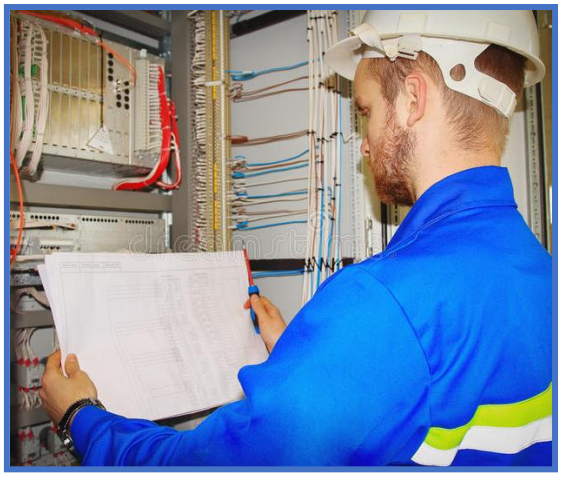
COURSE OVERVIEW EE1047
A1186 Electrical System Basics and Diagrams (E-Learning Module)



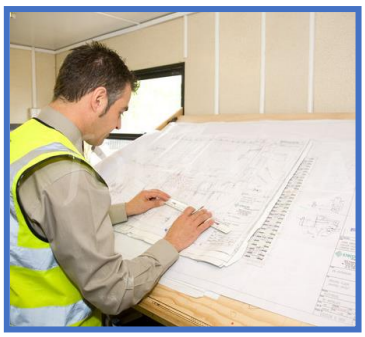
Course Title
A1186 Electrical System Basics and Diagrams (E-Learning Module)

Course Reference
EE1047

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 E-Learning course is designed to provide participants with an overview of electrical system basics and diagrams. It covers the fundamentals of electric systems and machinery principles; the Ohm's law and conversions; the relationships of the basic electrical quantities; the electro-magnetic theory, magnetic flux, Faraday's law of induction and Lenz's law; the transient effects, AC circuit components and circuits with multiple components; the heat, current in a resistor and magnetic hysteresis; the balance three-phase voltages and three phase circuit; the wave and full wave rectifier and rectification; the action and principle of operation, components and core characteristics of transformers; the schematic symbols for transformer; leakage flux; and the primary and secondary phase relationship, turns, voltage ratios and current ratios.

During this course, participants will learn the transformer tests, open-circuit test, short-circuit test, transformer losses and efficiency; the types of transformers, other uses of a transformer and effects of current on the human body; the cut view of transformer, transformer with conservator and breather; the apparent power rating of a transformer, inrush current and classification of transformer; the basis of cooling employed and transformer efficiency and losses; and the moisture content in cellulose insulation, water heat run test, transformer testing and voltage ratio test.

Course Objectives

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

- Apply and gain a basic knowledge on electrical system and diagrams
- Discuss the fundamentals of electric systems and machinery principles
- Explain Ohm's law and conversions including the relationships of the basic electrical quantities
- Describe electro-magnetic theory, magnetic flux, Faraday's law of induction and Lenz's law
- Illustrate transient effects, AC circuit components and circuits with multiple components
- Differentiate heat versus current in a resistor and discuss magnetic hysteresis, balance three-phase voltages and three phase circuit
- Identify rectifiers that include half wave and full wave rectifier as well as rectification
- Discuss transformers and its principle of operation, components and core characteristics
- Recognize schematic symbols for transformer, leakage flux, primary and secondary phase relationship, turns, voltage ratios and current ratios
- Carryout transformer tests, open-circuit test and short-circuit test as well as identify transformer losses and efficiency
- Recognize the types of transformers, other uses of a transformer and effects of current on the human body
- Describe cut view of transformer, transformer with conservator and breather
- Review apparent power rating of a transformer, inrush current and classification of transformer
- Classify the basis of cooling employed as well as determine transformer efficiency and losses
- Identify moisture content in cellulose insulation as well as employ water heat run test, transformer testing and voltage ratio test

Who Should Attend

This course provides a basic overview of electrical system and diagrams for those who are involved in electrical drawing activities including engineers, draftsmen, electrical technicians and other technical staff.

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

- Introduction & Overview
- Fundamentals of Electric Systems: Introduction to Machinery Principles
- Introduction
- Atom
- What are the Parts of an Atom?
- The Atom
- What is electricity?
- Static electricity
- Current (I, Amps)
- Potential (V, Volts)
- Resistance (R, Ohms)
- Ohm's Law
- Ohm's Law & Conversions
- Capacitance (C, Farads)
- Current Carrying Conductor Produces Magnetism
- Magnetic Lines w.r.t. Current Flow Direction
- Direction of Current in Windings Establish N & S Poles
- Inductance (L, Henrys)
- Frequency (f, Hertz)
- Reactance (X, Ohms)

- Impedance (Z, Ohms)
- Active Power (P Watts)
- Reactive Power (Q, Vars)
- Apparent Power (A, Volt-Amps, VA)
- Power Factor (PF) - Real Power/ Apparent Power
- Relationships of the Basic Electrical Quantities
- COURSE RECAP
- Electro-Magnetic Theory
- Introduction to Electromagnetics
- Induction Experimental
- Magnetic Flux
- Faraday's Law of Induction
- Generator
- Lenz's Law: Against the change
- Lenz's Law: Example
- Flux Density (B) & Flux (Φ)
- Summary: Electromagnetic Induction & Faraday's Law
- Faraday's law
- Extra facts 1: Fleming's Right Hand Rule
- Extra facts 2 – Non-Perpendicular B-Fields
- Extra facts 3 – Coils
- What does it all mean?
- Transient Effects
- Phasors
- AC Circuit Components
- Circuits with Multiple Components
- Heat vs. Current in a Resistor
- Magnetic Hysteresis
- Balance Three-Phase Voltages
- Three Phase Circuit
- Eddy Current
- Course Recap
- Rectifiers and Rectification
- Half Wave Rectifier

- Full Wave Rectifier
- Course Recap
- Transformers
- Introduction
- Definition and Principle
- Transformer Action
- Principle of Operation
- Components of a Transformer
- Core Characteristics
- Laminated Cores
- Hollow Core Transformers
- Shell Core Transformers
- Transformer Windings
- Schematic Symbols for Transformer
- How A Transformer Works
- Exciting Current
- Effect of a Load
- Coefficient of Coupling
- Leakage Flux
- Primary and Secondary Phase Relationship
- Turns and Voltage Ratios
- Turns and Current Ratios
- Power Relationship between Primary and Secondary Windings
- Ideal Transformers
- Transformer Tests
- Open-circuit Test
- Short-circuit Test
- Transformer Losses
- Transformer Efficiency
- All Day Efficiency
- Transformer Ratings
- Types of Transformers
- Other Uses of a Transformer
- Effects of Current on the Human Body

- Cut View of Transformer
- Transformer with Conservator and Breather
- Apparent Power Rating of a Transformer
- Inrush Current
- 3 phase Transformer Connections
- Star- Star Connection
- Delta - Delta Connection
- Star- Delta Connection
- Delta - Star connection
- Classification of Transformer
- Classification on the Basis of Cooling Employed
- Transformer Efficiency
- Transformer Losses
- Eddy Currents
- Hysteresis Loss
- Rating/Specifications
- Vector Group
- Cooling Arrangement
- Components of a Transformer
- Oil filled Transformer
- Dry Type Transformer
- Core
- Oil
- Insulation
- Bushing
- OTI
- WTI
- Buchholz Relay
- Overloading Capacity
- Condition Monitoring
- DGA- Key gases
- DGA
- DGA (Rogers Ratio Method)
- DGA (IEC 60599)

- Moisture Content in Cellulose Insulation
- Water Heat Run Test
- Relative saturation (RS) of water in oil
- Transformer Testing
- Voltage Ratio Test
- 1Φ Excitation Current at 415V
- Polarity Check
- Winding Resistance
- IR of Winding & Core
- Capacitance & Tan Delta of Winding & Bushing
- Diagnostic Testing
- SFRA
- DP Index
- Current Transformers & Potential Transformers CT and PT
- Oil Type Transformer
- Indicative Drawing
- Dry Type Transformers
- Transformers IR
- Dry Type Transformers
- Course Recap
- Introduction to Electrical Machines
- Electric Motors and Generators
- Introduction
- A Simple AC Generator
- Thus for the arrangement shown below
- A Simple DC Generator
- Use of a Commutator
- A Simple Generator with Two Coils
- DC Generators or Dynamos
- A four-pole DC Generator
- Field Coil Excitation
- DC Generator Characteristics
- AC Generators or Alternators
- A Four-Pole Alternator

- A Four-Pole Alternator
- Example
- DC Motors
- DC Motor Characteristics
- AC Motors
- A Squirrel-Cage Induction Motor
- Universal Motors
- Electrical Machines – A Summary
- Key Points
- Meters Must have for Troubleshooting
- Induction Motors
- Objectives of the Session
- Motors vs Engines
- AC Motors
- Motors
- Magnetic Induction
- Basic Principles of Rotating Machines
- Motor Parts
- Enclosure
- Stator (Windings)
- Rotor
- Wound Rotor Motors
- Bearings
- Other Parts
- Motor Speed
- Synchronous Speed
- Rated Speed
- Motor Slip
- Torque
- Torque-Speed Curve
- Motor Power
- Calculating Horsepower
- Electrical = Input
- Example:1

- Example:2
- Nameplate – Examples
- Classification of Motors
- Synchronous vs Induction Motors
- Single Phase Induction Motors
- Split Phase Motor
- Capacitor Run Motor (Permanent Split Capacitor or PSC)
- Capacitor Start Motor
- Capacitor Start-Capacitor Run
- Universal Motor
- Course Recap
- Construction & Speed Control of Induction Motors
- Induction Motors
- Introduction
- Construction
- Rotating Magnetic Field
- Synchronous Speed
- Rotating Magnetic Field
- Principle of Operation
- Induction Motor Speed
- The Slip
- Frequency
- Torque
- Horse power
- Example
- Solution
- Equivalent Circuit of an Induction Motor
- Power Relations
- Example
- Solution
- Rating of AC Induction Motors
- Cooling and Ventilation of Electric Motors (IC)
- Degree of Protection of Motor Enclosures (IP)
- Construction and Mounting of AC Induction Motors

- AC Motor Starting Methods
- Synchronous Machines Synchronous Generators
- Basic AC Power Flow
- Losses
- Power Factor
- Basic Expressions
- Synchronous Generators
- Construction of Synchronous Machines
- Prime Movers (Mechanical Energy)
- Equivalent Circuit of a Synchronous Generator
- Power and Torque in Synchronous Generators
- Phasor Diagram of a Synchronous Generator
- The Synchronous Generator Operating Alone
- Terminal Characteristics of Synchronous Generators
- Parallel Operation of Synchronous Generators
- Conditions Required for Paralleling
- General Procedure for Paralleling Generators
- Operation of Generators in Parallel with Large Power Systems
- Motor Protection, Insulation & Troubleshooting
- Motor Preliminary Standards
- Causes of Motor Failures
- Why Motors Fail?
- Protection of Low Voltage Motors
- Overload Protection
- Short Circuit Protection
- Motor Protection
- Motor Protection Co-Ordination
- Medium Voltage Motor Protection
- Electrical Faults in Stator Windings
- Motor Differential Protection
- Overload and Locked Rotor (Stalling) Motor Protection
- Operation of a Thermal Over Current Relay During Lock Rotor Condition
- Unbalanced Phases
- Single Phasing Cause

- Loss of Phase or Single Phasing
- Under and Overvoltage Protection
- Effect of Voltage Variation
- Undervoltage Cause
- Under voltage Effect
- Over Voltage Cause
- Over Voltage Effect
- Under and Overvoltage Protection
- Motor Winding Temperature
- Under and Overvoltage Protection
- Siemens Motor Protection Relays
- SIPROTEC Motor Protection
- Motor Protection Function provided by SIPROTEC
- Motor Protection of Small Motor 100-500kw
- Motor Protection of Small Motor 500kw (1-2MW)
- Motor Protection of Small Motor (>2MW)
- What Makes Insulation to Deteriorate?
- How Insulation Resistance is Measured
- Insulation and Testing
- How to Interpret Resistance Readings
- Types of Insulation Resistance Tests
- Test Voltage vs. Equipment Rating
- Use of DC Dielectric Test Set
- 11kV XLPE Aluminum Single Core 500mm² with Voids
- Insulation Resistance to Ground
- Introduction
- Polarization Index PI
- Course Recap
- Generator Protection
- Stator Ground Fault Protection
- Differential Protection
- Phase Unbalance or Negative Phase Sequence Protection
- Interturn Protection
- Under-frequency and Over-frequency Protection

- Out-of-Step Protection
- Loss of Excitation Protection
- Overexcitation Protection
- Reverse Power Protection
- Phase Back-up Protection
- Generator Overcurrent Protection Voltage Controlled & Voltage Restrained
- Generator Short-Circuit Current
- Course Recap