COURSE OVERVIEW EE0776-4D

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

Course Title

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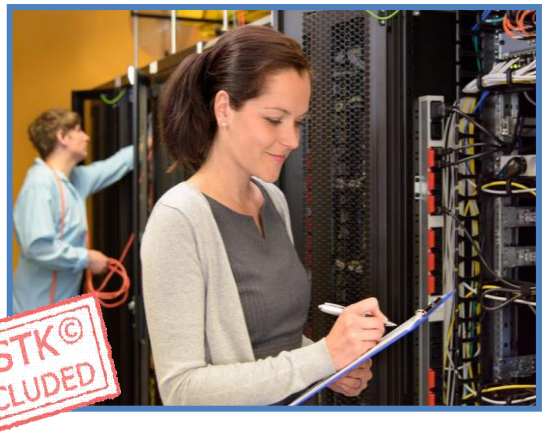


Course Reference

EE0776-4D

Course Duration/Credits

Four days/2.4 CEUs/24 PDHs

Course Date/Venue

Session(s)	Date	Venue
1	January 22-25, 2024	Jubail Hall, Signature Al Khobar Hotel, Al Khobar, KSA
2	March 04-07, 2024	Business Center, Concorde Hotel Doha, Doha Qatar
3	June 03-06, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
4	September 02-05, 2024	Ajman Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE

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 equipments 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

This interactive training course includes the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Workshops & Work Presentations
30% Case Studies & Practical Exercises
20% Software, Simulators & 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

Certificates are accredited by the following international accreditation organizations: -

- 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 **2.4 CEUs** (Continuing Education Units) or **24 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.

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. Saed Aljundi is a **Senior Electrical** & **Instrumentation Engineer** with over **35 years** of extensive experience within the **Oil & Gas**, **Power & Water Utilities** and other **Energy** sectors. His expertise widely covers in the areas of **Operational Technology Cyber Security**, **System Analysis**, **Power System** Faults, **Protection Scheme** Components, Current & Voltage **Transformers**, **Power System** Neutral Grounding, **Feeder Overcurrent** Protection, **Starting & Control**, **Transformer** Protection, **Generator** Protection, **Capacitor** Protection, **Numerical Relays**, **SCADA** Security, **ESD** System Analysis & Control, **Electrical** & **Instrumentation**, **Installation & Inspection**, **Custody** Measurement, **Loss Control** for Petroleum Products, **Process Control** & **Instrumentation**, **Fiber Optics** Access Network Planning, **Electric Power System**, Basics of **Power System** Equipment, Condition Monitoring of **Power System** Equipment, **Power System** Control & Stability, **Power System** Harmonics, **Transmission Networks** Maintenance Management, Intensive Overhead **Transmission** Line (OHTL), **Transmission** Line Networks, **Transmission** Line Protection, HVDC **Transmission** & Control, **Distribution Networks** & **Load Forecasting**, T&D Load Forecasting Methods, **Electrical** Load **Forecasting** & Planning, **Electrical Forecasting Techniques**, **Electrical Drawings** & **Schematics**, Interpretation of **Electrical Drawings**, **Electrical Drawing** and Wiring, **Electrical Drawings** & Control Systems, **Electrical Distribution** Network, Inspection & Testing in **Distribution** Networks, **Electrical Equipment** in **Distribution** Networks, **Electrical Control** & Monitoring System, **Electrical Transmission** & **Distribution** Network Automation, **Substation** Maintenance Techniques, **Electrical Power Substation**, **GIS Substation** Maintenance, Electrical Substation and Design Testing, **Substation** Automation Systems & Application, HV Substation **Inspection** & Reporting, High & Low Voltage **Electrical Safety**, **Electrical Inspection** & Testing, **Power Cable** Testing, **Cable** Testing & Fault Location, **Cable** Jointing, **Cable** & **Overhead Line** Inspection, **Power Generation**, **Overhead Power Line** Construction & Patrolling, **Electronic Circuits**, **Fault Analysis** in **Electrical Networks**, **Fault Detection** Devices for Emergency Technician, Electrical Fault Analysis, Fault Analysis in Transformers, **Electrical Faults** & Relay Protection**, LV/MV Electrical Safety**, **Variable Frequency Drives** (VFD), **Motors & Variable Speed Drives**, **UPS System & Battery Charger**, **Circuit Breakers & Switchgears**, **HV/LV** Switching and Isolation, Uninterruptible Power Supply (**UPS**), AC/DC & Batteries, **Generator** Maintenance & Troubleshooting, **Diesel Generator** Troubleshooting, **Transformers** Troubleshooting & Maintenance, **Motors & Variable Speed Drives**, **Electrical Safety**, **Heat Loads Calculations**, **Ducted Spilt & Rooftop Package Air Conditioners** and **ISO 9001:2008** Quality Management System.

Mr. Saed gained his expertise and experience through several positions as an **Senior Electrical Engineer**, **Project Manager**, **Electrical Project Engineer**, **Electrical Site Engineer**, **Installations Supervisor**, **MEP Estimator**, **Senior Instructor/Lecturer** and **Electrical Engineering Laboratory Instructor** for various companies such as Samara & Yousef Contracting Co., Tanweer Electrical Contracting Co., Sayyar Al-Husseini & Partner for Electromechanical Contracting, Electromechanical Contracting Company (EMCC), Al-Balad Electromechanical Contracting Est., Faculty of Medicine, Damad Hospital, Advanced Modular Power Systems (AMPS), King Saud University and the University of Jordan.

Mr. Saed has a **Bachelor's** degree and **Higher Diploma** in **Electrical & Power Engineering**. Further, he is a **Certified Instructor/Trainer** and has delivered various trainings, seminars, conferences, workshops and courses internationally.

Course Fee

Al Khobar	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Doha	**US$ 4,500** per Delegate. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Dubai	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Abu Dhabi	**US$ 4,500** 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

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Fundamentals of Electric Systems*** *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*** *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*** *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*** *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*** *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*** *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***
1430	*Lunch & End of Day One*

Day 2

0730 – 0830	***Speed Control of 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 ● Induction Motor Ratings*
0830– 0900	***Maintenance of Motors*** *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*
0900 - 0930	***Power Electronics, Rectifiers & Pulse-Width Modulation Inverters*** *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*
0930 – 0945	*Break*
0945 – 1030	***Variable Speed Drives*** *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*
1030 – 1130	***Synchronous Machines*** *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*
1130 – 1145	*Break*

1145 – 1330	***Synchronous Generators*** *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*
1330 - 1420	***Generator Components, Auxiliaries & Excitation*** *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*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

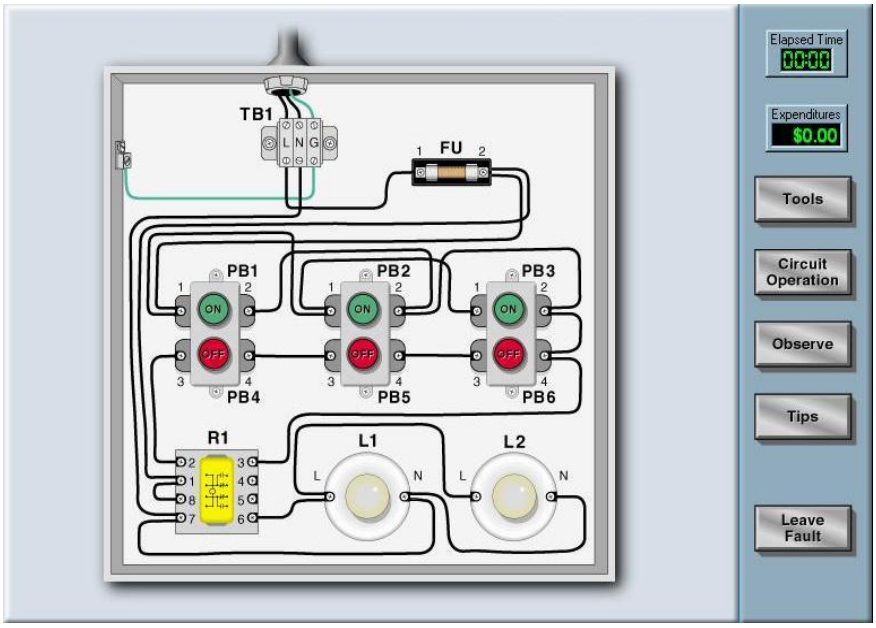
0730 – 0830	***Generator Main Connections*** *Introduction ● Isolated Phase Bus Bar Circulatory Currents ● System Description*
0830– 0900	***Performance & Operation of Generators*** *Generator Systems ● Condition Monitoring ● Operational Limitations ● Fault Conditions*
0900 - 0930	*Break*
0930 – 0945	***Generator Surveillance & Testing*** *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*
0945 – 1030	***Generator Inspection & Maintenance*** *On-Load Maintenance & Monitoring ● Off-Load Maintenance ● Generator Testing*
1030 – 1130	***Generator Operational Problems, & Refurbishment Options*** *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*
1130 – 1145	*Break*
1145 – 1330	***Circuit Breakers*** *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*
1330 - 1420	***Fuses*** *Types of Fuses ● Features of Current Limiting Fuses ● Advantages of Fuses Over Circuit Breakers*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

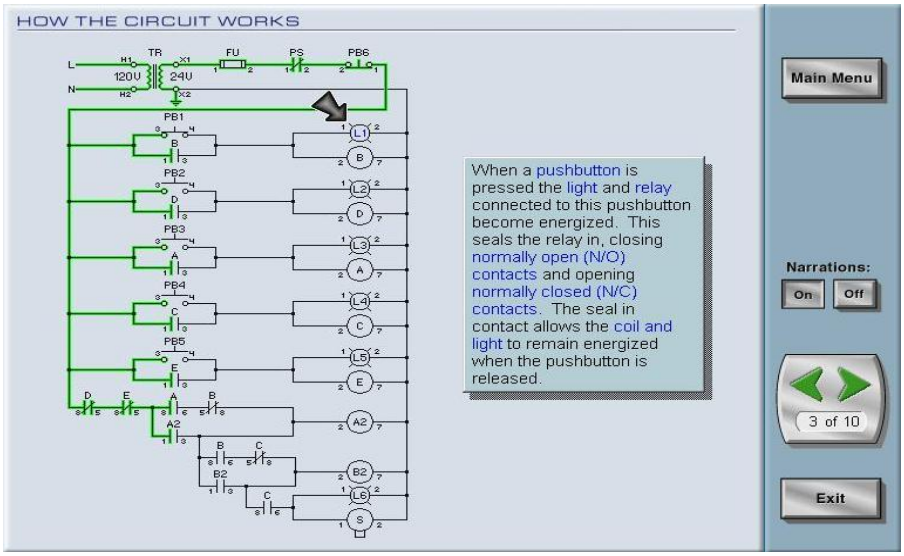
Day 4

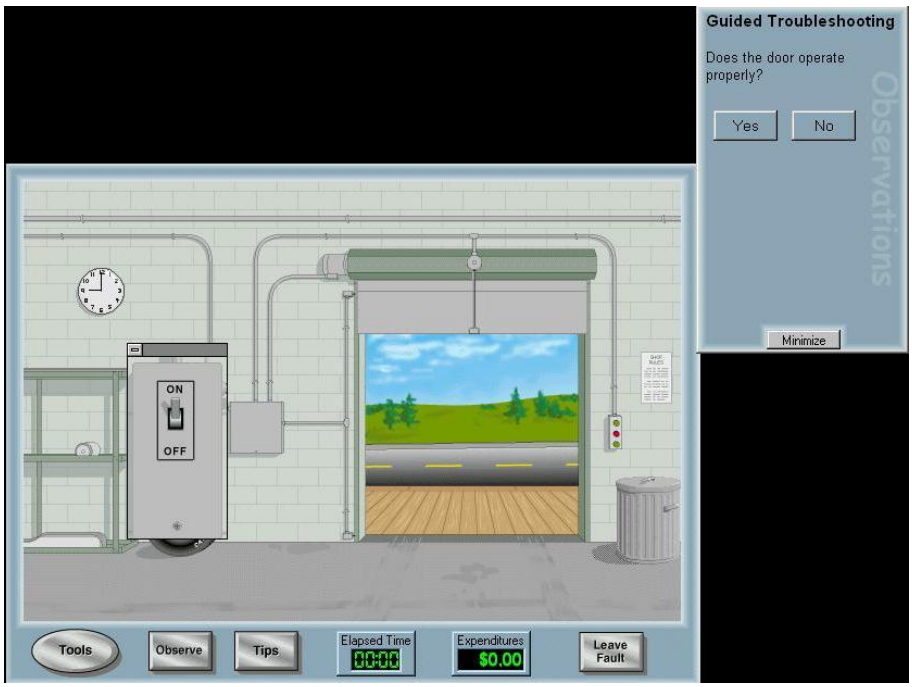
0730 – 0830	***Bearings*** *Types of Bearings ● Statistical Nature of Bearing Life ● Materials & Finish ● Sizes of Bearings ● Types of Roller Bearings ● Thrust Bearings ● Lubrication*
0830 – 0930	***Used Oil Analysis*** *Proper Lube Oil Sampling Technique ● Test Description & Significance ● Visual & Sensory Inspection ● Chemical & Physical tests ● Summary*
0930 – 0945	*Break*
0945 – 1100	***Vibration Analysis*** *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*
1100 – 1230	***Power Station Electrical Systems & Design Requirements*** *Introduction ● System Requirements ● Electrical System Description ● System Performance ● Power Plant Outages & Faults ● Uninterruptible Power Supply (UPS) Systems ● DC Systems*
1230 – 1245	*Break*
1245 – 1315	***Power Station Protective Systems*** *Introduction ● Design Criteria ● Generator Protection ● DC Tripping Systems*
1315 - 1345	***Frequently Asked Questions*** *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***
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

Kamel Ghanem, Tel: +971 2 30 91 714, Email: kamel@haward.org