COURSE OVERVIEW EE0135
Variable Speed Drive Hands on Course

Course Title
Variable Speed Drive Hands on Course

Course Reference
EE0135

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Date/Venue

Session(s)	Date	Venue
1	August 24-28, 2025	Tamra Meeting Room, Al Bandar Rotana Creek, Dubai, UAE
2	November 30-December 04, 2025	Al Buraimi Meeting Room, Sheraton Oman Hotel, Muscat, Oman
3	February 08-12, 2026	Al Buraimi Meeting Room, Sheraton Oman Hotel, Muscat, Oman
4	March 29-April 02, 2026	Tamra Meeting Room, Al Bandar Rotana Creek, Dubai, 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.

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 operates 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 this 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 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.

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 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

Accommodation

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

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.

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. Herman Eksten, PE, PgDiP, is a **Senior Electrical Engineer** with over **40 years** of extensive experience **Oil**, **Gas**, **Petrochemical**, **Refinery** & **Power** industries and **Water & Utilities** specializing in **Electrical Safety**, Certified **HV Electrical Safety**, **Low Voltage Electrical Safety**, **Electrical Circuits**: Series and Parallel Connection, **Electrical Faults & Protective Devices**, **Renewable Energy Integration**, **Smart Grid** & **Renewable Integration**, **Renewable Energy** Storage Systems, **Renewable Energy** Economics & Finance, Risk Control Methods, **LOTO – Breakers** Operation in Electricity Substation, **LOTO** Principles and Procedures, **Arc Flash Risk Assessment**, Safety in **Power Electronic Equipment & Lasers**, **Circuit Breakers & Switchgears**, **Switchgear Assets Management**, **Circuit Breakers Control Circuits**, **Substation Maintenance** Techniques, **High Voltage Operation, Electrical Protection**, **Overhead Lines & Substation**, **Power Supply**, **High Voltage Substation**, **Electrical Protection Design**, **Earthing & Lightning Protection Design, Underground Equipment**, **Distribution Network Maintenance & Construction**, **Transformers Operation & Maintenance**, **Electric Power System, Power Plant Management**, **Substation Commissioning & Troubleshooting**, **Cable Splicing & Termination, Electrical Installation & Maintenance**, **Power Generation Operation & Control, Switchgear Life Assessment**, **Structured Cabling, Electric Power System, Power System Stability, Power System Planning & Economics**, **Power Flow** Analysis, **Combined Cycle Power Plant**, **UPS & Battery System, Variable Speed Drives,** and **HV Motors & Transformers**. He is currently the **Lead Electrical Engineer** of **SNC-LAVALIN** wherein he is responsible for basic designs and successful implementation of electrical engineering to plant overhead lines and substations.

During his career life, Mr. Eksten held various positions such as the **Lead Electrical Engineer**, **Operations Manager**, **Project Engineer**, **Technical Specialist**, **Customer Executive**, **District Manager**, **Electrical Protection Specialist**, **High-Voltage Operator** and **Apprentice Electrician** for FOX Consulting, UHDE (ThyssenKrupp Engineering), TWP Projects/Consulting (EPMC-Mining), ISKHUS Power, Rural Maintenance (PTY) Energia de Mocambique Lda., Vigeo (PTY) Ltd and ESKOM.

Mr. Eksten is a **Registered Professional Engineering Technologist** and has a Postgraduate Diploma in Management Development Programme and a National Higher Diploma (NHD) in Electrical Power Engineering. Further, he is a **Certified Instructor/Trainer**, a Senior member of the South African Institute Electrical Engineers (**SAIEE**) and holds a Certificate of Registration Membership Scheme from the Engineering Council of South Africa (**ESCA**). He has further delivered numerous trainings, courses, seminars, workshops and conferences internationally.

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	***Basic Principles of Electrical Machines*** *Introduction to Electrical Machines • AC Power Systems • Meters Used in Troubleshooting*
0930 - 0945	*Break*
0945 – 1130	***Electrical Devices, Symbols & Circuits*** *Devices & Symbols • Electrical Circuits • Reading and Understanding Electrical Drawings • Reading and Understanding Ladder Logic • Wires & Terminal Numbering*
1130 – 1230	***Electric Motors Types, Operations and Performance*** *Fundamentals of Motor Technology • Basic Principles of Rotating Electrical Machines • Fundamental Principles of Speed Control • Efficiency, Torque, Inertia, Horsepower / Power Factor*
1230 – 1245	*Break*
1245 – 1420	***Electric Motors Types, Operations & Performance (cont'd)*** *Torque -Speed Curves • Induction / Wound Rotor /Synchronous Motor Types • Basic Construction of a Motor • Principles of Operation & Performance*
1420 - 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 – 0930	***3-Phase AC Induction Motors*** *Basic Construction • Principles of Operation • The Equivalent Circuit • Electrical & Mechanical Performance • Motor Acceleration • AC Induction Generator Performance • Efficiency of Electric Motors*
0930 - 0945	*Break*
0945 – 1130	***3-Phase AC Induction Motors (cont'd)*** *Rating of AC Induction Motors • Electric Motor Duty Cycles • Cooling & Ventilation of Electric Motors (IC) • Degree of Protection of Motor Enclosures (IP) • Construction & Mounting of AC Induction Motors • Anti-Condensation Heaters • Methods of Starting AC Induction Motors*
1130 – 1230	***Motor Speed Control*** *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*
1230 – 1245	*Break*
1245 – 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***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Protection of AC Converters & Motors*** *AC Frequency Converter Protection Circuits ● Operator Information & Fault Diagnostics ● Electric Motor Protection ● Thermal Overload Protection - Current Sensors ● Thermal Overload Protection - Direct Temperature Sensing*
0930 – 0945	*Break*
0945 – 1130	***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*
1130 – 1230	***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*
1230 – 1245	*Break*
1245 – 1420	***Installation & Commissioning of AC Variable Speed Drives*** *General Installation & Environmental Requirements ● Power Supply Connections & Earthing Requirements ● Start/Stop Control of AC Drives ● Installing AC Converters Into Metal Enclosures ● Control Wiring for Variable Speed Drives ● Commissioning Variable Speed Drives*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4

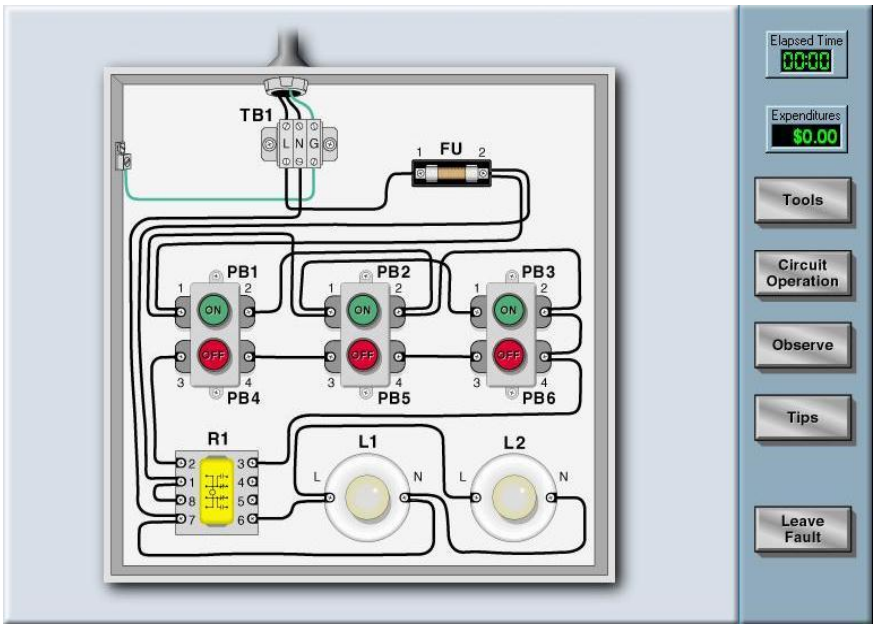
0730 – 0930	***Electromagnetic Compatibility (EMC)*** *The Sources of Electromagnetic Interference ● Harmonics Generated on the Supply Side of AC Converters ● Power Factor & Displacement Factor ● Voltages & Current on the Motor Side of PWM Inverters*
0930 - 0945	*Break*
0945 – 1130	***Motor Failure Analysis & Testing*** *Types of Motor Failure ● Common Causes of Motor Failure ● Modern Developments ● Insulation Life & Resistance ● Polarization Index ● DC Hipot ● DC Ramp Test*
1130 – 1230	***Motor Failure Analysis & Testing (cont'd)*** *AC Hipot ● Capacitance Test ● Dissipation Factor ● Partial Discharge ● Surge Test ● Mechanical Testing ● Online Testing*
1230 – 1245	*Break*
1245 – 1420	***Predictive Maintenance Techniques: Basics*** *Maintenance Philosophies ● Evolution of Maintenance Philosophies ● Plant Machinery Classification & Recommendations ● Principles of Predictive Maintenance ● Predictive Maintenance Techniques ● Vibration Analysis - A key Predictive Maintenance Technique*
1420 - 1430	***Recap***
1430	*Lunch & End of Day Four*

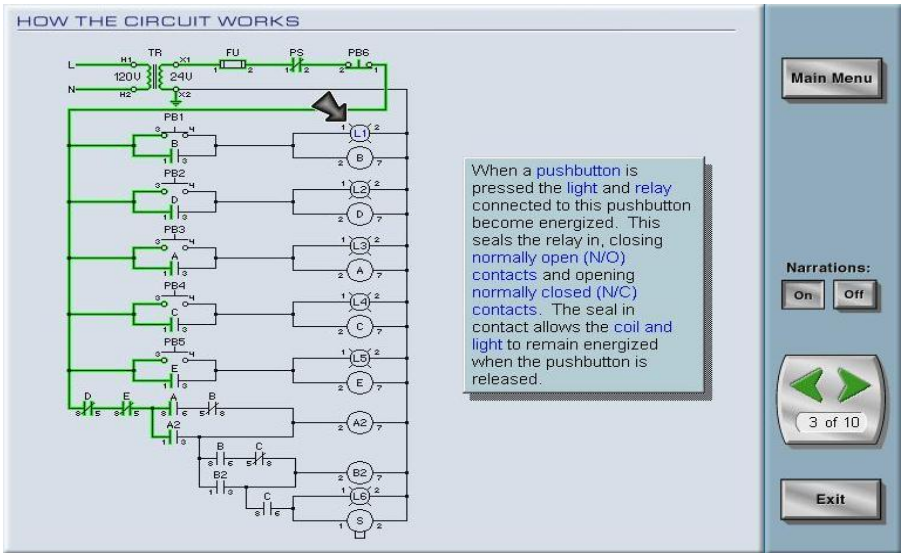
Day 5

0730 – 0930	***Predictive Maintenance Techniques: Vibration Basics*** *Spring -Mass System: Mass, Stiffness, Damping ● System Response ● What is Vibration? ● The Nature of Vibration ● Harmonics ● Limits & Standards of Vibration (ISO 2372, API, AGMA, IRD)*
0930 - 0945	*Break*
0945 – 1130	***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*
1130 – 1230	***Bearing Failure Analysis*** *The Bearing ● Failure Analysis ● Bearing Failures ● Grease & Greasing ● The Belt Drive ● Balance ● Storage Issues ● Services Factor Loading*
1230 - 1245	*Break*
1245 – 1345	***Lubrication & Oil Analysis Program*** *Oil Fundamentals ● Condition-Based Maintenance & 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)*
1345 – 1400	*Summary, Open Forum & Closure*
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 simulators “Simutech Troubleshooting Electrical Circuits V4.1”, “Lab Volt Testing Device” and “ABB ACS 600 VSD”.





Simutech Troubleshooting Electrical Circuits V4.1

Lab Volt Testing Device

ABB ACS 600 VSD

Course Coordinator

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