COURSE OVERVIEW EE1171
Electrical High Voltage System Protection & Studies

Course Title
Electrical High Voltage System Protection & Studies

Course Date/Venue
September 14-18, 2025/Musandam Meeting Room, Royal Tulip Muscat, Muscat, Oman

Course Reference
EE1171

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

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.

This course is designed to provide participants with a detailed and up-to-date overview of Electrical High Voltage System Protection & Studies. It covers the high voltage systems, protection system objectives and functions and types of faults in HV systems; the components of protection systems, basic protection principles and system studies; the evolution and types of protection relays and current transformers (CTs) in protection; the voltage transformers (VTs / PTs) and circuit breakers and protection role; the overcurrent protection, earth fault protection, transformer protection and generator protection; the motor protection, busbar protection, transmission line protection and breaker failure and backup protection; and the distance protection in HV lines, pilot protection schemes and stability in power systems.

During this interactive course, participants will learn the short-circuit studies, protection coordination studies and protection against overvoltage; the surges and protection in HVDC and EHV systems, ring main unit (RMU) protection and substation automation systems; the grid-tied renewable generation (solar, wind) and microgrid protection strategies; the role of SCADA in HV protection and remote relay setting and control; the fault location, isolation and restoration (FLISR); the integration with distribution management system (DMS); the adaptive protection schemes, IEC 61850 and GOOSE messaging and synchrophasor technology in protection; and the wide area monitoring and protection (WAMPAC).

Course Objectives

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

- Apply and gain an in-depth knowledge on electrical high voltage system protection and studies
- Discuss high voltage systems, protection system objectives and functions and types of faults in HV systems
- Identify the components of protection systems, basic protection principles and system studies
- Recognize the evolution and types of protection relays including current transformers (CTs) in protection, voltage transformers (VTs / PTs) and circuit breakers and protection role
- Carryout overcurrent protection, earth fault protection, transformer protection and generator protection
- Apply motor protection, busbar protection, transmission line protection and breaker failure and backup protection
- Illustrate distance protection in HV lines, pilot protection schemes and stability in power systems
- Employ short-circuit studies, protection coordination studies, protection against overvoltage and surges and protection in HVDC and EHV systems
- Apply ring main unit (RMU) protection, substation automation systems, grid-tied renewable generation (solar, wind) and microgrid protection strategies
- Define the role of SCADA in HV protection and carryout remote relay setting and control, fault location, isolation and restoration (FLISR) and integration with distribution management system (DMS)
- Discuss adaptive protection schemes, IEC 61850 and GOOSE messaging, synchrophasor technology in protection and wide area monitoring and protection (WAMPAC)

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, course conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides an overview of all significant aspects and considerations of electrical high voltage system protection and studies for electrical engineers, industrial and utility engineers, HSE personnel and other staff exposed to high voltages. Supervisors or managers concerned with the safety of electrical workers will find this course especially useful in providing an insight into electrical safety.

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. Steve Mark, PE, MSc, BSc, is a **Senior Electrical & Telecommunications Engineer** with over **20 years** of extensive experience within the **Oil & Gas**, **Petrochemical** and **Power** industries specializing in **HV/LV Equipment**, **High Voltage Electrical Safety**, **LV & HV Electrical System**, **HV Equipments Inspection & Maintenance**, **HV Switchgear Operation & Maintenance**, **LV Distribution Switchgear & Equipment**, Basic **Electricity**, **Electrical & Special Hazards**, **Personnel Protection**, **Motor Controllers**, **Electrical Switching Practices**, **Emergency Planning**, **Safety Management**, **Earthing & Bonding Installation**, **Energized & De-Energized Work**, **Protection Relays**, **Testing & Commissioning**, **Lock & Tag Out**, **Circuit Breakers & Switchgears**, Portable **Cables**, **Transformers**, **Surge Arrestors**, **Isolators & Fuses**, **Capacitor Banks**, Earth & Shunt Reactors, Gas Insulated Substations (**GIS**), **HV Substation Inspection & Reporting**, **HV Cable Design**, **HV Electrical System Commissioning**, **HV Equipments Inspection & Maintenance**, **UPS & Generators**, Electrical Installations Design & Construction, **Electrical Mechanical Installations**, **GIS Substations**, **GE Turbine Power Plant** and **Steam Power Plants**. Further, he is also well-versed in **Network & System Administration**, Data/Voice Networking, Network Capacity Calculations, VPN Connection Implementation, Structured Cabling Constructions, Engineering Design, Security Installations Design & Implementation, Logistics Management, IT Analysis, Business Continuity Plan Design, Disaster Recovery Simulations, Supply Chain System Design, Barcode Marking & RFID Applications. He is currently the **Lead Electrical Engineer** of Public Power Corporation S.A wherein he is responsible for site manufacturing supervision of works and electrical maintenance support for the existing Steam Electrical Power Plant.

During his career life, Mr. Mark has gained his expertise and thorough practical experience through handling challenging positions such as being the **IT & Telecommunications Manager**, **IT & Organization Manager**, **Logistics Manager**, **Electrical Engineer**, **Safety Engineer**, **Public Works Contractor**, **IT Support Analyst**, **Project Supervisor**, **Systems & Network Administrator**, **Data Protection Officer**, Shop Auditor and Amateur Radio Operator for various multi-national companies and institutes.

Mr. Mark is a **Registered Professional Engineer** and holds a **Master's** degree in **Quality Management & Technology** from the **Hellenic Open University** as well as a **Bachelor's** degree in **Electrical Engineering** from the **Technical University of Halkida**, **Euboea**, **Greece**. Further, he is a **Certified Instructor/Trainer**, a **Certified Safety Engineer** and a **Certified Data Protection Officer** (**DPO**). Moreover, he is a member of Scientific Society of Technological Education of Engineers (EETEM) and has delivered numerous trainings, courses, seminars, workshops and conferences internationally.

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 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: ***Sunday, 14th of September 2025***

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Introduction to High Voltage Systems*** *Overview of HV Transmission & Distribution Networks • Importance of System Protection & Reliability • Key HV Equipment (Transformers, Switchgear, Circuit Breakers) • International Standards (IEC, IEEE, ANSI)*
0930 – 0945	*Break*
0945 – 1030	***Protection System Objectives & Functions*** *Fault Detection and Isolation • Ensuring Continuity of Supply • Limiting Equipment Damage • Enhancing System Stability*
1030 – 1130	***Types of Faults in HV Systems*** *Symmetrical versus Asymmetrical Faults • Line-to-Ground, Line-to-Line & Double-Line Faults • Causes of HV Faults (Insulation Failure, Lightning, Contamination) • Fault Current Magnitude & Impact*
1130 – 1215	***Components of Protection Systems*** *Protective Relays (Electromechanical, Static, Digital) • Instrument Transformers (CTs & VTs) • Circuit Breakers & Fuses • Communication Systems for Protection*
1215 – 1230	*Break*

1230 – 1330	***Basic Protection Principles*** *Selectivity & Coordination • Sensitivity & Reliability • Speed of Operation • Redundancy in HV Protection*
1330 – 1420	***Basics of System Studies*** *Load Flow Studies • Short-Circuit Analysis • Transient Stability Studies • Protective Device Coordination*
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, 15th of September 2025***

0730 – 0830	***Protection Relays: Evolution & Types*** *Electromechanical Relays • Static Relays • Numerical/Digital Relays • Advantages of Modern Relay Technology*
0830 – 0930	***Current Transformers (CTs) in Protection*** *CT Construction & Operation • CT Accuracy & Burden • CT Saturation & Errors in Protection • Application in Differential & Overcurrent Protection*
0930 – 0945	*Break*
0945 – 1100	***Voltage Transformers (VTs / PTs)*** *Types of VTs (Electromagnetic, Capacitive) • Voltage Scaling for Relays • VT Errors & Impact on Measurements • Application in Distance Protection*
1100 – 1215	***Circuit Breakers & Protection Role*** *HV Circuit Breaker Types (SF6, Vacuum, Oil, Air-Blast) • Interrupting Medium Selection • Arc Extinction Methods • Breaker Failure Protection*
1215 – 1230	*Break*
1230 – 1330	***Overcurrent Protection*** *Time Overcurrent Protection • Inverse Time Characteristics • Coordination with Fuses & Relays • Applications in Radial & Ring Systems*
1330 – 1420	***Earth Fault Protection*** *Ground Fault Detection Methods • Residual Current & Neutral Grounding Systems • Directional Earth Fault Protection • Sensitive Earth Fault Relaying*
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, 16th of September 2025***

0730 – 0830	***Transformer Protection*** *Differential Protection Principles • Overcurrent & Thermal Overload Protection • Restricted Earth Fault Protection • Inrush Current Discrimination*
0830 – 0930	***Generator Protection*** *Stator Earth Fault & Differential Protection • Rotor Earth Fault Protection • Loss-of-Excitation Protection • Out-of-Step & Unbalanced Protection*
0930 – 0945	*Break*
0945 – 1100	***Motor Protection*** *Overload & Thermal Protection • Phase Failure & Unbalance Detection • Locked Rotor & Stall Protection • Motor Differential Protection*

1100 – 1215	***Busbar Protection*** *Differential Busbar Protection Schemes • Zone of Protection Considerations • Fast Bus Tripping Schemes • Challenges: CT Saturation & Stability*
1215 – 1230	*Break*
1230 – 1330	***Transmission Line Protection: Fundamentals*** *Protection Zones in Transmission Systems • Distance (Impedance) Protection • Overcurrent versus Distance Schemes • Pilot Protection Basics*
1330 – 1420	***Breaker Failure & Backup Protection*** *Breaker Failure Detection Logic • Trip Command Redundancy • Local versus Remote Backup Schemes • Coordination with System Stability*
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 Three*

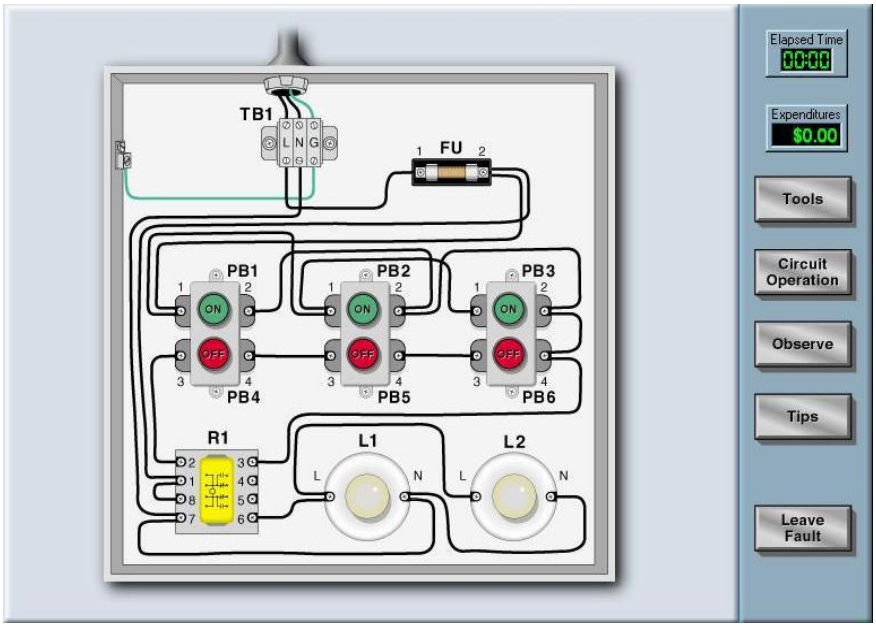
Day 4: ***Wednesday, 17th of September 2025***

0730 – 0830	***Distance Protection in HV Lines*** *Impedance Relay Principle • Mho & Quadrilateral Characteristics • Zones of Protection (Zone 1, Zone 2, Zone 3) • Fault Resistance Impact*
0830 – 0930	***Pilot Protection Schemes*** *Current Differential Protection • Directional Comparison Schemes • Phase Comparison Techniques • Communication Channels (Fiber, Microwave, PLC)*
0930 – 0945	*Break*
0945 – 1100	***Stability in Power Systems*** *Transient Stability Analysis • Swing Curves & Equal Area Criterion • Stability Margin & Enhancement • Role of Protection in Stability*
1100 – 1215	***Short-Circuit Studies*** *Calculation of Fault Currents • Symmetrical Component Method • Three-Phase & Single-Line Faults • Impact on Protective Device Selection*
1215 – 1230	*Break*
1230 – 1330	***Protection Coordination Studies*** *Relay Coordination Principles • Time-Current Characteristic Curves • Protection Grading Examples • Software Tools for Coordination*
1330 – 1420	***Protection Against Overvoltage & Surges*** *Lightning Overvoltage Protection • Switching Surges in HV Systems • Surge Arresters & Insulation Coordination • Temporary Overvoltage Challenges*
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 Four*

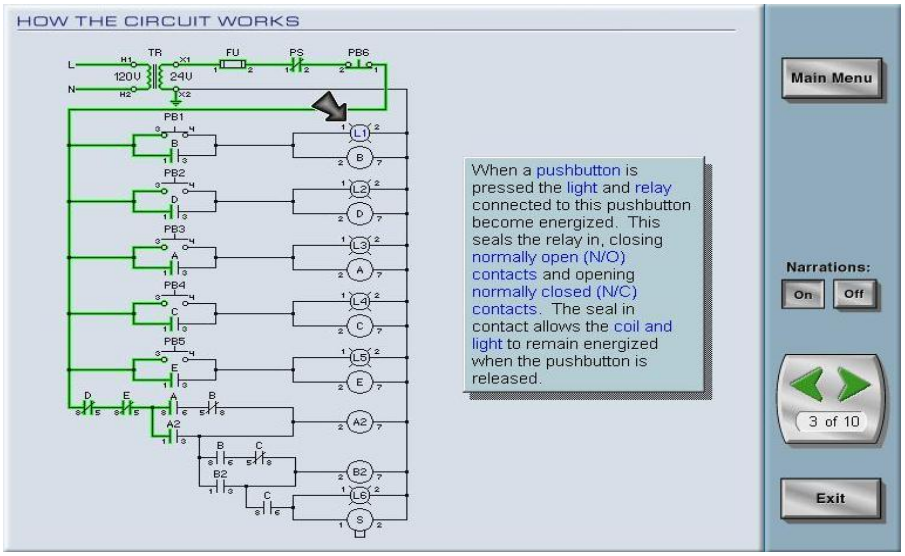
Day 5:	***Thursday, 18th of September 2025***
0730 – 0830	***Protection in HVDC & EHV Systems*** *HVDC Link Configurations • Converter Station Protection • DC Fault Characteristics • AC versus DC Protection Comparison*
0830 – 0930	***Protection in Industrial & Utility Networks*** *Ring Main Unit (RMU) Protection • Substation Automation Systems • Grid-Tied Renewable Generation (Solar, Wind) • Microgrid Protection Strategies*
0930 – 0945	*Break*
0945 – 1100	***Protection Coordination with SCADA/DMS*** *Role of SCADA in HV Protection • Remote Relay Setting & Control • Fault Location, Isolation & Restoration (FLISR) • Integration with Distribution Management System (DMS)*
1100 – 1230	***Advanced Topics in Digital Protection*** *Adaptive Protection Schemes • IEC 61850 & GOOSE Messaging • Synchrophasor Technology in Protection • Wide Area Monitoring & Protection (WAMPAC)*
1230 – 1245	*Break*
1245 – 1345	***Case Studies & Fault Analysis*** *Transformer Differential Relay Operation Case • Distance Protection Misoperation Analysis • Blackout Events & Lessons Learned • Relay Coordination Study Using Real Utility Data*
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 simulators “Haward Troubleshooting”, “Power World”, “GE Multilin Relay 469” and “GE Multilin Relay 750.

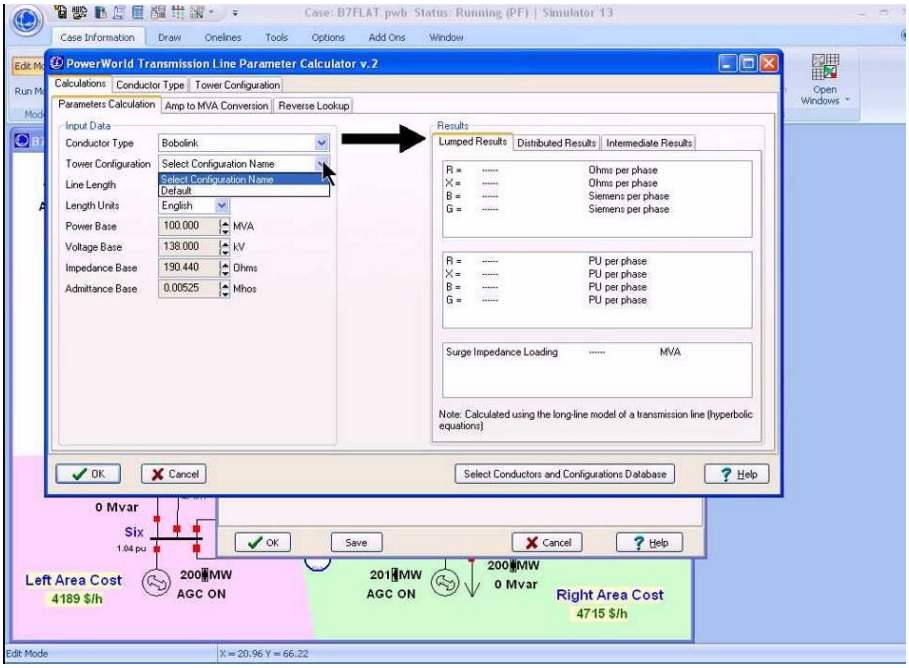


Basic Techniques



Basic Control Circuits

Motor Control Techniques



Power World Simulator

GE Multilin Relay 469 Simulator

GE Multilin Relay 750 Simulator

Course Coordinator

Mari Nakintu, Tel: +971 2 30 91 714, Email: mari1@haward.org