



COURSE OVERVIEW EE0135-3D
Electric Motors & Variable Speed Drives

Selection, Applications, Operation, Diagnostic Testing, Protection, Control, Troubleshooting & Maintenance

Course Title

Electric Motors & Variable Speed Drives: Selection, Applications, Operation, Diagnostic Testing, Protection, Control, Troubleshooting & Maintenance

Course Date/Venue

November 17-19, 2020/Bateen Meeting Room, Crowne Plaza Abu Dhabi Hotel, Abu Dhabi, UAE

Course Reference

EE0135-3D

Course Duration/Credits

Three days/1.8 CEUs/18 PDHs

Course Description



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

It is estimated that electrical drives and other rotating equipment consume about 50% of the total electrical energy consumed in the world today. The cost of maintaining electrical motors can be a significant amount in the budget item of manufacturing, oil, gas, petrochemical and power industries. This course gives you a thorough understanding of electrical motor's working, maintenance and failure modes and gives you the tools to maintain and troubleshoot electrical motors and variable speed drives.

Maximum efficiency, reliability, and longevity of the various types of motors and variable-speed drives 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 motors, and variable-speed drives. It provides the latest in technology.



The course covers how this equipment operate and provides 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.

You will gain a fundamental understanding of the installation, operation and troubleshooting of electric motors. Typical applications of electric motors in oil, gas, petrochemical, power, manufacturing, materials handling, process control are covered in detail. You will learn the basic steps in specifying, installing, wiring and commissioning motors. The concluding section of the course gives you the fundamental tools in troubleshooting motors confidently and effectively.

This course is designed to provide participants with a comprehensive understanding of the various types variable-speed drives. Participants will be able to specify select, commission and maintain these equipment for their applications. The excellent knowledge and skills that participants gained in this course will help their companies in achieving 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:-

- Apply proper techniques on selection, application, operation, diagnostic testing, protection, control, troubleshooting and maintenance of electric motors and variable speed drives
- Gain an in-depth knowledge on electrical machines and discuss their devices, symbols and circuits
- Enumerate the electric motor types and demonstrate how to operate and perform their functions
- Discuss the construction, operation and performance of 3-Phase AC induction motors
- Emphasize the importance of motor speed control and become familiar with power electronic converters
- Protect and select AC converters, motors & control system and conduct installation & commissioning of AC variable speed drives
- Identify the sources of electromagnetic compatibility (EMC) and analyse & test the different types of motor failure
- Carryout predictive maintenance techniques such as the vibration analysis
- Conduct machinery faults diagnosis & correction using vibration analysis and corrective measures
- Apply bearing failure analysis and discuss the importance of lubrication & oil analysis program

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, sample video clips of the instructor’s actual lectures & practical sessions during the course conveniently saved in a **Tablet PC**.

Who Should Attend


This course provides an overview of all significant aspects and considerations of electric motors and variable speed drives for engineers and other technical personnel who are in charge of selection, application, operation, diagnostic testing, protection, control, troubleshooting or maintenance of motors and variable speed drives.

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:-

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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, Virginia 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 **1.8 CEUs** (Continuing Education Units) or **18 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.

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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.

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:



Dr. Hassan Ibrahim, PhD, MSc, BSc, is a **Senior Electrical & Instrumentation Engineer** with over **25 years** of extensive industrial experience. He specializes in **HV/MV Cable Splicing, Jointing & Termination; LV/MV/HV; Power Cabling**; Micro Electromechanical Systems (**MEMS**); **Load Calculations; Electrical Engineering Design, Installation, Maintenance, Troubleshooting, Inspection & Testing; Engineering Drawings, Codes & Diagrams**; Power System **Protective Relay**; Power **Generation; Transformers; Lighting System, Earthing & Grounding; Electrical Circuits; Switchgear & Circuit Breakers; CCTV; AutoCAD; DCS, PLC, SCADA, Instrumentation & Control, Control Valves & Actuators; Power Electronics; Metering Pumps; Flow Metering & Custody Measurement; Pneumatic Systems and Fire & Gas Detection Systems**. Further, he is also well-versed in **UPS and Battery Systems, Protection Gears, ETAP, System Analysis & Design, Energy Saving Techniques, Rational Use of Energy, Green Houses, Software, Hardware, Modeling, Simulation & Design, Renewable Energy Technologies, Solar PV and Thermal Solar**. Currently, he is the **Technical Professor** for various **Academic organizations** like the **Arab Academy for Science & Technology and Maritime Transport, ARADO, ACTS, PROJACS, ITCC and AlexPetro Technical Service**.

During his career life, Dr. Ibrahim has been actively involved in rigorous Teaching and Consulting jobs in the **USA and Middle East**. He has been the **Professor, Associate Professor, Teaching Assistant, Lecturer/Trainer, Consultant, Academic Advisor, Author, Head of Graduate Projects, Technical Consultant and Research & Teaching Assistant** of various international and academic institutions and companies. He has been the **Project Engineer** as well of **Textron Automotive Industry, USA** where he was responsible for the speed and position control for a virtual vehicle simulation system and testing the electronic circuits and overall system.

Dr. Ibrahim is a **Registered Professional Engineer** and a **Registered Professional Consultant Engineer** and has a **PhD in Systems Engineering** from the **Oakland University (USA)**, a **Master degree in Electrical Power & Machines Engineering** and a **Bachelor degree in Power & Electrical Machines Engineering**. Further, he is a **Certified Instructor/Trainer** and a **Certified Internal Verifier/Trainer/Assessor** by the **Institute of Leadership & Management (ILM)**. He has supervised various electrical and instrumentation graduate projects and master thesis, published numerous papers and delivered innumerable trainings, courses, workshops and seminars worldwide.

Course Fee

US\$ 3,750 per Delegate + **5% VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

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

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
- 20% Case Studies & Practical Exercises
- 30% Videos, Software & Simulators

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

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: Tuesday, 17th of November 2020

0730 – 0800	<i>Registration & Coffee</i>
0800 – 0815	<i>Welcome & Introduction</i>
0815 – 0830	PRE-TEST
0830 – 0930	Basic Principles of Electrical Machines <i>Introduction to Electrical Machines • AC Power Systems • Meters Used in Troubleshooting</i>
0930 – 1000	Electrical Devices, Symbols and Circuits <i>Devices and Symbols • Electrical Circuits • Reading and Understanding Electrical Drawings • Reading and Understanding Ladder Logic • Wires and Terminal Numbering</i>
1000 – 1015	<i>Break</i>
1015 – 1100	Electric Motors Types, Operations and Performance <i>Fundamentals of Motor Technology • Basic Principles of Rotating Electrical Machines • Fundamental Principles of Speed Control • Efficiency, Torque, Inertia, Horsepower / Power Factor • Torque -Speed Curves • Induction / Wound Rotor /Synchronous Motor Types • Basic Construction of a Motor • Principles of Operation and Performance</i>
1100 – 1200	3-Phase AC Induction Motors <i>Basic Construction • Principles of Operation • The Equivalent Circuit • Electrical and Mechanical Performance • Motor Acceleration • AC Induction Generator Performance • Efficiency of Electric Motors • Rating of AC Induction Motors • Electric Motor Duty Cycles • Cooling and Ventilation of Electric Motors (IC) • Degree of Protection of Motor Enclosures (IP) • Construction and Mounting of AC Induction Motors • Anti-Condensation Heaters • Methods of Starting AC Induction Motors</i>
1200 – 1215	<i>Break</i>
1215 – 1315	Motor Speed Control <i>The Need for Variable Speed Drives • Fundamental Principles • Torque-Speed Curves for Variable Speed Drives • Types of Variable Speed Drives • Mechanical Variable Speed Drive Methods • Hydraulic Variable Speed Drive Methods • Electromagnetic or 'Eddy Current' Coupling • Electrical Variable Speed Drive Methods</i>



1315 – 1420	Power Electronic Converters Power Diodes • Power Thyristors • Commutation • Power Electronic Rectifiers (AC/DC Converters) • Gate Commutated Inverters (DC/AC Converters) • Gate Controlled Power Electronic Devices • Other Power Converter Circuit Components
1420 – 1430	Recap 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: Monday, 18th of November 2020

0730 – 0900	Protection of AC Converters & Motors AC Frequency Converter Protection Circuits • Operator Information and Fault Diagnostics • Electric Motor Protection • Thermal Overload Protection - Current Sensors • Thermal Overload Protection - Direct Temperature Sensing
0900 – 1000	Control Systems for AC Variable Speed Drives The Overall Control System • Power Supply to the Control System • The DC Bus Charging Control System • The PWM Rectifier for AC Converters • Variable Speed Drive Control Loops • Vector Control for AC Drives • Current Feedback in AC Variable Speed Drives • Speed Feedback from the Motor
1000 – 1015	Break
1015 – 1100	Selection of AC Converters The Basic Selection Procedure • The Loadability of Converter Fed Squirrel Cage Motors • Operation in the Constant Power Region • The Nature of the Machine Load • The Requirements for Starting • The Requirements for Stopping • Control of Speed, Torque and Accuracy • Selecting the Correct Size of Motor and Converter
1100 – 1200	Installation & Commissioning of AC Variable Speed Drives General Installation and Environmental Requirements • Power Supply Connections and Earthing Requirements • Start/Stop Control of AC Drives • Installing AC Converters Into Metal Enclosures • Control Wiring for Variable Speed Drives • Commissioning Variable Speed Drives
1200 – 1215	Break
1215 – 1300	Electromagnetic Compatibility (EMC) The Sources of Electromagnetic Interference • Harmonics Generated on the Supply Side of AC Converters • Power Factor and Displacement Factor • Voltages and Current on the Motor Side of PWM Inverters
1300 – 1420	Motor Failure Analysis & Testing Types of Motor Failure • Common Causes of Motor Failure • Modern Developments • Insulation Life And Resistance • Polarization Index • DC Hipot • DC Ramp Test • AC Hipot • Capacitance Test • Dissipation Factor • Partial Discharge • Surge Test • Mechanical Testing • Online Testing
1420 – 1430	Recap 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





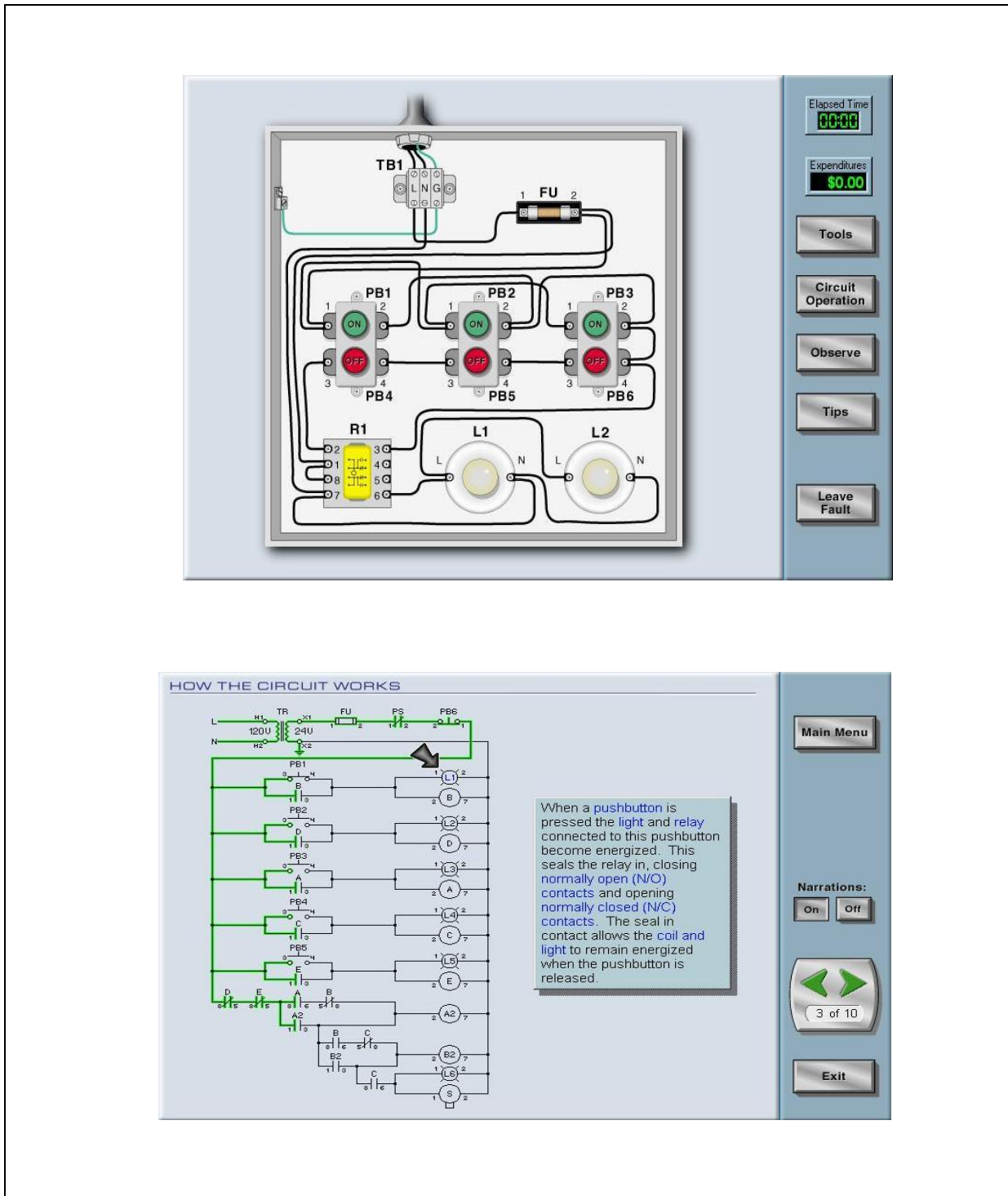
Day 3: Tuesday, 19th of November 2020

0730 – 0900	Predictive Maintenance Techniques: Basics Maintenance Philosophies • Evolution of Maintenance Philosophies • Plant Machinery Classification and Recommendations • Principles of Predictive Maintenance • Predictive Maintenance Techniques • Vibration Analysis - A key Predictive Maintenance Technique
0900 - 1000	Predictive Maintenance Techniques: Vibration Basics Spring -Mass System: Mass, Stiffness, Damping • System Response • What is Vibration? • The Nature of Vibration • Harmonics • Limits and Standards of Vibration (ISO 2372, API, AGMA, IRD)
1000 – 1015	Break
1015- 1100	Machinery Faults Diagnosis & Correction Using Vibration Analysis & Corrective Measures Unbalance • Eccentric Rotor • Bent Shaft • Misalignment • Mechanical Looseness • Resonance • Rotor Rubs • Journal Bearings • Rolling Element Bearings • Gearing Defects • Belt Defects • Electrical Problems • Flow Related Vibrations • Rotor Crack
1100 – 1200	Bearing Failure Analysis The Bearing • Failure Analysis • Bearing Failures • Grease and Greasing • The Belt Drive • Balance • Storage Issues • Services Factor Loading
1200 – 1215	Break
1215 – 1300	Lubrication & Oil Analysis Program Oil Fundamentals • Condition-Based Maintenance and Oil Analysis • Setting Up an Oil Analysis Program • Oil Analysis - Sampling Methods • Oil Analysis - Lubricant Properties • Oil Analysis - Contaminants in Lubricants • Particle Analysis Techniques • Alarm Limits for Various Machines (source - National Tribology Services)
1300 – 1345	Summary, Open Forum & Closure
1345 – 1400	Course Conclusion 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 “Simutech Troubleshooting Electrical Circuits V4.1” and “Lab Volt Testing Device”.





Simutech Troubleshooting Electrical Circuits V4.1

Lab Volt Testing Device

Course Coordinator

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