

## HIGH VOLTAGE ENGINEERING

<b>VII Semester: EEE</b>								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AEE015	Core	L	T	P	C	CIA	SEE	Total
		3	1	-	4	30	70	100
<b>Contact Classes: 45</b>		<b>Tutorial Classes: 15</b>		<b>Practical Classes: Nil</b>			<b>Total Classes: 60</b>	
<p><b>COURSE OBJECTIVES:</b>  <b>The course should enable the students to:</b></p> <ol style="list-style-type: none"> <li>I. Summarize the types of insulation and breakdown process used for power system protection.</li> <li>II. Design the networks for generation of high direct current voltage, high alternating current voltage and to measure the same.</li> <li>III. Identify the causes for over voltages and explain the principals of insulation co-ordination in high voltage power systems.</li> <li>IV. Measure the various electrical parameters of insulation used for power system equipment for their withstand.</li> <li>V. Examine breakdown strength of insulation mediums for power system using type and routine test</li> </ol> <p><b>COURSE OUTCOMES (COs):</b></p> <p>CO 1: Describe the causes of over voltages and its effect and protection against over voltages by using protecting devices..</p> <p>CO 2: Explain the different types breakdown process used in power system protection.</p> <p>CO 3: Construct the Generation of high voltages and currents and controlling of impulse generators.</p> <p>CO 4: Measure the high voltages and currents in power system by using different types of instruments and digital techniques.</p> <p>CO 5: Use Analysing the high voltage apparatus in power system using BIL and international standards and insulation level.</p> <p><b>COURSE LEARNING OUTCOMES (CLOs):</b></p> <ol style="list-style-type: none"> <li>1. Study the effect of over voltage on power system and causes.</li> <li>2. Check the cause which leads to over surges and over currents in power system.</li> <li>3. Identify the methods for protection against over voltages in power system.</li> <li>4. Discuss different phenomenon which leads to break down of gas insulation medium and specify the particular gas any power system apparatus.</li> <li>5. Explain the various methods which causes breakdown in liquid dielectric medium and their importance in power system protection.</li> <li>6. Illustrate the process which decreases the breakdown strength of solid insulating mediums and their application in power system.</li> <li>7. Design the networks for generation of high direct current voltages and high alternating current voltages.</li> <li>8. Measure the value of high direct current voltages , high alternating current voltages , impulse voltage and current after generation..</li> <li>9. Analyze tripping and control of impulse generator.</li> <li>10. Determine the process which leads to over voltage and lightning phenomenon on power system equipment.</li> </ol>								

11.	Study the insulation co-ordination in safe operation of extra high voltage power system.
12.	Calculate the DC resistivity , loss factor and dielectric constant of different insulation mediums used in power system protection.
13.	Identify the difference between type test and routine test used to understand withstand capability of insulation system in power system.
14.	Examine the power system equipment like insulators, bushings, isolators and circuit breakers for their breakdown strength.
15.	Investigate the power system equipment like cable, transformers and surge arresters of their dielectric strength.
16.	Understand importance of high voltage engineering, Insulation technology, generation, measurement and testing related to high voltage power system.
17.	Explore the knowledge and skills of employability to succeed in national and international level competitive examinations
<b>UNIT - I</b>	<b>OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS</b>
<b>Classes: 09</b>	
Origin of over voltages: Causes of over voltages and their effects on power system, lightning, switching surges and temporary over voltages, corona and its effects, reflection and refraction of travelling waves, protection against over voltages. Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, Surge modifiers.	
<b>UNIT - II</b>	<b>DIELECTRIC BREAKDOWN</b>
<b>Classes: 09</b>	
Breakdown of dielectrics: Gaseous breakdown in uniform and non uniform fields, corona discharges, breakdown of vacuum, conduction and breakdown in pure and commercial liquids, maintenance of oil quality, breakdown mechanisms in solid and composite dielectrics.	
<b>UNIT - III</b>	<b>GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS</b>
<b>Classes: 09</b>	
High AC, DC voltages and currents: Generation of high DC, AC and impulse voltages and currents. Triggering: Triggering and control of impulse generators.	
<b>UNIT - IV</b>	<b>MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS</b>
<b>Classes: 09</b>	
High voltage and current measurement: High resistance with series ammeter, dividers, resistance, capacitance and mixed dividers, peak voltmeter, generating voltmeters, capacitance voltage transformers, electrostatic voltmeters, sphere gaps, high current shunts, digital techniques in high voltage measurement.	
<b>UNIT - V</b>	<b>HIGH VOLTAGE TESTING AND INSULATION COORDINATION</b>
<b>Classes: 09</b>	
Testing: High voltage testing of electrical power apparatus as per international and Indian standards, power frequency, impulse voltage and dc testing of insulators, circuit breakers, bushings, isolators and transformers, insulation coordination.	
<b>Text Books:</b>	
<ol style="list-style-type: none"> <li>1. S Naidu, V Kamaraju, “High Voltage Engineering”, Tata McGraw-Hill, 5<sup>th</sup> Edition, 2013.</li> <li>2. E Kuffel, W S Zaengl, J Kuffel, “High voltage Engineering fundamentals”, Newnes, 2<sup>nd</sup> Edition Elsevier, New Delhi, 2005.</li> <li>3. Subir Ray, “An Introduction to High Voltage Engineering”, PHI Learning Private Limited, New Delhi, 2<sup>nd</sup> Edition, 2013.</li> </ol>	

**Reference Books:**

1. L L Alston, "High Voltage Technology", Oxford University Press, 1<sup>st</sup> Indian Edition, 2011.
2. C L Wadhwa, "High Voltage Engineering", New Age International Publishers, 3<sup>rd</sup> Edition, 2010.

**Web References:**

1. <https://www.nptel.ac.in/courses/108104048/>
2. <https://www.hve.iisc.ernet.in/>
3. <https://www.ee.iisc.ac.in/research-hve.php>
4. [https://www.wikipedia.org/wiki/High\\_voltage](https://www.wikipedia.org/wiki/High_voltage)
5. <https://www.annauniv.edu/HighVoltage/>