INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**HIGH VOLTAGE ENGINEERING AND SOLAR LABORATORY**				
Course Code	**AEE111**				
Programme	**B.Tech**				
Semester	**VII**	**EEE**			
Course Type	**Core**				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	-	-	-	3	2
Chief Coordinator	Mr. G Kranthi kumar, Assistant Professor				
Course Faculty	Mr. G Kranthi kumar ,Assistant Professor Mr. A Sathish kumar ,Assistant Professor				

I. COURSE OVERVIEW:

The aim of this course is to conduct experiments deals with different mediums of insulation, break down of insulation, understanding need of insulation technology in power system, generation of high direct current and alternating current voltage, measurement of high alternating current and direct current voltages, testing of insulation under all types of conditions using generated high direct current and alternating current voltages. This course includes experiments deal with solar power generation and measurement technology.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS007	I	Applied Physics	4
UG	AEE006	III	Electromagnetic Field Theory	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
High Voltage Engineering And Solar Laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✘	Quiz	✘	Assignments	✘	MOOCs
✔	LCD / PPT	✘	Seminars	✘	Mini Project	✔	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS.

The emphasis on the experiments is broadly based on the following criteria:

20 %	To test the preparedness for the experiment.
20 %	To test the performance in the laboratory.
20 %	To test the calculations and graphs related to the concern experiment.
20 %	To test the results and the error analysis of the experiment.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Table 1: Assessment pattern for CIA

Component	**Laboratory**		**Total Marks**
Type of Assessment	Day to day performance	Final internal lab assessment	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

Preparation	**Performance**	**Calculations and Graph**	**Results and Error Analysis**	**Viva**	**Total**
2	2	2	2	2	10

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Calculations of the observations
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Term observations
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations**.**	3	Exercise, Discussion and Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Problem Solving:** Exploit the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	1	Presentation on real-world problems
PSO 2	**Professional Skills:** To explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	2	Exercise, Discussion and Seminars
PSO 3	**Modern Tools in Electrical Engineering:** To be able to utilize of technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, maintain power systems and industrial applications.	3	Calculations of the observations

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the principles of high voltage generation and measurements.
II	Determine the break down voltage of atmospheric air using rod gap and sphere gap apparatus.
III	Understand breakdown phenomena in solid, liquid and gas mediums.
IV	Familiarize the students with solar power generation and measurement technology.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE111.01	CLO 1	Measure the value of high direct current voltages , high alternating current voltages , impulse voltage and current after generation.	PO 1	3
AEE111.02	CLO 2	Examine the power system equipment like insulators, bushings, isolators and circuit breakers for their breakdown strength	PO 1, PO 4	3
AEE111.03	CLO 3	Explain the various methods which causes breakdown in liquid dielectric medium and their importance in power system protection.	PO 1, PO 4	3
AEE111.04	CLO 4	Illustrate the process which decreases the breakdown strength of solid insulating mediums and their application in power system.	PO 1, PO 4	3
AEE111.05	CLO 5	Discuss different phenomenon which leads to break down of gas insulation medium and specify the particular gas any power system apparatus.	PO 1, PO 4	3
AEE111.06	CLO 6	Study of off-grid solar inverter with battery charging controller.	PO 1, PO 4	3
AEE111.07	CLO 7	Understand the role of solar energy in the context of regional and global energy system, its economic, social and environmental connotations, and the impact of technology on a local and global context.	PO 1, PO 4	3
AEE111.08	CLO 8	Understand the physical principles of the photovoltaic (PV) solar cell and what its sources of losses are.	PO 1, PO 4	2
AEE111.09	CLO 9	Draw and analysis of maximum power point tracker using Perturb and observe algorithm using digital simulation.	PO 1, PO 5	2
AEE111.10	CLO 10	Study of characteristics and determination of parameters of solar cell using digital simulation.	PO 1, PO 5	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3			2									1		
CLO 3	3			3									1		
CLO 4	3			3									1		
CLO 5	3			2									1		

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 6	3			3											
CLO 7	3			2									1		
CLO 8	2			2										2	
CLO 9	2				3									2	3
CLO 10	2				3									2	3

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 4, PO 5	SEE Exams	PO 1, PO 4, PO 5	Assignments	-	Seminars	-
Laboratory Practices	PO 1, PO 4, PO 5	Student Viva	-	Mini Project	-	Certification	-

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

LIST OF EXPERIMENTS	
Expt. 1	**GENERATION OF AC HIGH VOLTAGES**
Study of generation of high AC voltages using cascaded transformers.	
Expt. 2	**VERIFICATION OF BREAKDOWN POTENTIAL OF AIR AT SPECIFIED GAP**
Verification of breakdown potential with reference to empirical formula.	
Expt. 3	**DETERMINATION OF BREAKDOWN VOLTAGE OF AIR BY ROD GAP APPARATUS**
Determination of breakdown voltage of atmospheric air using rod gap apparatus.	
Expt. 4	**DETERMINATION OF BREAKDOWN VOLTAGE OF AIR USING SPHERE GAP APPARATUS**
Determination of breakdown voltage of atmospheric air using sphere gap apparatus.	
Expt. 5	**DETERMINATION OF BREAKDOWN VOLTAGE OF SOLID INSULATOR**
Determination of breakdown of solid insulators such as paper, thermocol and glass.	
Expt. 6	**DETERMINATION OF BREAKDOWN VOLTAGE OF LIQUID INSULATOR**

Determination of breakdown of liquid insulator using oil insulation tester.	
Expt. 7	**CHARACTERSTICS OF SOLAR PANEL**
Determination of IV characteristics of solar panel and calculation of equivalent circuit parameters of a PV array in PACAD.	
Expt. 8	**SOLAR INVERTER**
Study of off-grid solar inverter with battery charging controller.	
Expt. 9	**EFFECT OF SHADING ON SOLAR PANNEL PERFORMANCE**
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.	
Expt. 10	**EFFECT OF TEMPERATURE AND TILT ANGLE ON SOLAR PANNEL**
Study of effect of surrounding temperature and tilt angle on the performance solar PV panel.	
Expt.11	**DESIGN OF SOLAR PANEL**
Study of solar panel manufacturing using solar cells by interconnecting them to get desired voltage and power rating.	
Expt. 12	**DATA ACQUISITION USING DIGITAL SIMULATION**
Data acquisition using temperature, voltage and irradiation with sensors of solar panel using digital simulation.	
Expt. 13	**MAXIMUM POWER POINT TRACKER USING DIGITAL SIMULATION / PSCAD**
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.	
Expt.14	**DETERMINATION OF PARAMETERS OF SOLAR CELL USING DIGITAL SIMULATION**
Study of characteristics and determination of parameters of solar cell using digital simulation.	

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Week No.	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Study of generation of high AC voltages using cascaded transformers.	CLO 1	T1:7.2-7.3 R2:4.1-4.6
2	Verification of breakdown potential with reference to empirical formula	CLO 1	T1:4.1-4.2 R2:1.14
3	Determination of breakdown voltage of atmospheric air using rod gap apparatus.	CLO 2, CLO 3	T1:4.4 R2:1.14
4	Determination of breakdown voltage of atmospheric air using sphere gap apparatus	CLO 2, CLO 3	T1:4.5 R2:1.14

Week No.	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
5	Determination of breakdown of solid insulators such as paper, thermocol and glass.	CLO 4	T1:4.5 R2:1.14
6	Determination of breakdown of liquid insulator using oil insulation tester.	CLO 3, CLO 5	T1:3.1-3.2 R2:1.11
7	Determination of IV characteristics of solar panel and calculation of equivalent circuit parameters of a PV array in PACAD.	CLO 9, CLO 10	T2:4.1-4.5 R3:1.56
8	Study of off-grid solar inverter with battery charging controller.	CLO 6, CLO 10	T2:3.1-3.2 R3:1.5
9	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	CLO 7, CLO 10	T2:2.1-2.5 R3:2.6
10	Study of effect of surrounding temperature and tilt angle on the performance solar PV panel.	CLO 6, CLO 8	T2:2.1-2.5 R3: 2.6
11	Study of solar panel manufacturing using solar cells by interconnecting them to get desired voltage and power rating	CLO 7, CLO 10	T2:2.8-2.9 R3:3.4
12	Data acquisition using temperature, voltage and irradiation with sensors of solar panel using digital simulation.	CLO 9, CLO 10	T2:2.5-2.6 R4:3.4-3.6
13	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	CLO 9	T2:3.1-3.2 R4:3.5-3.6
14	Study of characteristics and determination of parameters of solar cell using digital simulation	CLO 10	T2:1.5-1.4 R4: 2.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	More content of Tesla coil may be suggested.	Seminars / NPTEL	PO 1, PO 4	PSO 2
2	Design of Solar panel	Exercise, Practical's of Lab	PO 3, PO 4	PSO 2
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared by:
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