



## COURSE OVERVIEW EE0776 Transformer, Generator & Breaker Maintenance

### Course Title

Transformer, Generator & Breaker Maintenance

### Course Date/Venue

December 15-19, 2025/Meeting Room Haward Abu Dhabi Office, Al Falah Tower, Abu Dhabi, UAE

### Course Reference

EE0776

### 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.***

Maximum efficiency, reliability, and longevity of electrical equipment such as the various types of motors, variable-speed drives, transformers, generators, rectifiers, inverters, uninterruptible power systems, circuit breakers, fuses, power station electrical and protective systems are of great concern to many industries. These objectives can only be achieved by understanding the characteristics, selection criteria, common problems and repair techniques, preventive and predictive maintenance.



This course is a MUST for anyone who is involved in the selection, applications, or maintenance of electrical equipment. It provides the latest in technology. The course covers how these equipments operate and provide guidelines and rules that must be followed for a successful operation. Their basic design, operating characteristics, specification, selection criteria, advanced fault detection techniques, critical components as well as all maintenance issues are covered in detail.



This course is designed to provide a comprehensive understanding of the various types of motors, variable-speed drives, transformers, generators, rectifiers and inverters, uninterruptable power systems (UPS), circuit breakers, and fuses. Upon the successful completion of this course, participants will be able to specify, select, commission and maintain these equipment for their applications. Further, participants will have enough knowledge to achieve reduced capital, operating and maintenance costs along with increase in efficiency.

### Course Objectives

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

- Specify, select, install, operate, test, troubleshoot and maintain various types of electrical equipment such as transformers, motors, variable speed drives, generators, circuit breakers, switchgears and protective systems
- Carryout diagnostic testing and inspection, advanced fault detection techniques, critical components, and common failure modes for electrical equipment
- Apply selection criteria, commissioning requirements, predictive and preventive maintenance, reliability, testing and cost estimation for electrical equipment
- Implement the maintenance techniques required to minimize the operating cost and maximize the efficiency, reliability and longevity of electrical equipment

### 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 electrical equipment including transformers, motors, variable speed drives, generators, circuit breakers, switchgears and protective systems for engineers and other technical staff who are involved in the selection, installation, operation, testing, troubleshooting or maintenance of such electrical equipment.

### 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 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.

### 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. Ken Steel** is a **Senior Electrical & Instrumentation Engineer** with over **30 years** of extensive experience. His expertise widely covers **Electrical Motors Testing, Heat Tracing & Insulation Installation & Testing, HV Terminations, High & Low Voltages** on Overhead Cranes, **HV/MV Cable Splicing, Cable & Over Head Power Line, HV/MV Switchgear, HV Cable Design, Medium & High Voltage Equipment, High Voltage Circuit Breaker Inspection & Repair, High Voltage Power System, HV Equipment Inspection & Maintenance, HV Switchgear Operation & Maintenance, Resin / Heat Shrink & Cold Shrink Joints, HV/LV Equipment, LV & HV Electrical System, Cable Splicing & Termination, High Voltage Electrical Safety, LV, MV & HV Cable Installations & Properties, LV Substation, MV & LV Cable, UPS Systems, MV & LV Direct on Line Motor Drives, MV & LV VSD Motor Drives, MV & LV Soft Starter Motor Drives, LV Two Speed Motor Drives, Underground Transformer Oil Containment Tank, Electrical & Instrumentation Construction Installation, 1500KW, 1000KW, 1752KW Diesel Power Plant Installation, 110KV Overhead Line, 110KV Outdoor Switchgear, 110KV/10KV 6500KVA Transformer, Transformer Substation, 1600KVA 10KV/0.4KV & 2 Off 1000KVA Diesel Generators, 1600KVA 10KV/0.4KV & 1650KVA Diesel Generator, 110KV/35KV/10KV Substation, 110KV/10KV Transformers, 110KV & 2 Off 6KV Overhead Lines, 34.5KV, 13.8KV, 4.16KV & 480V Switchgear, 4.16KV & 480V MCC, Transformers & Motor Drives Substations, Diesel Driven Generators, Overhead Cranes, Overhead Cranes & HVAC Units, AC & DC Drives, Data Logger, Electrical, Instrumentation & Mechanical Installation Maintenance, Slab Mills, Pre Heat Ovens, Hydraulic Shears, Stamping Machine, Gearboxes, Rollers, Pumps, Valves, Electro Magnets & Pump House Operation, Boilers Construction And Commissioning, Valve Calibration & Testing, Level Gauges, Pressure & Flow Transmitters Installation & Calibration, Pressure & Leak Testing of Boilers, Leak Testing, SMP, Elect, I&C, F&G, HVAC & Utility Services, Nitrogen Leak Test Operations, Steam Blowing Activities, SMP, Elect, I&C, F&G, HVAC & Utility Services, PTW Issue (PA/AC), Installation & Mechanical Piping and Hydro Testing & Leak Testing of Lines Installation.**

During Mr. Steel's career life, he has gained his practical experience through several significant positions and dedication as the **3GP PBF & Boilers SC Commission Support, SC Site Execution Superintendent, E&I Construction Superintendent, High Voltage Construction Supervisor, Control & Power Construction Supervisor, Electrical & Instrumentation Supervisor, Electrical Technician, Construction Support Electrical Engineer, E&I Engineer, Electrical/Instrumentation Site Supervisor, Q.A/Q.C Inspector, Electrical/ Instrumentation Technician, Maintenance Fitter Instrumentation Technician, Millwright, Apprentice Millwright and Senior Instructor/Lecturer** for Tengiz Chevron Oil Kazakhstan, Al Jubail Saudi Arabia, Escravos Delta state Nigeria, Lurgi S.A, SuD Chemie Sasol Catalysts, J C Groenewalds Construction (LTA), Tycon (Goodyear S.A.), Dragline Construction and Iscor Vanderbijlpark.

Mr. Steel has a **Diploma in Electronics Mechanic**. Further, he is a **Certified Instructor/Trainer** and delivered numerous trainings, courses, workshops, seminars and conferences internationally.



### 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.

### 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: Monday 15<sup>th</sup> of December 2025**

0730 – 0800	Registration & Coffee
0800 – 0815	Welcome & Introduction
0815 – 0830	<b>PRE-TEST</b>
0830 – 0930	<b>Fundamentals of Electric Systems</b> Capacitors • Current & Resistance • The Magnetic Field • Faraday's Law of Induction • Lenz's Law • Inductance • Alternating Currents • Three-Phase System
0930 – 0945	Break
0945 – 1030	<b>Introduction to Machinery Principles</b> Electric Machines & Transformers • Common Terms & Principles • The Magnetic Field • Magnetic Behavior of Ferromagnetic Materials • Faraday's Law – Induced Voltage From a Magnetic Field Changing with Time • Core Loss Values • Permanent Magnets • Production of Induced Force on a Wire • Induced Voltage on a Conductor Moving in a Magnetic Field
1030 – 1130	<b>Transformers</b> Importance of Transformers • Types & Construction of Transformers • The Ideal Transformer • Impedance Transformation Through a Transformer • Analysis of Circuits Containing Ideal Transformers • Theory of Operation of Real Single-Phase Transformers • The Voltage Ratio Across a Transformer • The Magnetizing Current in a Real Transformer • The Dot Convention • The Equivalent Circuit of a Transformer • The Transformer Voltage Regulation & Efficiency • The Autotransformer • Three-Phase Transformers • Transformer Ratings
1130 – 1230	<b>Transformer Components &amp; Maintenance</b> Introduction, Classification of Transformers • Main Components of a Power Transformer • Types & Features of Insulation • Forces • Cause of Transformer Failures • Transformer Oil • Gas Relay & Collection Systems • Relief Devices • Interconnection with the Grid
1230 – 1245	Break
1245 – 1330	<b>AC Machine Fundamentals</b> The Rotating Magnetic Field • The Induced Voltage in AC Machines • The Induced Torque in a Three-Phase Machine • Winding Insulation in AC Machines • AC Machine Power Flow & Losses
1330 – 1420	<b>Induction Motors</b> Induction Motor Construction • Basic Induction Motor Concepts • The Equivalent Circuit of an Induction Motor • Losses & The Power-Flow Diagram • Induction Motor Torque-Speed Characteristics • Control of Motor Characteristics By Squirrel-Cage Rotor Design • Starting Induction Motors
1420 – 1430	<b>Recap</b> 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: Tuesday 16<sup>th</sup> of December 2025**

0730 – 0830	<b>Speed Control of Induction Motors</b> Speed Control by Changing the Line Frequency • Speed Control by Changing the Line Voltage • Speed Control by Changing the Rotor Resistance • Solid-State Induction Motor Drives • Motor Protection • The Induction Generator • Induction Motor Ratings
0830– 0930	<b>Maintenance of Motors</b> Characteristics of Motors • Enclosures & Cooling Methods • Application Data • Design Characteristics • Insulation of AC Motors • Failures in Three-Phase Stator Windings • Predictive Maintenance • Motor Troubleshooting • Diagnostic Testing for Motors • Repair & Refurbishment of AC Induction Motors • Failures in Three-Phase Stator Windings
0930 – 0945	Break
0945 – 1100	<b>Power Electronics, Rectifiers &amp; Pulse-Width Modulation Inverters</b> Introduction to Power Electronics • Power Electronics Components • Power & Speed Comparison of Power Electronic Components • Basic Rectifier Circuits • Filtering Rectifier Output • Pulse Circuits • A Relaxation Oscillator Using a PNP Diode • Pulse Synchronization • Voltage Variation By AC Phase Control • The Effect of Inductive Loads on Phase Angle Control • Inverters
1100 – 1230	<b>Variable Speed Drives</b> Basic Principles of AC Variable Speed Drivers (VSD'S) • Inverters • Input Power Converter (Rectifier) • DC Link Energy • Output IGBT Inverter, Input Sources for Regeneration or Dynamic • Regeneration • PWM-2 Considerations • Transients • Harmonics Power Factor & Failures • Thyristor Failures & Testing • AC Drive Application Issues • AC Power Factor • IGBT Switching Transients • Cabling Details For AC Drives • Cable • Motor Bearing Currents • Summary of Application Rules For AC Drives • Selection Criteria of VSD's • Maintenance • Common Failure Modes • Motor Application Guidelines
1230 – 1245	Break
1245 – 1420	<b>Synchronous Machines</b> Physical Description • Pole Pitch: Electrical Degrees • Airgap & Magnetic Circuit of a Synchronous Machine • Synchronous Machine Windings • Field Excitation • No-Load & Short-Circuit Values • Torque Tests • Excitation of a Synchronous Machine • Machine Losses
1420 – 1430	<b>Recap</b> 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: Wednesday 17<sup>th</sup> of December 2025**

0730 – 0930	<b>Synchronous Generators</b> Synchronous Generator Construction • The Speed of Rotation of a Synchronous Generator • The Internal Generated Voltage of a Synchronous Generator • The Equivalent Circuit of a Synchronous Generator • The Phasor Diagram of a Synchronous Generator • Power & Torque in Synchronous Generators • The Synchronous Generator Operating Alone • Parallel Operation of AC Generators • Operation of Generators in Parallel with Large Power Systems • Synchronous Generator Ratings • Synchronous Generator Capability Curves • Short-Time Operation & Service Factor
0930 – 0945	Break



0945 – 1030	<b>Generator Components, Auxiliaries &amp; Excitation</b> Introduction, The Rotor, Turbine-Generator Components, Cooling Systems, Shaft Seals & Seal Oil Systems, Stator Winding Water Cooling Systems, Other Cooling Systems, Excitation, The Voltage Regulator, The Power System Stabilizer, Characteristics of Generator Exciter Power Systems (GEP), Generator Operation
1030 – 1100	<b>Generator Main Connections</b> Introduction • Isolated Phase Bus Bar Circulatory Currents • System Description
1100 – 1230	<b>Performance &amp; Operation of Generators</b> Generator Systems • Condition Monitoring • Operational Limitations • Fault Conditions
1230 – 1245	Break
1245 – 1420	<b>Generator Surveillance &amp; Testing</b> Generator Operational Checks (Surveillance & Monitoring) • Generator Diagnostic Testing • Insulation Resistance & Polarization Index • DC Hipot Test • AC Tests for Stator Windings • Synchronous Machine Rotor Windings • Partial Discharge Tests • Low Core Flux Test (EL-CID) • Mechanical Tests • Groundwall Insulation • Rotor Winding • Turn Insulation • Slow Wedges & Bracing • Stator & Rotor Cores
1420 – 1430	<b>Recap</b> 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: Thursday 18<sup>th</sup> of December 2025**

0730 – 0830	<b>Generator Inspection &amp; Maintenance</b> On-Load Maintenance & Monitoring • Off-Load Maintenance • Generator Testing
0830 – 0930	<b>Generator Operational Problems, &amp; Refurbishment Options</b> Typical Generator Operational Problems • Generator Rotor Reliability & Life Expectancy • Generator Rotor Refurbishment • Types of Insulation • Generator Rotor Modifications • Upgrades & Uprates • High Speed Balancing • Flux Probe Test
0930 – 0945	Break
0945 – 1100	<b>Circuit Breakers</b> Theory of Circuit Interruption • Physics of Arc Phenomena • Circuit Breaker Rating • Conventional Circuit Breakers • Methods for Increasing Arc Resistance • Plain Break Type • Magnetic Blow-out Type • Arc Splitter Type • Application • Oil Circuit Breakers • Recent Developments in Circuit Breakers
1100 – 1230	<b>Fuses</b> Types of Fuses • Features of Current Limiting Fuses • Advantages of Fuses Over Circuit Breakers
1230 – 1245	Break
1245 – 1420	<b>Bearings</b> Types of Bearings • Statistical Nature of Bearing Life • Materials & Finish • Sizes of Bearings • Types of Roller Bearings • Thrust Bearings • Lubrication
1420 – 1430	<b>Recap</b> Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today & Advise Them of the Topics to be Discussed Tomorrow
1430	Lunch & End of Day Four





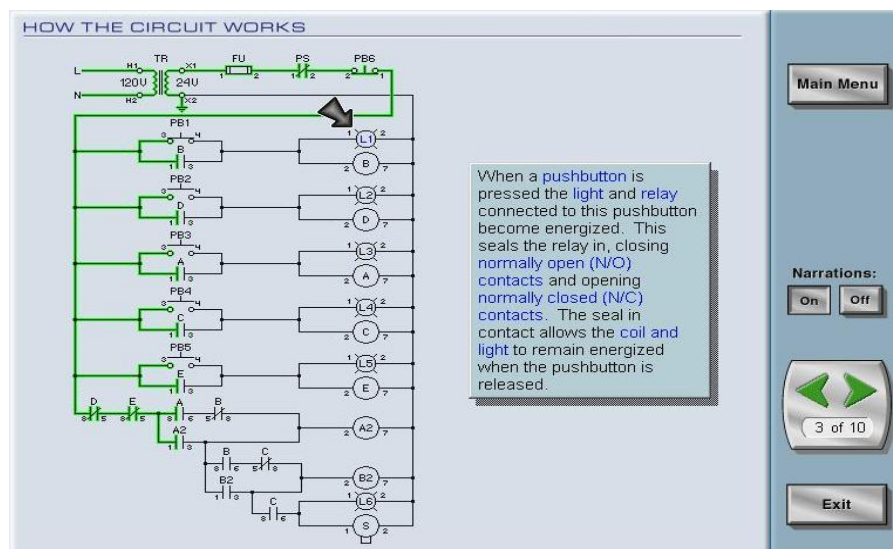
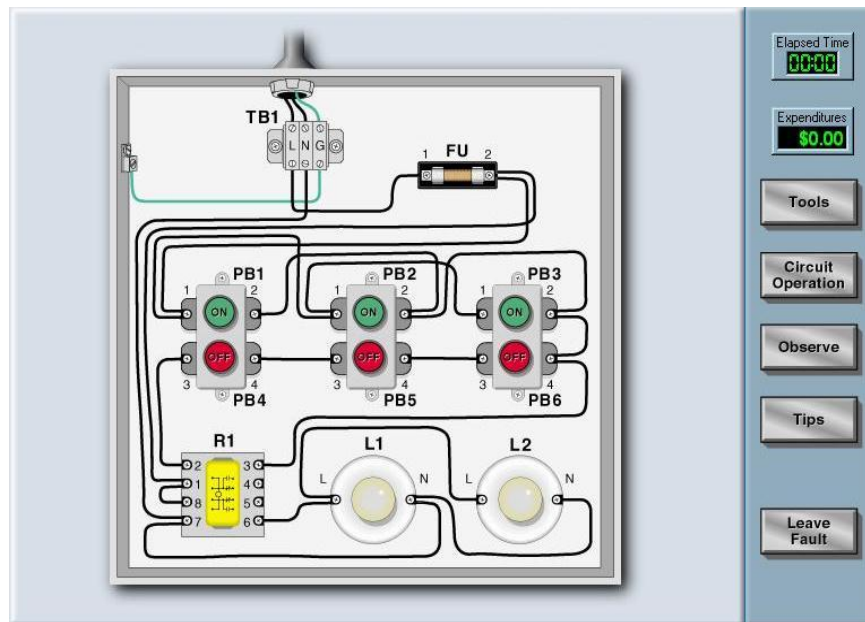
**Day 5: Friday 19<sup>th</sup> of December 2025**

0730 – 0830	<b>Used Oil Analysis</b> <i>Proper Lube Oil Sampling Technique • Test Description &amp; Significance • Visual &amp; Sensory Inspection • Chemical &amp; Physical tests • Summary</i>
0830 – 0930	<b>Vibration Analysis</b> <i>The Application of Sine Waves to Vibration • Multimass Systems • Resonance • Logarithms &amp; Decibels (db) • The Use of Filtering • Vibration Instrumentation • Time Domain • Frequency Domain • Machinery Example • Vibration Analysis • Resonant Frequency • Vibration Severity</i>
0930 – 0945	Break
0945 – 1100	<b>Power Station Electrical Systems &amp; Design Requirements</b> <i>Introduction • System Requirements • Electrical System Description • System Performance • Power Plant Outages &amp; Faults • Uninterruptible Power Supply (UPS) Systems • DC Systems</i>
1100 – 1230	<b>Power Station Protective Systems</b> <i>Introduction • Design Criteria • Generator Protection • DC Tripping Systems</i>
1230 – 1245	Break
1245 – 1345	<b>Frequently Asked Questions</b> <i>Fundamentals of Electric Systems • Introduction to Machinery Principles • Transformers • Transformer Components &amp; Maintenance • Interconnection With the Grid • AC Machine Fundamentals • Induction Motors • Speed Control of Induction Motors • Maintenance of Motors • Variable Speed Drives • Synchronous Generators • Generator Components • Auxiliaries, &amp; Excitation</i>
1345 – 1400	<b>Course Conclusion</b> <i>Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course</i>
1400 – 1415	<b>POST-TEST</b>
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 “Troubleshooting Electrical Circuits V4.1 Simulator”, “Lab Volt Testing Device” and “Switchgear Simulator”.



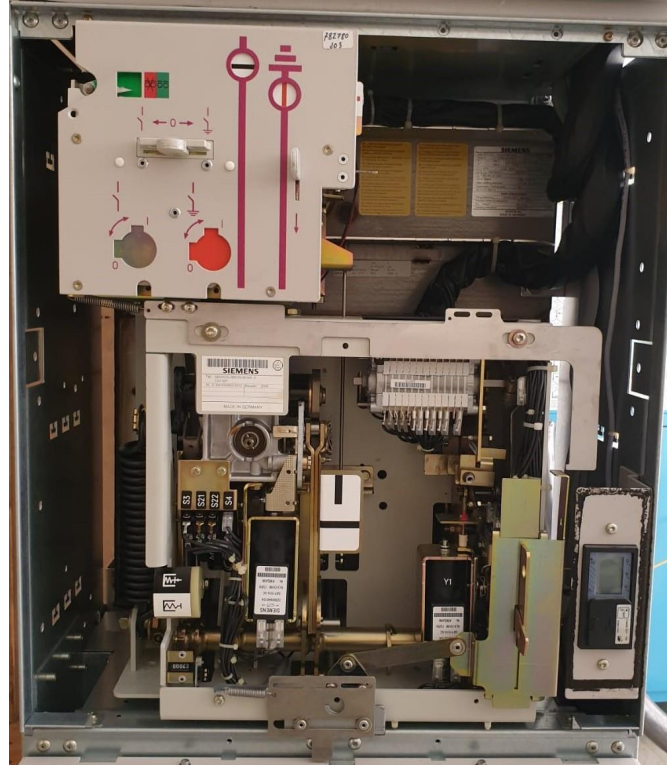
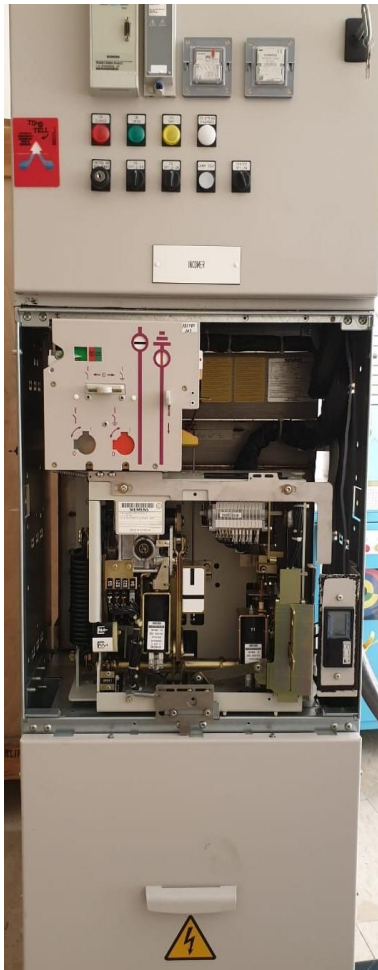


**Troubleshooting Electrical Circuits V4.1 Simulator**



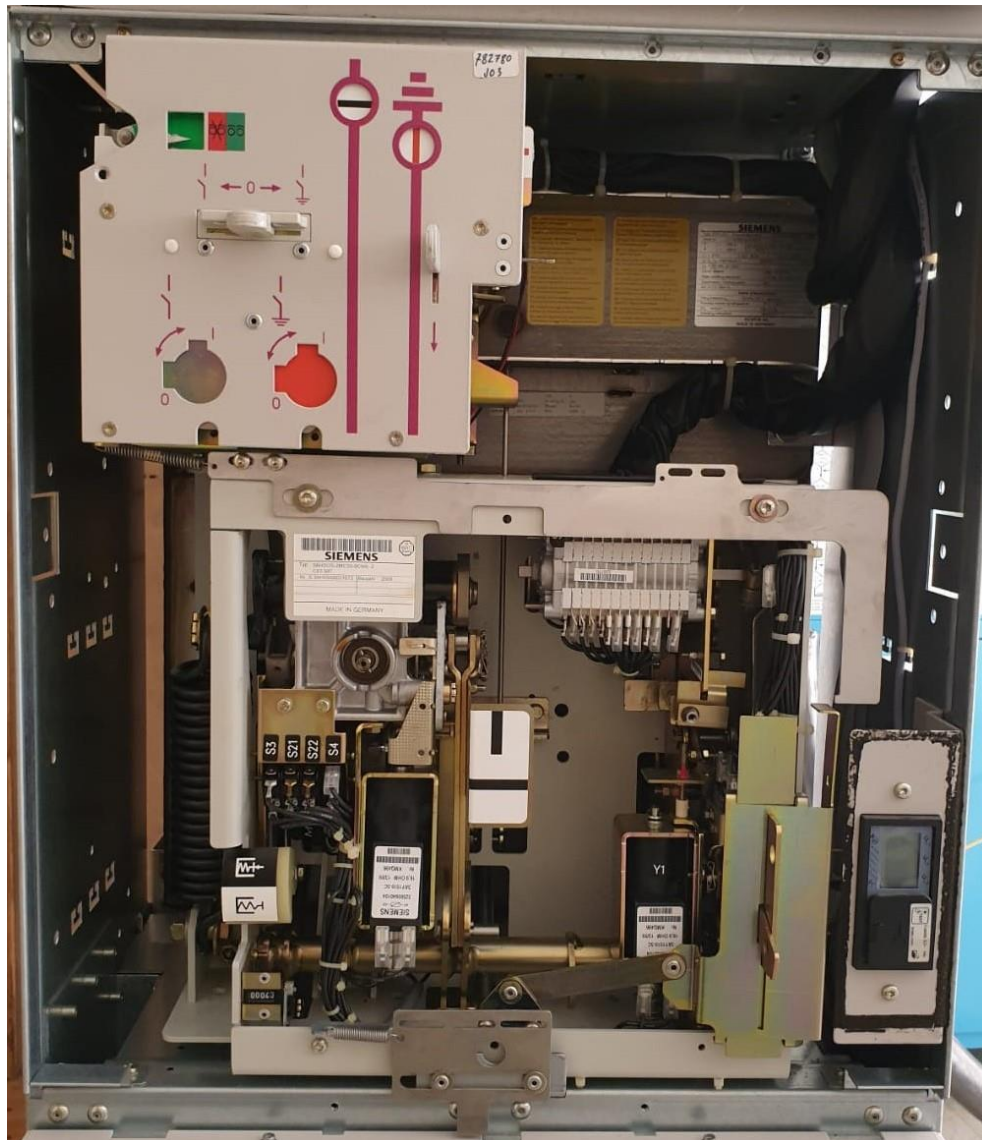
**Lab Volt Testing Device**





**Switchgear Simulator**





**Switchgear Simulator**

**Course Coordinator**

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