COURSE OVERVIEW EE1128
Advanced Circuit Breaker Operation & Maintenance

Course Title
Advanced Circuit Breaker Operation & Maintenance

Course Date/Venue
June 01-05, 2025/Tamra Meeting Room, Al Bandar Rotana Creek, Dubai, UAE

Course Reference
EE1128

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

3.0 CEUs (30 PDHs) AWARD

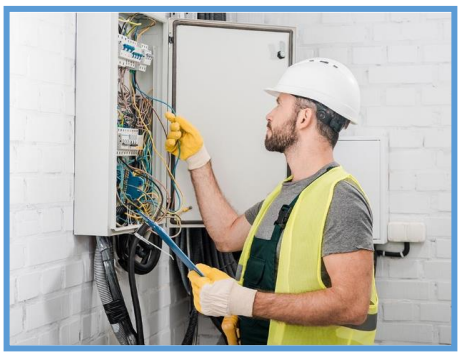
H-STK© INCLUDED

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 advanced overview of circuit breakers operation and maintenance. It covers the importance of circuit breakers in oil and gas electrical systems and its applications in substations, motors and generators; the classification and operating principles of air, SF_6, vacuum, and oil circuit breakers, arc interruption methods, current breaking capacity and tripping mechanisms; the electrical design, rating parameters and construction and components of circuit breakers; and interrupting medium and dielectric strength standards and applications.

Further, the course will also discuss the control circuits and interlocks covering typical AC/DC control schemes, interlocking mechanisms, control wiring schematics and testing control circuits; the protection schemes in petroleum plants; the breaker operating sequences and breaker failures and protection; the coordination with relays and fuses and breaker communication and remote operation; the preventive maintenance philosophy and visual and mechanical inspection; the electrical testing of circuit breakers, diagnostic techniques and testing equipment and setup; and maintaining different breaker types and the common operational issues.



During this interactive course, participants will learn the root cause analysis (RCA) for failures, corrective and predictive actions and breaker replacement and retrofit strategy; the safety practices during troubleshooting covering lockout-tagout (LOTO), arc flash risk assessment, PPE requirements and isolation procedures; the breaker performance, digitalization and smart breakers and environmental and regulatory compliance; the advanced arc quenching technologies; and the field application in petroleum operations.

Course Objectives

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

- Apply and gain an advanced knowledge on circuit breakers operation and maintenance
- Discuss the importance of circuit breakers in oil and gas electrical systems and its applications in substations, motors and generators
- Explain the classification and operating principles of air, SF_6, vacuum, and oil circuit breakers, arc interruption methods, current breaking capacity and tripping mechanisms
- Identify electrical design, rating parameters and construction and components of circuit breakers as well as interrupting medium and dielectric strength standards and applications
- Recognize control circuits and interlocks covering typical AC/DC control schemes, interlocking mechanisms, control wiring schematics and testing control circuits
- Apply protection schemes in petroleum plants including breaker operating sequences and breaker failures and protection
- Describe coordination with relays and fuses and breaker communication and remote operation
- Carryout preventive maintenance philosophy and visual and mechanical inspection
- Apply electrical testing of circuit breakers, diagnostic techniques and testing equipment and setup
- Maintain different breaker types and identify the common operational issues
- Employ root cause analysis (RCA) for failures, corrective and predictive actions and breaker replacement and retrofit strategy
- Apply safety practices during troubleshooting covering lockout-tagout (LOTO), arc flash risk assessment, PPE requirements and isolation procedures
- Evaluate breaker performance and discuss digitalization and smart breakers and environmental and regulatory compliance
- Carryout advanced arc quenching technologies and implement field application in petroleum operations

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 advanced circuit breaker operation and maintenance for senior electrical engineers, maintenance technicians and electricians, plant engineers and facility managers, utility technicians, supervisors and team lead in electrical departments, technical trainers and safety officers, third-party service contractors, renewable energy technicians and other technical staff.

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: -

- 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.

- 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. Pan Marave, PE, MSc, BEng, is a **Senior Electrical & Instrumentation Engineer** with over **30 years** of extensive experience in **Oil**, **Gas**, **Petrochemical**, **Refinery** & **Power** industries. His expertise includes Safety Instrumented Systems (**SIS**), Safety Integrity Level (**SIL**), Emergency Shutdown (**ESD**); **DCS**, **SCADA** & **PLC**; **Measurement** (**Flow**, **Temperature**, **Pressure**); **Process Analyzers** & **Analytical Instrumentation**; **Process Control**, **Instrumentation** & **Safeguarding**; **Process Controller**, **Control Loop & Valve Tuning**; Industrial **Distribution Systems**; Industrial **Control & Control Systems**, Power Systems **Protection & Relaying**; **Earthing**, **Bonding**, **Grounding**, **Lightning & Surge Protection**; Electric Power **Substation** & **Systems**; Electrical Engineering Principles; **Motor Control Circuit**; **Electrical Fault Analysis**; Electrical Networks & Distribution **Cables**; **Circuit Breakers**, **Switchgears**, **Transformers**, **Hazardous Areas Classification** and **Detailed Engineering Drawings**, **Codes** & **Standards**. Furthermore, he is also well-versed in Microprocessors Structure, Lead Auditor (**ISO 9000:2000**), **ISO 9002**, Quality Assurance, and Projects & Contracts Management.

Presently, Mr. Marave is the **Technical Advisor** of **Chamber of Industry & Commerce** in Greece. Prior to this, he gained his thorough practical experience through several positions as the **Technical Instructor**, **Engineering Manager**, **Electronics & Instruments Head**, **Electrical**, **Electronics & Instruments Maintenance Superintendent**, **Assistant General Technical Manager** and **Engineering Supervisor** of various international companies such as the **Alumil** Mylonas, **Athens Papermill**, **Astropol** and the **Science Technical Education**.

Mr. Marave is a **Registered Professional Engineer** and has **Master's** and **Bachelor's** degrees in **Electrical Engineering** from the **Polytechnic Institute of New York** and **Pratt Institute of New York** (**USA**) respectively. Further, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management** (**ILM**) and an active member of the **Technical Chamber** and the Institute of Electrical and Electronics Engineer (**IEEE**) in Greece. He has presented and delivered **numerous international** courses, conferences, trainings and workshops worldwide.

Accommodation

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

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.

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 Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the workshop for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1 Sunday 01st of June 2025

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Introduction to Circuit Breakers in Petroleum Facilities*** *Importance of Circuit Breakers in Oil & Gas Electrical Systems • Applications in Substations, Motors, and Generators • Types of Faults Managed by Circuit Breakers • Integration with Protective Relays*
0930 – 0945	*Break*
0945 – 1030	***Classification & Operating Principles*** *Air, SF_6, Vacuum, and Oil Circuit Breakers • Arc Interruption Methods • Current Breaking Capacity • Tripping Mechanisms Overview*
1030 – 1130	***Electrical Design & Rating Parameters*** *Rated Voltage and Current • Short Circuit Breaking Capacity • Making and Breaking Time Characteristics • Duty Cycle and Operating Sequence (O-3min-CO-3min-CO)*
1130 – 1215	***Construction & Components of Circuit Breakers*** *Main Contacts, Arcing Contacts, Arc Chutes • Operating Mechanism: Spring vs. Pneumatic vs. Hydraulic • Insulation Components • Auxiliary Contacts and Trip Coils*
1215 – 1230	*Break*
1230 – 1330	***Interrupting Medium & Dielectric Strength*** *Comparative Study: Air, Vacuum, SF_6, Oil • Dielectric Recovery Characteristics • Environmental Concerns of SF_6 • Safe Handling and Alternatives*
1330 – 1420	***Standards & Specifications*** *IEC and ANSI Standards for Circuit Breakers • Compliance with IEEE C37 Series • Testing and Certification Protocols • Nameplate Data Interpretation*
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 02nd of June 2025**

0730 – 0830	***Control Circuits & Interlocks*** *Typical AC/DC Control Schemes • Interlocking Mechanisms (Electrical and Mechanical) • Control Wiring Schematics • Testing Control Circuits*
0830 – 0930	***Protection Schemes in Petroleum Plants*** *Overcurrent and Short Circuit Protection • Earth Fault Detection and Isolation • Differential Protection • Integration with SCADA and DCS*
0930 – 0945	*Break*
0945 – 1100	***Breaker Operating Sequences*** *Open/Close Cycle Behavior • Spring Charging and Energy Storage Mechanisms • Trip-Free Operation • Safety Interlocks During Operation*
1100 – 1215	***Breaker Failures & Protection*** *Breaker Failure Detection Relays (BF) • Trip Circuit Supervision • Circuit Breaker Health Monitoring • Fail-Safe Designs*
1215 – 1230	*Break*
1230 – 1330	***Coordination with Relays & Fuses*** *Time-Current Characteristics (TCC) • Relay Grading and Selectivity • Protection Zones and Discrimination • Fuse and Breaker Coordination*
1330 – 1420	***Breaker Communication & Remote Operation*** *Remote Switching Schemes • Communication Protocols (IEC 61850, Modbus, DNP3) • Integration With Protective Relay IEDs • Cybersecurity Considerations*
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 03rd of June 2025**

0730 – 0830	***Preventive Maintenance Philosophy*** *Maintenance Intervals Based on Duty Cycle • Risk-Based Maintenance for CBs • OEM Recommendations vs. Field Practice • Maintenance Documentation*
0830 – 0930	***Visual & Mechanical Inspection*** *Contact Wear Analysis • Inspection of Arc Chutes and Insulation • Mechanical Alignment and Tension Check • Lubrication and Cleaning*
0930 – 0945	*Break*
0945 – 1100	***Electrical Testing of Circuit Breakers*** *Insulation Resistance Test • Contact Resistance Measurement (DLRO) • Timing Tests (Opening/Closing/Travel) • Static and Dynamic Tests*
1100 – 1215	***Diagnostic Techniques*** *SF_6 Moisture and Gas Analysis • Partial Discharge Detection • Thermal Imaging and Infrared Scanning • Condition Monitoring Systems*
1215 – 1230	*Break*
1230 – 1330	***Testing Equipment & Setup*** *Primary Injection Testing • Secondary Injection Testing for Protection Relays • Motion Analyzer and Contact Travel Test • Test Set Connections and Safety Precautions*
1330 – 1420	***Maintenance of Different Breaker Types***

	Oil Circuit Breaker Oil Sampling & Filtration • Vacuum Interrupter Testing • SF_6 Gas Topping and Evacuation • Medium Voltage vs. High Voltage Practices
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 04th of June 2025

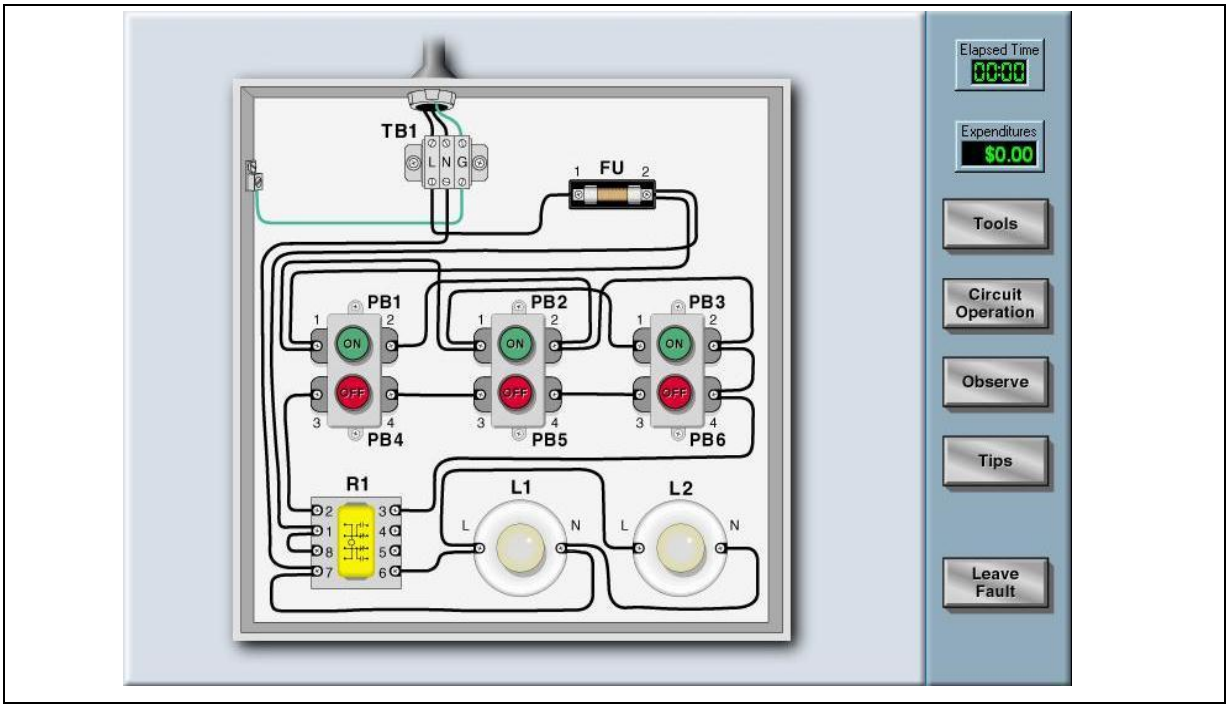
0730 – 0830	***Common Operational Issues*** *Slow Tripping or Non-Operation • Spurious Tripping or Reclosing • Mechanical Jamming or Latch Failure • Control Supply Failure*
0830 – 0930	***Root Cause Analysis (RCA) for Failures*** *Step-by-Step RCA Methodology • Electrical Signature Analysis • Failure Logs and SCADA Review • Case-Based Discussions*
0930 – 0945	*Break*
0945 – 1100	***Corrective & Predictive Actions*** *Contact Tip Replacement • Retrofitting with Digital Relays • Life Extension Strategies • Implementing Predictive Analytics*
1100 – 1215	***Breaker Replacement & Retrofit Strategy*** *Obsolescence Issues • Upgrading to Vacuum/SF_6 Breakers • Retrofitting in Legacy Panels • Cost-Benefit Evaluation*
1215 – 1230	*Break*
1230 – 1330	***Safety Practices During Troubleshooting*** *Lockout-Tagout (LOTO) • Arc Flash Risk Assessment • PPE Requirements • Isolation Procedures*
1330 – 1420	***Troubleshooting Simulation & Exercises*** *Interpreting Breaker Behavior • Hands-On Simulated Fault Finding • Interactive Fault Scenarios • Team-Based Troubleshooting Task*
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*

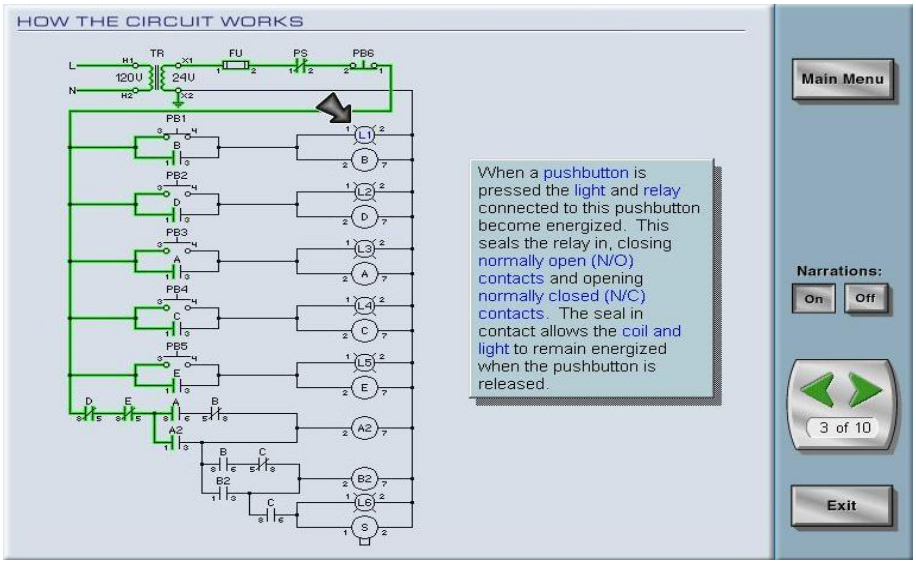
Day 5 **Thursday 05th of June 2025**

0730 – 0830	***Breaker Performance Evaluation*** *CBM vs. TBM Strategies • Analyzing Trip Logs • Load and Fault Current Trends • Performance Benchmarking*
0830 – 0930	***Digitalization & Smart Breakers*** *IoT-Enabled Breakers • Condition Monitoring and Diagnostics • Cloud-Based CB Data Analysis • Integration with Energy Management Systems*
0930 – 0945	*Break*
0945 – 1115	***Environmental & Regulatory Compliance*** *SF_6 Management Guidelines • EPA Reporting and Monitoring • Recycling and Leak Detection • Environmental Footprint Reduction*
1115 – 1245	***Advanced Arc Quenching Technologies*** *Magnetic Arc Blowout • Hybrid Interruption Methods • Vacuum Interrupter Improvements • Next-Gen Arc Control Devices*
1245 – 1300	*Break*
1300 – 1345	***Field Application in Petroleum Operations*** *Offshore/Onshore Installation Considerations • Corrosion and Humidity Effects • Maintenance Challenges in Hazardous Areas • ATEX/IECEx Compliance*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about t Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

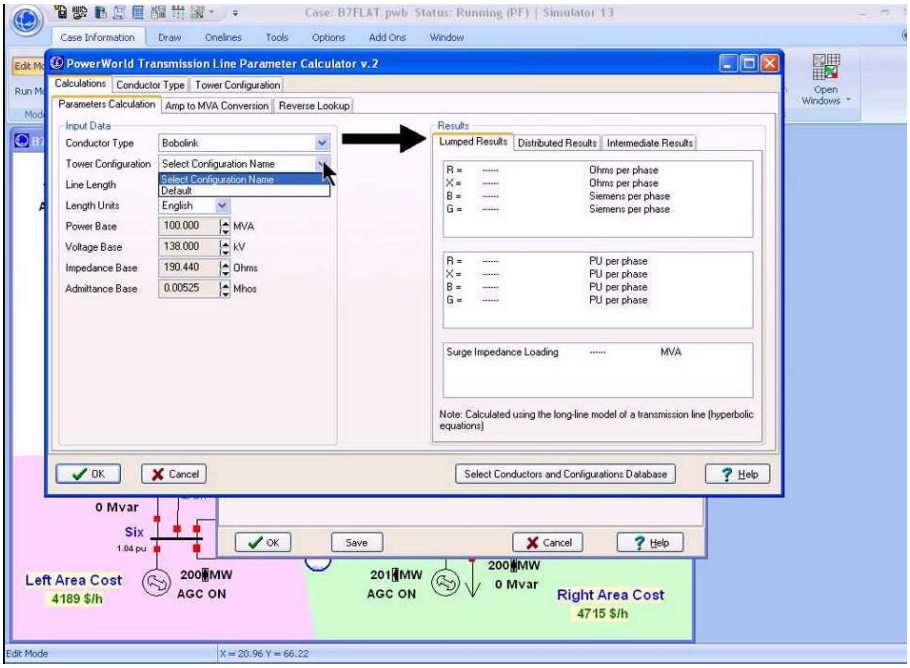
Simulator (Hands-on Practical Sessions)

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", Power World" and "ETAP software".

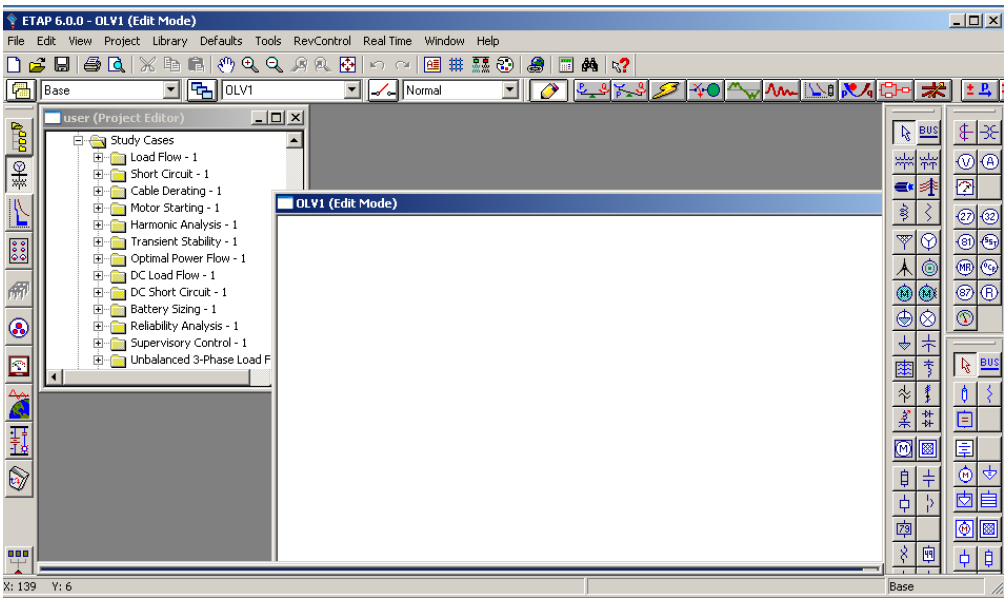




Simutech Troubleshooting Electrical Circuits V4.1



Power World Simulator



ETAP Software Simulator

GE Multilin Relay 469 Simulator

GE Multilin Relay 750 Simulator

Course Coordinator

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