

## State-of-the-Art Power System Protection and Switchgear

### Program Description

<b>Course Name</b>	<b>State-of-the-Art Power System Protection and Switchgear</b>
<b>Course Name as on Certificate</b>	Certification in State-of-the-Art Power System Protection and Switchgear
<b>Certificate Type</b>	Certificate of Completion by IITM Pravartak and L&T EduTech
<b>Certificate Issued by</b>	IIT MADRAS and L&T EduTech
<b>Course Objectives</b>	<p><b>Course Overview:</b>            This advanced course titled "State-of-the-Art Power System Protection and Switchgear" focuses on advanced protection techniques, including Transmission line protection, Generator protection, Transformer protection, and Bus bar protection, all-encompassing cutting-edge numerical protection relay technologies. Additionally, this course offers valuable insights into various types of switchgears, encompassing both air insulated switchgears and gas insulated switchgears. Moreover, this course offers a comprehensive exploration of artificial intelligence applications in power systems, covering the utilization of neural networks for transformer and generator protection, as well as substation automation.</p> <p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. Learners will be able to understand details about Transmission Line Protection.</li> <li>2. Learners will be able to understand details about Generator Protection</li> <li>3. Learners will be able to understand details about Transformer and Reactor protection.</li> <li>4. Learners will be able to understand details of Numerical Protection along with Substation Automation System.</li> <li>5. Learners will be able to understand Electrical Switchgear and its system components.</li> <li>6. Learners will be able to understand the details about the Various Circuit Breakers</li> </ol>
<b>Eligibility</b>	Students pursuing Diploma / UG / PG Programs in Electrical & Electronics Engineering
<b>Pre-Requisites</b>	Basic knowledge on Electrical Protection
<b>Target Segment</b>	Students pursuing Diploma/ UG / PG Programs in Electrical & Electronics Engineering Faculties / Working Professionals in the above domain & other aspiring learners
<b>Course Content</b>	<b>See Enclosed Program details – as Annexure 1</b>

<b>Pedagogy</b>	Online Self-paced E-Learning Content		
<b>Assessment</b>	One Final Assessment		
<b>Programme Faculty</b>	<p><b>Dr. P. Rangarajan</b> – Subject Matter Expert – Electrical &amp; Electronics Engineering, L&amp;T EduTech</p> <p>He holds a Doctorate (Ph.D) in Electrical Engineering from Anna University (2004), specializing in VLSI &amp; Signal Processing. With thirty years of experience, he has authored seventy publications in international journals, published four patents, and guided eighteen Ph.D. scholars. He has executed projects worth more than 1.5 crores from AICTE and DST and received the CTS Best Faculty award in 2014.</p>		
<b>Duration</b>	Units: 7 Hours: 12		
<b>Class Schedule</b>	Self-Paced		
<b>Programme Highlights/USPs</b>	<ol style="list-style-type: none"> <li>1. Advanced transmission line protection</li> <li>2. Basic distance protection principles to advanced numerical protection schemes.</li> <li>3. Advanced generator protection</li> <li>4. Generator differential protection, Stator and rotor protection &amp; Under frequency protection</li> <li>5. Advanced protection for transformers and shunt reactors</li> <li>6. Differential protection including magnetizing current protection.</li> <li>7. Over fluxing and overcurrent protection</li> <li>8. Demonstration of different testing on transformers</li> <li>9. Busbar differential protection</li> <li>10. High impedance and low impedance busbar protection</li> <li>11. Different microprocessor based numerical relays.</li> <li>12. Application of artificial intelligence to power system</li> <li>13. Application of neural networks to transformer and generator protection</li> <li>14. Substation automation</li> <li>15. Different types of switchgears and its operating principles</li> <li>16. Walkthrough video of a switchgear in a substation</li> <li>17. Air insulated to Gas insulated switchgears.</li> <li>18. Testing and commissioning of switchgear</li> </ol>		
<b>Total Fees</b>		<b>Total Fees (Rs.)</b>	
	Total Programme Fee	Rs.1,900 /- inclusive of GST	

## ANNEXURE 1

Proposed Course outline / programme / plan - Unit wise syllabus details.

<b>Unit I - Transmission Lines Protection</b>
<ul style="list-style-type: none"> <li>• Introduction to Distance Protection</li> <li>• Impedance Relay</li> <li>• MHO Type Distance Relay</li> <li>• Distance Relay using Quadrilateral Characteristics</li> <li>• Setting of Distance Relays for Zone Protection</li> <li>• Fault Resistance of Transmission lines</li> <li>• Distance Protection Schemes for Transmission Lines</li> <li>• Distance Pilot Scheme Protection of Transmission Lines</li> <li>• Carrier Assisted Distance Protection</li> <li>• PUTT and POTT Schemes</li> <li>• SOTF and Stub Bus Protection</li> <li>• Power Swing Blocking and Open Conductor Protection</li> </ul>
<b>Unit II - Generator Protection</b>
<ul style="list-style-type: none"> <li>• Introduction to Generator Protection</li> <li>• Classification of Generator Protection</li> <li>• Generator Differential Protection</li> <li>• Backup Impedance Protection</li> <li>• Voltage Restrained Overcurrent Protection</li> <li>• Negative Phase Sequence Protection</li> <li>• Generator Stator Earth Fault Protection</li> <li>• Loss of Excitation</li> <li>• Low Forward Power Relay &amp; Reverse Power relay</li> <li>• Rotor Earth Fault Protection, Standby Earth Fault Protection</li> <li>• Pole Slip Relay, Generator Over voltage Protection</li> <li>• Generator Under Frequency Protection</li> </ul>
<b>Unit III - Transformer and reactor protection</b>
<ul style="list-style-type: none"> <li>• Protection Requirements of Transformers</li> <li>• Types of Faults</li> <li>• Differential Protection of Transformers</li> <li>• Protection against Magnetizing Inrush Current</li> <li>• Restricted Earth Fault Protection</li> <li>• Over Fluxing Protection</li> <li>• Overcurrent Protection</li> <li>• Overload Protection</li> <li>• Buchholz Protection</li> </ul>

- Sudden-Pressure Relay
- Typical Protective Schemes for Industrial Power Transformers
- Protection of Shunt Reactors
- Walk through Video of Transformer Components
- Demonstration of Transformer Insulation Resistance Testing
- Demonstration of Transformer Winding Resistance Testing
- Demonstration of Transformer Voltage Ratio Test
- Demonstration of Transformer Magnetizing Current Testing
- Demonstration of Transformer Magnetic Balance Test
- Demonstration of Transformer Vector Group Test

**Unit IV - Bus Bars Protection, Load Shedding and Frequency Relaying**

- Bus Protection Schemes
- Bus Differential Relaying Schemes
- Bus Differential Protection with Overcurrent Relays
- Bus Protection with Percentage Restrained Differential Relays
- Bus High-Impedance Voltage Differential Protection
- Alternative Bus Protective Schemes
- Introduction and Rate of Frequency Decline
- Load Shedding
- Frequency Relays
- Formulating a Load Shedding Scheme
- Restoring Service

**Unit V - Numerical Protection**

- Introduction to Numerical Protection
- Different types of Numerical Protection
- Microprocessor based Overcurrent Relay
- Microprocessor based Distance Relay
- Microprocessor based Differential Relay
- Microprocessor based Directional Relay
- Microprocessor based Quadrilateral Relay
- Demonstration of Numerical Protection Relay
- Application of Artificial Intelligence to Power System Protection
- Application of Artificial Neural Network (ANN) to Transformer Protection, Generator Protection
- Substation Automation

**Unit VI - Switchgear Theory**

- Essential Features of Switch Gear
- Low Voltage Switch Gear Equipment
- Medium Voltage Switch Gear Equipment
- High Voltage Switch Gear Equipment
- Short Circuit Currents and Switching Duties
- Concept of Circuit Interruption
- Formation of Arc during Circuit Breaking
- AC Circuit Breaking
- DC Circuit Breaking
- Rate of rise of Recovery Voltage
- Current Chopping
- Resistance Switching
- A Walk-through video of Switch gear in substation

**Unit VII - Practical Switchgear**

- introduction to Circuit Breakers
- Rating of Circuit Breaker
- Classification of Circuit Breakers
- Air Circuit Breakers
- Oil Circuit Breakers
- SF6 Circuit Breakers
- Vacuum Circuit Breakers
- High Voltage DC (HVDC) Circuit Breakers
- Gas Insulated Substation / Switch gears.
- Automatic Highspeed Reclosing of Circuit Breakers
- Single and Three Phase Auto Reclosing
- Testing and Commissioning of Circuit Breakers
- BIM modelling of Air Insulated Substation and Gas Insulated Substation
- A Walk-through Video of GIS Substation
- Demonstration Air Circuit Breaker Maintenance