COURSE OVERVIEW EE0217
Electrical Drives & Motors - Advanced (E-Learning Module)

Course Title
Electrical Drives & Motors - Advanced (E-Learning Module)

Course Reference
EE0217

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 course is designed to provide participants with a detailed and up-to-date overview of advanced electrical drives and motors. It covers the shock, arc flash and the effects of current on the body; the factors affecting shock, the 1910 CFR 851 and NFPA 70e, electrically safe work condition and shock hazard analysis; the shock approach boundaries, flash hazard analysis, arc flash protection and hazard risk categories (HRC); the safe switching procedures and rotating equipment safety; the general PPE requirements; the safety practice for electrical motor and drive system; the safety in hazardous area; and the basic principle of explosion protection and safety.

Further, the course will also discuss the source of ignition; the types of protection and relevant standards; the induction motor and the major faults of electrical machines; the on-line condition monitoring of motors using electrical signature analysis; the various types of faults and their detection techniques; the four types of rolling element bearing misalignment; the four types of load; the 10 most common problems in troubleshooting; the PID application, DDC interface, motors and available configurations; the functions of a variable frequency drive (VFD); and the isolation procedures, testing live equipment and using flash protective clothing.

During this course, participants will learn the troubleshooting techniques; the general meter rules, meter precautions and voltmeter; key VSD troubleshooting; the 3-phase power electronic systems of VFDs; the thermal imaging, poor electrical contact, high resistance connection and power lines; troubleshooting electronic boards; and the VFD components and motor considerations.

Course Objectives

At the end of this course, the Trainee will be able to:-

- Apply and gain an advanced knowledge on electrical drives and motors
- Explain correct monitoring and recording of data for the electrical drives and motors
- Explain the main risks and hazards to consider when working on electrical drives and motors
- Explain the risks associated with maintaining electrical drives and motors in zoned/classified areas
- Explain permit to work requirements for maintaining electrical drives and motors
- Explain correct isolation activities prior to working on electrical drives and motors
- Demonstrate proper inspection and maintenance of electrical drives and motors
- Demonstrate how to troubleshoot/diagnose common faults on electrical drives and motors
- Demonstrate repair/replacement of faulty parts and consumables
- Coach others on applying and implementing elements of KOC electrical drives and motors procedures and standards
- Manage maintenance records
- Assess the technical competence of others in implementing KOC electrical drives and motors procedures and standards
- Discuss shock, arc flash and the effects of current on the body
- Identify the factors affecting shock including voltage thresholds, nature of the arc, accelerator flash incident and electrical hazard mitigation
- Explain 1910 CFR 851 and NFPA 70e, electrically safe work condition and shock hazard analysis
- Recognize shock approach boundaries and apply flash hazard analysis, arc flash protection and hazard risk categories (HRC)
- Review boundary and PPE table, electro-magnetic energy and worker responsibilities
- Plan and perform your work, identify TWD requirements, contract specific safety plan (CSSP) and its content and the insulated tools
- Carryout safe switching procedures, operate breakers and disconnection, tenets of maintenance safety and safety meetings
- Identify accident causes, unsafe conditions, unsafe acts and hazard awareness

- Implement rotating equipment safety and discuss electrical lock out, lockout terms, personal protective equipment, roles and responsibilities
- Recognize the general PPE requirements and use proper equipment for head protection, eye and face protection, hand protection, body protection and foot protection
- Employ safety practice for electrical motor and drive system and determine the energized parts and motor circuits
- Check power in motor circuits, apply lockout/tagout procedures and use cords
- Recognize safe work system, PTW requirements and tips, safe work permit/pre-job meeting form, safe work certificate, hot work permit and isolation certificate
- Check isolation tags, operational tag, electrical work and limitation of access certificate
- Implement safety in hazardous area and discuss the basic principle of explosion protection and safety
- Identify the source of ignition, classification “rule of thumb”, zone concept, explosion groups and temperature classes
- Recognize the types of protection and relevant standards including the advantages, limitation, application, specialties and standards of intrinsic safety
- Define simple apparatus, intrinsically safe electrical apparatus and associated electrical apparatus
- Discuss induction motor including the three-phase induction motor, parts of AC motor, construction, squirrel cage rotor, nameplate and rotating magnetic field
- Identify slip ring rotor, slip and rotor speed, principle of operation, direction of rotor rotates and equivalent circuit of induction machines
- Analyze induction machines and determine power flow diagram, efficiency, torque-equation, speed control, varying rotor resistance and supply voltage and supply frequency
- Start the method of 3 phase induction motor, reduce starting current and discuss the advantages and disadvantages of DOL and Star Delta
- Monitor and diagnose induction motors fault and identify the major faults of electrical machines
- Recognize the symptoms produced for one or more of these faults and employ on-line condition monitoring of motors using electrical signature analysis
- Identify the various types of faults and their detection techniques including the broken rotor bar and end ring faults
- Determine rotor bar damage, eccentricity related faults, static eccentricity and dynamic eccentricity
- List the four types of rolling element bearing misalignment, bearing problems, stator or armature faults and interturn shorts

- Discuss drives basics, drive system, power source, incoming power stability, grounding, cable distance, electrical noise and control circuit
- Recognize the basic control scheme, load control, speed control, closed loop control, logic control and the prime mover
- Describe name plate data, speed/torque curve, frequency, voltage, drive train, torque transmission, speed changer and enclosed gearing
- Determine coupling devices, feedback devices, inverter, motor torque control, motor horse power control, variable frequency control and block diagram
- Illustrate solid state block, converter, VFC sections, DC bus, inverter, soft charge circuit and dynamic braking
- Identify the tools and safety issues, test equipment, electronic multi-meters, “clamp” current meter and portable oscilloscopes
- Recognize the four types of load covering constant torque, constant horse power, variable torque and impact load
- Stop the load through line regenerative and DC injection braking, apply vector control and avoid the 10 most common problems in troubleshooting
- Discuss the need of VFD’s and discuss PID application, DDC interface, motors and available configurations
- Identify the functions of a variable frequency drive (VFD) covering start/stop, change speed, constant speed, limits, ramping, forward/reverse and save energy
- Recognize the parts of a variable frequency drive (VFD) and troubleshoot safely
- Avoid shock hazard, identify the causes of shocks and the effect of electricity on the body
- Protect against shock hazards and explain lockout/tagout principles
- Employ proper isolation procedures, test live equipment, use flash protective clothing and apply troubleshooting techniques
- Determine test locations, identify the general meter rules, apply meter precautions and use a voltmeter
- Carryout key VSD troubleshooting and identify the 3-phase power electronic systems of VFDs
- Describe thermal imaging, poor electrical contact, high resistance connection and power lines
- Troubleshoot electronic boards and identify the VFD components and motor considerations

Who Should Attend

This course covers systematic techniques and methodologies in advanced electrical drives and motors 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: -

- 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.

Course Fee

As per proposal

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 Contents

- Electrical Safety Refresher
- Introduction
- Most Common Electrical Events
- Shock & Arc Flash
- Why are We Susceptible to Injury by Electric Shock?
- Effects of Current on the Body
- Effect of Current Passing through the Body
- Factors Affecting Shock
- Example
- Is He/She Stuck?
- Voltage Thresholds
- Rescuing & Treatment
- Arc Flash
- Nature of the Arc
- Three Factors Affecting Arc Energy
- Burns from the Arc
- First Degree Burns from a 480 Fault
- Second Degree Burns from the Same 480 Fault
- Effects of the Arc- Burns
- Accelerator Flash Incident

- Importance of FR Clothing
- From the Type a Investigation
- Electrical Hazard Mitigation
- 1910 CFR 851 & NFPA 70e
- Turn it Off!
- Electrically Safe Work Condition
- Energized Work
- Shock Hazard Analysis
- Shock Approach Boundaries
- Flash Hazard Analysis
- Arc Flash Protection
- Exposed Live Part
- Hazard Risk Categories (HRC)
- Boundary & PPE Table
- Example Arc Flash Labels
- Electro-Magnetic Energy
- Worker Responsibilities
- Planning Your Work
- Conclusion
- TWD Requirements
- Contract Specific Safety Plan (CSSP)
- Content of the CSSP
- Insulated Tools
- Safe Switching Procedures
- Shock
- Breaker Explosion
- Arc Flash – 2006
- Operating Breakers & Disconnects
- Review – Switching Operations
- Conclusion
- Wrap-Up
- Tenets of Maintenance Safety
- Safety Meetings

- Accident Causes
- Unsafe Conditions
- Unsafe Acts
- Hazard Awareness
- Rotating Equipment Safety
- Electrical Lock Out
- Lockout Terms
- Definitions
- Lock Definitions
- Tagout Definitions
- Summary
- Personal Protective Equipment
- Definitions
- Roles & Responsibilities
- General PPE Requirements
- Head Protection
- Eye & Face Protection
- Face Shields
- Hand Protection
- Glove Inspection
- Body Protection
- Aprons
- Foot Protection
- Definitions
- Safety for 3 Phase Motors
- Safety Practice for Electrical Motor & Drive System
- Energized Parts
- Motor Circuits
- Checking For Power in Motor Circuits
- Lockout/Tagout Procedures
- Use of Cords
- Safe Work System
- What is a Safe Work Permit?

- PTW Requirements & Tips
- Safe Work Permit/ Pre-Job Meeting Form
- Safe Work Certificate
- Hot Work Permit
- Hot or Red Hot
- Isolation Certificate
- Sanction to Test Certificate
- Isolation Tags
- Operational Tag
- Electrical Work & Limitation of Access Certificate
- PTW & Site Observation Checklist
- Always Remember
- Safety in Hazardous Area
- Basic Principle of Explosion Protection
- Basic Principle of Safety
- Some Common Mis-Understandings
- The Source of Ignition
- Ignition Sources
- Zone Classification
- Example for a Zone Classification
- Classification “Rule of Thumb”
- Zone Concept
- Explosion Groups
- Temperature Classes
- Classification of Gases & Vapours into Explosion Groups & Temperature Classes
- Ingress Protection (Ip Xx)
- Types of Protection & Relevant Standards
- Oil Immersion
- Pressurized Apparatus
- Powder Filling
- Flameproof Enclosure
- Increased Safety
- Encapsulation

- Intrinsic Safety
- What Is Intrinsic Safety?
- Advantages of Intrinsic Safety
- Limitation of Intrinsic Safety
- Application of Intrinsic Safety
- Specialties of Intrinsic Safety
- Standards for Intrinsic Safety
- Joint Responsibility!
- Definitions (Simple Apparatus)
- Definitions (Intrinsically Safe Electrical Apparatus)
- Definitions (Associated Electrical Apparatus)
- Installation of I.S. Circuits
- Points About Installation
- Some Special Points
- Verification (New Standard)
- Recap
- Induction Motor
- Overview of Three-Phase Induction Motor
- Introduction
- General Aspects
- Parts of Ac Motor
- Construction
- Squirrel Cage Rotor
- Construction (Stator Construction)
- Construction (Enclosure)
- Nameplate
- Rotating Magnetic Field
- Ac Machine Stator
- MMF Due to ‘A’ Phase Current
- Currents in Different Phases of AC Machine
- Slip Ring Rotor
- Slip & Rotor Speed
- Principle of Operation

- Torque Producing Mechanism
- Direction of Rotor Rotates
- Equivalent Circuit of Induction Machines
- Analysis of Induction Machines
- Power Flow Diagram
- Efficiency
- Torque-Equation
- Speed Control
- Varying Rotor Resistance
- Varying Supply Voltage
- Varying Supply Voltage & Supply Frequency
- Starting Method of 3 Phase Induction Motor
- DOL Starter
- Advantage of DOL
- Disadvantage of DOL
- Star Delta Starter
- How Reduce Starting Current
- Advantage of Star Delta
- Disadvantage of Star Delta
- Monitoring & Fault Diagnosis of Induction Motors
- Motor Fault & Diagnosis
- For a Successful Motor Operation, The Keys are
- Induction Motor
- Major Faults of Electrical Machines
- Symptoms Produced for One or More of these Faults
- The Diagnostic Methods to Identify these Faults can be
- On-Line Condition Monitoring of Motors Using Electrical Signature Analysis
- Electrical Signature Analysis
- FFT (Fast Fourier Transform) Analyzer
- Various Types of Faults & their Detection Techniques
- Broken Rotor Bar & End Ring Faults
- Rotor Bar Damage
- Eccentricity Related Faults

- Static Eccentricity
- Dynamic Eccentricity
- Four Types of Rolling Element Bearing Misalignment
- Bearing Problems
- Stator or Armature Faults
- Interturn Shorts
- Drives Basics
- Minding Your P's & Q's
- A Drive System is not a Motor Speed Control
- The Power Source
- Incoming Power Stability
- Grounding
- Cable Distance
- Electrical Noise
- The Control Circuit
- The Basic Control Scheme
- Load Control
- Speed Control
- Closed Loop Control
- Logic Control
- The Prime Mover
- The AC Induction Motor Most Common Motor Used in Industry Today
- Name Plate Data
- The AC Induction Motor
- The AC Induction Motor is Designed to Convert Electrical Power into Mechanical Work
- The Speed/Torque Curve
- Frequency is Speed
- Voltage is Torque
- The Drive Train
- Torque Transmission
- Speed Changer
- Speed Changer Torque Transmission
- Enclosed Gearing

- The Coupling Devices
- The Feedback Devices
- How does an Electronic Variable Frequency Control Work?
- Motor Torque Control
- Typical Constant Torque Speed Ranges
- Motor Horse Power Control
- Variable Frequency Control
- Block Diagram
- Solid State Block
- Converter
- VFC Sections
- DC Bus
- Inverter
- Soft Charge Circuit
- Dynamic Braking
- Tools & Safety Issues
- Test Equipment
- Electronic Multi-Meters
- “Clamp” Current Meter
- Portable Oscilloscopes
- Don’t Do It!
- What Makes a Drive Application Successful?
- The Load
- Constant Torque
- Constant Horse Power
- Variable Torque
- Inverters for Variable Torque
- Impact Load
- Regeneration
- Stopping the Load
- Line Regenerative
- DC Injection Braking
- Applications

- Vector Control
- Applications for Vector Drives
- Vector Drives versus Inverters
- Caution!
- Some Application Considerations
- Other Application Considerations
- Trouble Shooting
- 10 Most Common Problems
- What are the Pitfalls?
- Case Study 1
- Case Study 2
- Case Study 3
- Introduction & Agenda
- Why Do We Need VFDs?
- What is a VFD?
- Savings - Typical HVAC System Load
- Where VFDs are Used
- Where VFDs are Used – Fans & Pumps
- Where VFDs are Used - Packaged Equipment
- How VFDs are Used: Fan Application – VAV System
- Where Drives are Used: Cooling Tower Fans
- Where Drives are Used: Primary Chilled Water Pump
- VFD
- PID Application
- DDC Interface
- Motors/Concerns
- Motors
- Maintenance
- Available Configurations
- Functions of an Variable Frequency Drive (VFD)
- Example of Cooling Tower Fans
- Start/Stop
- Change Speed

- Constant Speed
- Limits
- Ramping
- Forward/Reverse
- Save Energy
- Parts of a Variable Frequency Drive (VFD)
- Control Arrangements for a VFD
- Parts & Operations of a Drive
- Rectifier Section
- Soft Charge Circuit
- Intermediate Circuit (DC Link)
- Brake Circuit
- Inverter Section
- Pulse Width Modulation
- Control & Regulation
- How To Troubleshoot Safely
- Shock Hazard
- What Causes Shock
- Electricity's Effect on the Body
- Physiological Effects of Current on the Body
- Protecting against Shock Hazards
- Lockout/Tagout Principles
- Proper Isolation Procedures
- Testing Live Equipment
- A Note About Regulations
- Arc Flash Hazard
- Factors Affecting the Hazard
- Protecting against Flash Hazards
- Flash Protective Clothing
- NFPA 70e
- Troubleshooting Techniques
- Systematic Troubleshooting
- Preparation

- Step 1: Observe
- Step 2: Define Problem Area
- Step 3: Identify Possible/Probable Causes
- Step 4: Test
- Step 5: Repair/Replace
- Follow Up
- Using a Meter
- Determining Test Locations
- General Meter Rules
- Meter Precautions
- Using a Voltmeter
- Key VSD Troubleshooting
- Practice Case Study
- 3 Phase Power Electronic Systems: VFDs
- Thermal Imaging
- Poor Electrical Contact
- Excessive Current Examples
- High Resistance Connection
- Power Lines
- Troubleshooting Electronic Boards
- Utility Feeds
- Main Breakers
- VFD Components
- VFD – Motor Considerations
- Example of PWM Voltage Damage to Motor Wiring
- Example of Bearing Damage Due to PWM Output Fluting
- Points to Remember