss Values ● Permanent Magnets ● Production of Induced Force on a Wire ● Induced Voltage on a Conductor Moving in a Magnetic Field* |
| *1030 – 1130* | ***Transformers***<br>*Importance of Transformers ● Types & 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 Dot Convention ● The Equivalent Circuit of a Transformer ● The Transformer Voltage Regulation & Efficiency ● The Autotransformer ● Three-Phase Transformers ● Transformer Ratings* |
| *1130 – 1230* | ***Transformer Components & Maintenance***<br>*Introduction, Classification of Transformers ● Main Components of a Power Transformer ● Types & Features of Insulation ● Forces ● Cause of Transformer Failures ● Transformer Oil ● Gas Relay & Collection Systems ● Relief Devices ● Interconnection with the Grid* |
| *1230 – 1245* | *Break* |
| *1245 – 1330* | ***AC Machine Fundamentals***<br>*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 & Losses* |
| *1330 – 1420* | ***Induction Motors***<br>*Induction Motor Construction ● Basic Induction Motor Concepts ● The Equivalent Circuit of an Induction Motor ● Losses & The Power-Flow Diagram ● Induction Motor Torque-Speed Characteristics ● Control of Motor Characteristics By Squirrel-Cage Rotor Design ● Starting Induction Motors* |
| *1420 – 1430* | ***Recap***<br>*Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow* |
| *1430* | *Lunch & End of Day One* |

**Day 2**

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|---|---|
| 0730 – 0830 | ***Speed Control of Induction Motors***<br>*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 ● Induction Motor Ratings* |
| 0830– 0930 | ***Maintenance of Motors***<br>*Characteristics of Motors ● Enclosures & 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 & Refurbishment of AC Induction Motors ● Failures in Three-Phase Stator Windings* |
| 0930 – 0945 | *Break* |
| 0945 – 1100 | ***Power Electronics, Rectifiers & Pulse-Width Modulation Inverters***<br>*Introduction to Power Electronics ● Power Electronics Components ● Power & 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* |
| 1100 – 1230 | ***Variable Speed Drives***<br>*Basic Principles of AC Variable Speed Drivers (VSD'S) ● Inverters ● Input Power Converter (Rectifier) ● DC Link Energy ● Output IGBT Inverter, Input Sources for Regeneration or Dynamic ● Regeneration ● PWM-2 Considerations ● Transients ● Harmonics Power Factor & Failures ● Thyristor Failures & Testing ● AC Drive Application Issues ● AC Power Factor ● IGBT Switching Transients ● Cabling Details For AC Drives ● Cable ● Motor Bearing Currents ● Summary of Application Rules For AC Drives ● Selection Criteria of VSD's ● Maintenance ● Common Failure Modes ● Motor Application Guidelines* |
| 1230 – 1245 | *Break* |
| 1245 – 1420 | ***Synchronous Machines***<br>*Physical Description ● Pole Pitch: Electrical Degrees ● Airgap & Magnetic Circuit of a Synchronous Machine ● Synchronous Machine Windings ● Field Excitation ● No-Load & Short-Circuit Values ● Torque Tests ● Excitation of a Synchronous Machine ● Machine Losses* |
| 1420 – 1430 | ***Recap***<br>*Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow* |
| 1430 | *Lunch & End of Day Two* |

**Day 3**

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| 0730 – 0930 | ***Synchronous Generators***<br>*Synchronous Generator Construction ● The Speed of Rotation of a Synchronous Generator ● The Internal Generated Voltage of a Synchronous Generator ● The Equivalent Circuit of a Synchronous Generator ● The Phasor Diagram of a Synchronous Generator ● Power & Torque in Synchronous Generators ● The Synchronous Generator Operating Alone ● Parallel Operation of AC Generators ● Operation of Generators in Parallel with Large Power Systems ● Synchronous Generator Ratings ● Synchronous Generator Capability Curves ● Short-Time Operation & Service Factor* |
| 0930 – 0945 | *Break* |

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| 0945 – 1030 | ***Generator Components, Auxiliaries & Excitation***<br>*Introduction, The Rotor, Turbine-Generator Components, Cooling Systems, Shaft Seals & Seal Oil Systems, Stator Winding Water Cooling Systems, Other Cooling Systems, Excitation, The Voltage Regulator, The Power System Stabilizer, Characteristics of Generator Exciter Power Systems (GEP), Generator Operation* |
| 1030 – 1100 | ***Generator Main Connections***<br>*Introduction ● Isolated Phase Bus Bar Circulatory Currents ● System Description* |
| 1100 – 1230 | ***Performance & Operation of Generators***<br>*Generator Systems ● Condition Monitoring ● Operational Limitations ● Fault Conditions* |
| 1230 – 1245 | *Break* |
| 1245 – 1420 | ***Generator Surveillance & Testing***<br>*Generator Operational Checks (Surveillance & Monitoring) ● Generator Diagnostic Testing ● Insulation Resistance & Polarization Index ● DC Hipot Test ● AC Tests for Stator Windings ● Synchronous Machine Rotor Windings ● Partial Discharge Tests ● Low Core Flux Test (EL-CID) ● Mechanical Tests ● Groundwall Insulation ● Rotor Winding ● Turn Insulation ● Slow Wedges & Bracing ● Stator & Rotor Cores* |
| 1420 – 1430 | ***Recap***<br>*Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow* |
| 1430 | *Lunch & End of Day Three* |

***Day 4***

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| 0730 – 0830 | ***Generator Inspection & Maintenance***<br>*On-Load Maintenance & Monitoring ● Off-Load Maintenance ● Generator Testing* |
| 0830 – 0930 | ***Generator Operational Problems, & Refurbishment Options***<br>*Typical Generator Operational Problems ● Generator Rotor Reliability & Life Expectancy ● Generator Rotor Refurbishment ● Types of Insulation ● Generator Rotor Modifications ● Upgrades & Uprates ● High Speed Balancing ● Flux Probe Test* |
| 0930 – 0945 | *Break* |
| 0945 – 1100 | ***Circuit Breakers***<br>*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* |
| 1100 - 1230 | ***Fuses***<br>*Types of Fuses ● Features of Current Limiting Fuses ● Advantages of Fuses Over Circuit Breakers* |
| 1230 – 1245 | *Break* |
| 1245 – 1420 | ***Bearings***<br>*Types of Bearings ● Statistical Nature of Bearing Life ● Materials & Finish ● Sizes of Bearings ● Types of Roller Bearings ● Thrust Bearings ● Lubrication* |
| 1420 – 1430 | ***Recap***<br>*Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today & Advise Them of the Topics to be Discussed Tomorrow* |
| 1430 | *Lunch & End of Day Four* |

**Day 5**

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| 0730 – 0830 | ***Used Oil Analysis***<br>*Proper Lube Oil Sampling Technique ● Test Description & Significance ● Visual & Sensory Inspection ● Chemical & Physical tests ● Summary* |
| 0830 – 0930 | ***Vibration Analysis***<br>*The Application of Sine Waves to Vibration ● Multimass Systems ● Resonance ● Logarithms & Decibels (db) ● The Use of Filtering ● Vibration Instrumentation ● Time Domain ● Frequency Domain ● Machinery Example ● Vibration Analysis ● Resonant Frequency ● Vibration Severity* |
| 0930 – 0945 | *Break* |
| 0945 – 1100 | ***Power Station Electrical Systems & Design Requirements***<br>*Introduction ● System Requirements ● Electrical System Description ● System Performance ● Power Plant Outages & Faults ● Uninterruptible Power Supply (UPS) Systems ● DC Systems* |
| 1100 – 1230 | ***Power Station Protective Systems***<br>*Introduction ● Design Criteria ● Generator Protection ● DC Tripping Systems* |
| 1230 – 1245 | *Break* |
| 1245 – 1345 | ***Frequently Asked Questions***<br>*Fundamentals of Electric Systems ● Introduction to Machinery Principles ● Transformers ● Transformer Components & Maintenance ● Interconnection With the Grid ● AC Machine Fundamentals ● Induction Motors ● Speed Control of Induction Motors ● Maintenance of Motors ● Variable Speed Drives ● Synchronous Generators ● Generator Components ● Auxiliaries, & Excitation* |
| 1345 – 1400 | ***Course Conclusion***<br>*Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course* |
| 1400 – 1415 | ***POST-TEST*** |
| 1415 – 1430 | *Presentation of Course Certificates* |
| 1430 | *Lunch & End of Course* |

## Simulators (Hands-on Practical Sessions)

Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using our state-of-the-art "Troubleshooting Electrical Circuits V4.1 Simulator" and "Lab Volt Testing Device".

**Troubleshooting Electrical Circuits V4.1 Simulator**

**Lab Volt Testing Device**

**Course Coordinator**
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