

## HIGH VOLTAGE ENGINEERING AND SOLAR LABORATORY

<b>VII Semester: EEE</b>								
Course Code	Category	Hours / Week			Credit	Maximum Marks		
AEE111	Core	L	T	P	C	CIA	SEE	Total
		-	-	3	2	30	70	100
<b>Contact Classes: Nil</b>		<b>Tutorial Classes: Nil</b>		<b>Practical Classes: 42</b>			<b>Total Classes: 42</b>	
<b>I. COURSE OUTCOMES:</b>								
The objective of this course is to conduct experiments with different breakdown medium of insulation, measurement of high AC and DC voltages, testing of insulation under all types of conditions using generated high DC and AC voltages and this course includes experiments deal with solar power measurement technology.								
<b>II. OBJECTIVES:</b>								
<b>The course should enable the students to:</b>								
I The breakdown phenomenon of air using various electrode geometrics.								
II The functionalities of automatic insulating oil testing machine.								
III The polarity of I-V Characteristic in a fixed and solar tracking photovoltaic systems illuminated by an incandescent lamp, at different frequencies.								
<b>III. COURSE OUTCOMES:</b>								
<b>After successful completion of the course, students should be able to:</b>								
CO 1 Make use of the cascaded transformers for the generation of AC highvoltages.						Apply		
CO 2 Determine the breakdown voltage of atmospheric air and solidinsulators using rod and sphere gap apparatus.						Evaluate		
CO 3 Examine the breakdown phenomena in liquid insulator using oilinsulation tester.						Apply		
CO 4 Calculate the equivalent circuit parameters of a PV array for drawing the I-V characteristics.						Understand		
CO 5 Analyze the performance of the solar panel under various temperatures, tilt angles and shading effects.						Apply		
CO 6 Develop the mathematical model of PV cell, ensure MPPT algorithm using simulation tools.						Apply		
<b>IV. SYLLABUS:</b>								
<b>LIST OF EXPERIMENTS</b>								
<b>Expt. 1</b>	<b>GENERATION OF AC HIGH VOLTAGES</b>							
Study of generation of high AC voltages using cascaded transformers.								
<b>Expt. 2</b>	<b>VERIFICATION OF BREAKDOWN POTENTIAL OF AIR AT SPECIFIED GAP</b>							
Verification of breakdown potential with reference to empirical formula.								
<b>Expt. 3</b>	<b>DETERMINATION OF BREAKDOWN VOLTAGE OF AIR BY ROD GAP APPARATUS</b>							
Determination of breakdown voltage of atmospheric air using rod gap apparatus.								

<b>Expt. 4</b>	<b>DETERMINATION OF BREAKDOWN VOLTAGE OF AIR USING SPHERE GAP APPARATUS</b>
Determination of breakdown voltage of atmospheric air using sphere gap apparatus.	
<b>Expt. 5</b>	<b>DETERMINATION OF BREAKDOWN VOLTAGE OF SOLID INSULATOR</b>
Determination of breakdown of solid insulators such as paper, thermocol and glass.	
<b>Expt. 6</b>	<b>DETERMINATION OF BREAKDOWN VOLTAGE OF LIQUID INSULATOR</b>
Determination of breakdown of liquid insulator using oil insulation tester.	
<b>Expt. 7</b>	<b>CHARACTERISTICS OF SOLAR PANEL</b>
Determination of IV characteristics of solar panel and calculation of equivalent circuit parameters of a PV array in PACAD.	
<b>Expt. 8</b>	<b>SOLAR INVERTER</b>
Study of off-grid solar inverter with battery charging controller.	
<b>Expt. 9</b>	<b>EFFECT OF SHADING ON SOLAR PANNEL PERFORMANCE</b>
Study of a) Series parallel connections of solar panels and effect of shading. b) Improvement in power efficiency of photovoltaic array under shading conditions using bypass diode with PSCAD.	
<b>Expt. 10</b>	<b>EFFECT OF TEMPERATURE AND TILT ANGLE ON SOLAR PANNEL</b>
Study of effect of surrounding temperature and tilt angle on the performance solar PV panel.	
<b>Expt. 11</b>	<b>DESIGN OF SOLAR PANNEL</b>
Study of solar panel manufacturing using solar cells by interconnecting them to get desired voltage and power rating.	
<b>Expt. 12</b>	<b>DATA ACQUISITION USING DIGITAL SIMULATION</b>
Data acquisition using temperature, voltage and irradiation with sensors of solar panel using digital simulation.	
<b>Expt. 13</b>	<b>MAXIMUM POWER POINT TRACKER USING DIGITAL SIMULATION / PSCAD</b>
a) Implementation of maximum power point tracker using Perturb and observe algorithm using digital simulation. b) Determine the mathematical model of PV cell, ensure MPPT algorithm using PSCAD.	
<b>Expt. 14</b>	<b>DETERMINATION OF PARAMETERS OF SOLAR CELL USING DIGITAL SIMULATION</b>
Study of characteristics and determination of parameters of solar cell using digital simulation.	

**Reference Books:**

1. M S Naidu and V Kamaraju, "High Voltage Engineering", TMH Publications, 3<sup>rd</sup> Edition
2. E Kuffel, W S Zaengl, J Kuffel, "High Voltage Engineering Fundamentals", Elsevier, 2<sup>nd</sup> Edition
3. S P Sukhatme, J K Nayak., "Solar Energy", Tata McGraw-Hill Education Private Limited, New Delhi 1<sup>st</sup> Edition, 2010.
4. Mukund R. Patel, "Wind and Solar Power Systems: Design, Analysis, and Operation", 2<sup>nd</sup> Edition, CRC, 2005.

**Web References:**

1. <https://www.cl.cam.ac.uk/teaching/1011/CompFunds>
2. <https://www.bibcol.com>
3. [https://www.tutorialspoint.com/computer\\_fundamentals](https://www.tutorialspoint.com/computer_fundamentals)
4. <https://www.craftsmanspace.com>

**Course Home Page:****LIST OF EQUIPMENT REQUIRED FOR A BATCH OF 36 STUDENTS:**

S No	Name of the Equipment	Range
1	Cascaded transformer	0-100 kV
2	Rod gap apparatus	0-100 kV
3	Sphere gap apparatus	0-100 kV
4	Oil test setup	0-140 kV
5	Charge controller with inverter	0-220V, 50 Hz
6	Solar Panels	0-100W peak