COURSE OVERVIEW EE0320-4D
Fault Analysis in Electrical Networks & Distribution Cables
Power Systems Troubleshooting

Course Title
Fault Analysis in Electrical Networks & Distribution Cables: *Power Systems Troubleshooting*

Course Reference
EE0320-4D

Course Duration/Credits
Four days/2.4 CEUs/24 PDHs

Course Date/Venue

Session(s)	Date	Venue
1	February 05-08, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
2	May 06-09, 2024	Boardroom, Warwick Hotel Doha, Doha, Qatar
3	August 05-08, 2024	Ajman Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE
4	November 04-07, 2024	Al Aziziya Hall, The Proud Hotel Al Khobar, KSA

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.

The detection of faults on electrical distribution systems has been one of the most persistent and difficult problems facing the electric utility industry. The performance and characteristics of electrical system configurations are vital factor in reducing or increasing the effect of faults on the system as earthing system, switch gear, protective relays, active and reactive power generation, etc. Protective systems are designed to sense faults and initiate fault clearing in a timely manner while minimizing the affected area. Protective relays are used to sense the faults and initiate circuit breakers tripping. Alternatively, fuses are used on the distribution system to sense and clear faults.

Electrical faults can cause severe damage when not interrupted promptly. In some cases, high-impedance fault currents may be insufficient to operate protective relays or blow fuses. Standard overcurrent protection schemes utilized on secondary distribution at some industrial, commercial and large residential buildings may not detect high-impedance faults, commonly called arcing faults.

In these cases, more careful design techniques, such as the use of ground fault circuit interruption, are required to detect arcing faults and prevent burndown. When a short-circuit fault occurs, the fault path explodes in an intense arc. Local customers endure an interruption and customers farther away, a voltage sag; faults cause most reliability and power quality problems. Faults kill and injure line operators. Crew operating practices, equipment and training must account for where fault arc are likely to occur and must minimize crew exposure. When faults occur, we have ways to reduce their impacts. This course focuses on the general characteristics of faults and specific analysis of common fault types with suggestions on how to reduce them.

This course is designed to present methods of Electrical Fault analysis, causes, detection and remedies in Electrical Networks and Distribution Cables, particularly with the aid of a personal computer and Power System Simulator. The approach is designed to develop participant's thinking process, enabling them to reach a sound understanding of a broad range of topics related to electrical faults, while motivating their interest in the electrical power industry. The course includes many case studies describing present day, practical applications. Those case studies and exercises will be solved in the class.

Course Objectives

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

- Apply and gain an in-depth knowledge on fault analysis in electrical networks and distribution cables covering power systems troubleshooting
- Discuss the basic concepts covering main electric parameters and laws, standards, regulations and voltages
- Identify the types of faults and their effects as well as differentiate symmetrical faults, unsymmetrical faults, arc characteristics and symmetrical components
- Explain limiting fault currents and identify the various faults and types of transformers and equipments
- Determine system grounding covering generation, transformers, transmission, distribution and power system
- Illustrate protection and switching equipment tripping devices for circuit breakers, protection devices, technology and instrument transformers
- Employ grading and protection co-ordination, distance and differential protections, transformer protection, generator protection, overhead lines protection, cable protection, motor protection and miscellaneous protections
- Carryout protection relay management, reclosing practices and single-phase protective devices
- Perform electrical system restoration and electrical maintenance 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 covers systematic techniques of fault analysis in electrical networks and distribution cables for engineers, supervisors and other technical staff who work in transmission, distribution, maintenance, operation, control and analysis of utilities and industrial electrical networks.

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

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.
Doha	**US$ 5,500** per Delegate. 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.
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.

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. Ahmed Hayajneh is a **Senior Electrical Engineer** with **20 years** of experience within the **Power & Water Utilities** and other **Energy** sectors. His expertise widely covers in the areas of **Power System Equipment**, **Transmission Network** Maintenance, **Electrical Forecasting** Techniques, **Inspection Reporting** Techniques, **Electrical Substation** Design & Planning, **Electrical Drawings** & **Schematics**, **Fault Detection** Analysis, **Distribution Networks** & **Load Forecasting**, **Power Generation**, **Electrical Power** System, **Electrical** Installations & Utilities, **Electrical Distribution Systems & Control Circuits**, **Electrical Drawings**, **Relay Logic Circuits**, Troubleshooting **Transformers**, **System Grounding**, **Circuit Breakers**, **Protection Devices & Technology**, **Protection Relay**, **Transformers**, **Generators**, **Power Transformers**, **Motors**, **Substations**, **Switchgears & Distribution**, **Power System** Analysis, **Electrical Equipment** Control Systems, **Transformer Maintenance & Testing**, **Electrical Substation & Design**, **Power Quality** Studies & Load Criteria, LV/MV Electrical Safety (**11 KV, 415 & 220 Voltage**), **Substation Earthing System**, **Electrical Equipment** Maintenance, **Cables & Wiring**, **Overhead Transmission Lines**, **Electrical Safety**, **Electrical Protection**, **Batteries**, **Chargers & UPS**, **Electrical Submersible Pumps** (**ESP**), **Power Supply** Substations, Area Classification, Safety Management System, Permit to Work & Issuing Authority, Emergency **Diesel Generator**, **Variable Frequency Drives** (VFD), **PLC & SCADA** for Automation & Process Control, **DCS** Automated Process Control Systems, High & Low Voltage **Electrical Safety**, **Electrical Inspection** & Testing, **Electrical Control** & Monitoring System, **Electric Power System**, Intensive Overhead **Transmission** Line (OHTL), **Generator** Maintenance & Troubleshooting, **Transmission** Line Networks, **Distribution** Engineering, HVDC **Transmission** & Control, **Substation** Maintenance Techniques and **Overhead Power Line** Construction & Patrolling.

Mr. Ahmed gained his expertise and experience through several positions as a **Senior Electrical Project Engineer**, **Senior Electrical Engineer**, **Site Electrical Engineer** and **Senior Instructor/Trainer** for various companies such as United Electro-Mechanical International Company, AL OSAIS Contracting Co., ASTRACO, Saudi Service for Electro Mechanic Work Co. (S.S.E.M), Dubai Electricity & Water Authority (DEWA) and Saudi Electricity Company (SEC).

Mr. Ahmed has a **Bachelor's** degree in **Electrical Engineering**. Further, he is a **Certified Instructor/Trainer** and has delivered various trainings, seminars, conferences, workshops and courses globally.

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 Concepts*** *Introduction to Troubleshooting & Fault Analysis in Electrical Networks & Distribution Cables ● Main Electric Parameters & Laws ● Standards & Regulations ● Standard Voltages*
0930 -0945	*Break*
0945 – 1130	***Faults & Their Effects*** *Types of Faults ● Causes of Faults (Internal and External) ● High-Impedance Faults ● Lightning, Switching Overvoltage and Use of Surge Arresters ● Short-circuit Faults (Phase and Earth Faults) ● The Effect of Faults On Equipment (Thermal and Electromechanical Stress) ● Short-circuit Calculations*
1130 – 1145	*Break*
1145 – 1230	***Symmetrical & Unsymmetrical Faults*** *Series R-L Circuit Transients ● System Representation ● Sequence Bus Impedance Matrices*
1230 – 1315	***Arc Characteristics***
1315 – 1330	*Break*
1330 – 1345	***Symmetrical Components*** *Definition of Symmetrical Components ● Sequence Networks of Impedance Loads ● Sequence Networks of Series Impedances ● Sequence Networks of Three-Phase Lines ● Sequence Networks of Rotating Machines ● Per-Unit sequence Models of Three-Phase Two-Winding Transformers ● Per-Unit Sequences Models of Three-Phase Three-Winding Transformers ● Power in Sequence Networks*
1345 – 1400	***Limiting Fault Currents***
1400 - 1420	***Faults on Transformers*** *Types of Transformers ● Transformers Parameters ● Transformer Connections Fault Profiles ● Internal Faults &Protections ● Secondary Faults ● Primary-to-Secondary Faults*
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

0730 – 0745	***Equipment Faults*** *Generators ● Switchgears ● Motors ● Overhead Lines ● Underground Cables ● Fault Location*
0745 - 0800	***System Grounding*** *Solid, Impedance & Ungrounded Systems ● Generation Units ● Power Transformers ● Transmission Lines ● Distribution System ● Arrangement of Grounding in Power System● Touch & Step Potentials ● Earth Grid & Calculations*

0800 – 0815	***Protection & Switching Equipment*** *Switches ● Isolators ● Fuses*
0815 - 1045	***Tripping Devices – Circuit Breakers*** *The Mechanism of Electric Arc Breakdown ● Types of Circuit Breakers & Applications (LV, MV & HV) ● Main Characteristics ● Operating Mechanism, Tripping Circuits & Control Systems ● Reclosers*
1045 – 1100	*Break*
1100 – 1230	***Protection Devices & Technology*** *Introduction to Protection ● Protection Relays (History; Construction & Principles of Operation; Modern Technology) ● Classification of Protection Relays & Codes ● Main Protection & Back-up Protection ● Intelligent Electronic Devices (IED's) ● Fuses (Characteristics, Applications & Special Cares) ● Examples & Exercises*
1230 – 1245	*Break*
1245 – 1330	***Instrument Transformers*** *Current & Voltage Transformers ● Types, Construction, Performance, Specification & Applications ● Magnetisation Curve & Characteristics (Ratio, Accuracy & Burden Power) ● Testing ● Examples*
1330 – 1420	***Grading & Protection Co-ordination*** *Principles ● Analysis in HV, MV & LV Networks (Transmission & Distribution Networks; Users' Networks) ● Calculation of Settings ● LV Approach (Typical Time-Current Curves & Selectivity of LV Circuit Breakers) ● Recloser-Recloser Coordination ● Coordinating Instantaneous & Timed Elements ● Practical Examples*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the T were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Two*

Day 3

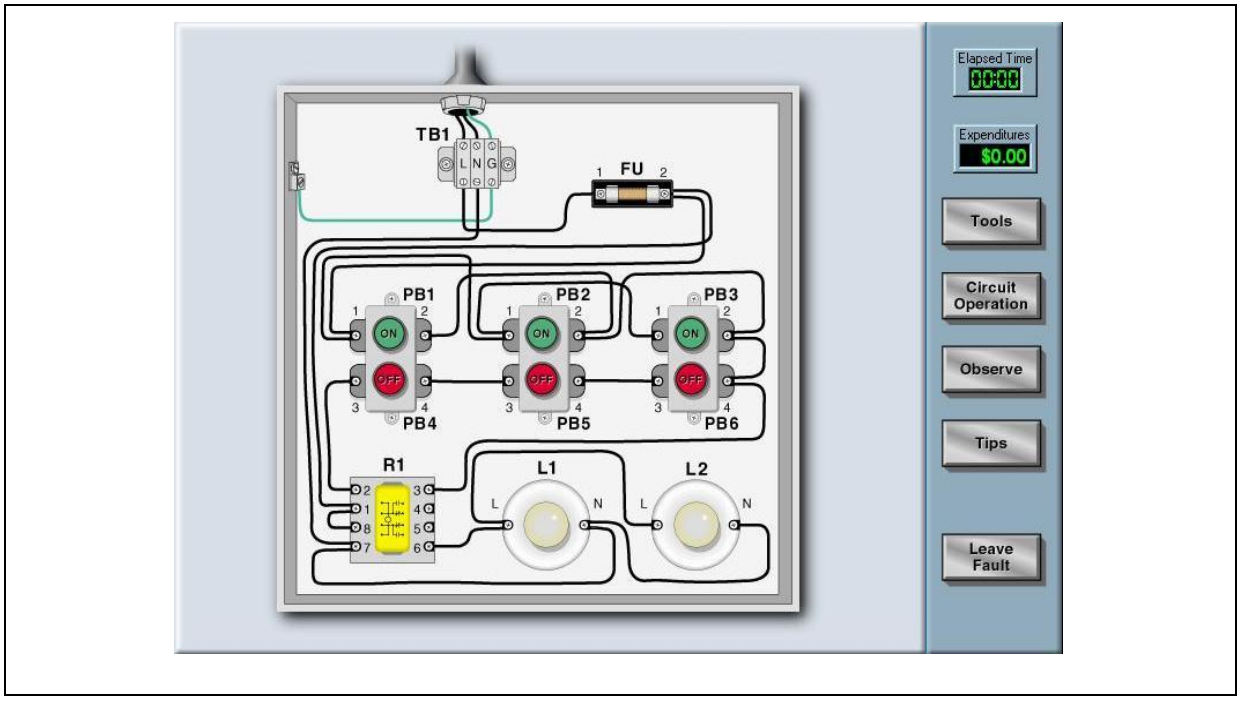
0730 – 0830	***Distance & Differential Protections***
0830 – 0930	***Transformer Protection***
0930 – 0945	*Break*
0945 – 1030	***Generator Protection***
1030 – 1130	***Overhead Lines Protection***
1130 - 1230	***Cable Protection***
1230 – 1245	*Break*
1245 - 1330	***Motor Protection***
1330 – 1420	***Miscellaneous Protections***
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

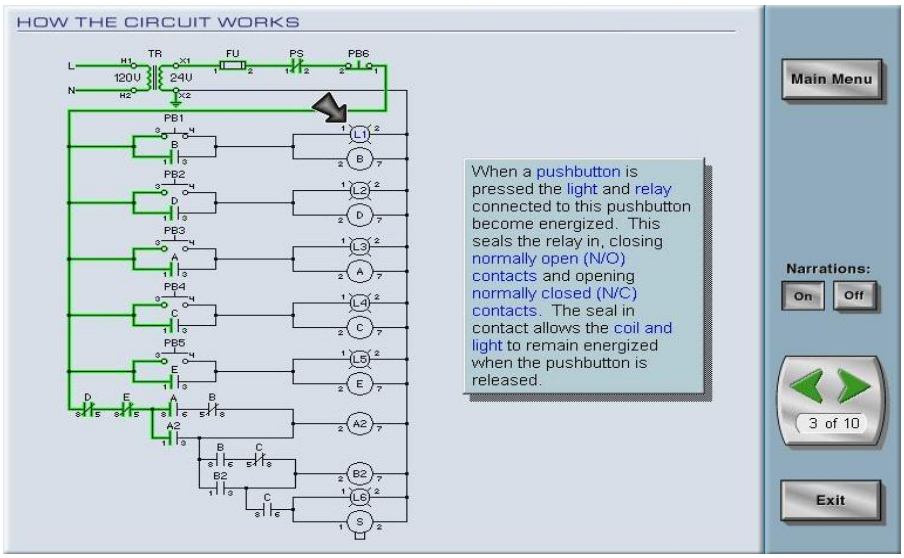
Day 4

0730 – 0930	***Protection Relay Management*** *Scheme Design ● SCADA Control of the Protection Scheme ● Adaptive Control by Phases ● Maintenance & Testing*
0930 – 0945	*Break*
0945– 1030	***Reclosing Practices*** *Reclose Attempts & Dead Times ● Immediate Reclose ● Reclosing with Live Works*
1030 – 1130	***Single-Phase Protective Devices*** *Single-Phase Reclosers with Three-Phase Lockout*
1130 – 1230	***System Restoration*** *Brown-Out ● Black-out*
1230 – 1245	*Break*
1245 – 1345	***Electrical Maintenance Program*** *Maintenance Actions ● Testing Intervals ● International Electrical Testing Association (NETA) Specifications*
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*

Simulator (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 simulator "Simutech Troubleshooting Electrical Circuits V4.1".





Simutech Troubleshooting Electrical Circuits V4.1

Course Coordinator
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