INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**POWER ELECTRONICS AND SIMULATION LABORATORY**				
Course Code	AEE108				
Programme	B. Tech				
Semester	V	EEE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. P Mabuhussain, Assistant Professor, EEE				
Course Faculty	Mr. S. Srikanth, Assistant Professor, EEE Mr. P Mabuhussain, Assistant Professor, EEE				

I. COURSE OVERVIEW:

The primary objective of this course is to examine the practical characteristics of various devices and application of firing circuits used in power electronics, performance characteristics of AC voltage regulators, choppers, inverters, rectifiers and cycloconverters. It also gives an emphasis on the use of MATLAB software for designing various power electronic devices and circuits using simulation.

II. COURSE PRE-REQUISITES:

Level	Course code	Semester	Prerequisites	Credits
UG	AEC001	II	Electrical Circuits	4
UG	AEE001	III	Electronic devices and circuits	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total marks
Power electronics and simulation laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

√	Chalk & talk	X	Quiz	X	Assignments	X	MOOCs
√	LCD / PPT	X	Seminars	X	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		**Strength**	**Proficiency assessed by**
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Calculations of the observations

Program Outcomes		Strength	Proficiency assessed by
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Characteristic curves
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Open ended experiments
PO4	**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	Open ended experiments
PO5	**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	Software simulation

3= High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency assessed by
PSO1	**Problem Solving Skills:** Exploit the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	-	-
PSO2	**Professional Skills:** Identify 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	Observations
PSO3	**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= High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Examine the characteristics of various devices and application of firing circuits used in power electronics.
II	Outline the performance characteristics of AC voltage regulators, choppers, inverters, rectifiers and cycloconverters.
III	Demonstrate the working principle of various power electronic devices and circuits using simulation.
IV	Design the simple power electronic circuits through digital simulation.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe the operation and characteristics of SCR, MOSFET and IGBT and their gate firing circuits.	CLO 1	Illustrate the characteristics of SCR, MOSFET and IGBT.
		CLO 2	Demonstrate the operation of different gate firing circuits of SCR

COs	Course Outcome	CLOs	Course Learning Outcome
CO 2	Explain the operation of Single phase and three phase controlled rectifiers and their commutating circuits.	CLO 3	Analyze the operation Single phase half controlled converter with R and RL loads.
		CLO 4	Describe the forced commutation circuits (Class A, Class B, Class C, Class D and Class E)
		CLO 5	Demonstrate the operation of Single phase fully controlled bridge converter with R and RL loads.
		CLO 9	Demonstrate the four quadrant operation of single phase dual converter with R and RL loads.
		CLO 11	Demonstrate the operation of three phase half converter with R and RL loads
CO 3	Discuss the operation of different types of Choppers, inverters.	CLO 6	Explain the operation of Single phase series inverter with different loads.
		CLO 7	Outline the operation of Single phase parallel inverter with different loads
		CLO 12	Analyze the principle of Operation of step down chopper using MOSFET
CO 4	Illustrate the functioning of AC voltage controllers and cycloconverters.	CLO 10	Discuss the operation of Single phase cycloconverter with R and RL loads.
		CLO 8	Describe the working principle and operation of single phase AC voltage controller with R and RL loads
CO 5	Design the different power electronic circuits using MATLAB/Simulation.	CLO 13	Analyze the operation of three phase full converter & PWM inverter with R and RL loads by using MATLAB
		CLO 14	Analyze the operation of boost, buck, buck boost converter with R and RL loads by using MATLAB
		CLO 15	Apply the concept of solid state electric drives to solve real time world applications
		CLO 16	Explore the knowledge and skills of employability to succeed in national and international level competitive examination

X. 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
AEE109.01	CLO 1	Illustrate the characteristics of SCR, MOSFET and IGBT.	PO1, PO2	2
AEE109.02	CLO 2	Demonstrate the operation of different gate firing circuits of SCR	PO2, PO3	2
AEE109.03	CLO 3	Analyze the operation Single phase half controlled converter with R and RL loads.	PO1, PO4	3
AEE109.04	CLO 4	Describe the forced commutation circuits (Class A, Class B, Class C, Class D and Class E)	PO3, PO4	3
AEE109.05	CLO 5	Demonstrate the operation of Single phase fully controlled bridge converter with R and RL loads.	PO1, PO4	2
AEE109.06	CLO 6	Explain the operation of Single phase series inverter with different loads.	PO1, PO3	3
AEE109.07	CLO 7	Outline the operation of Single phase parallel inverter with different loads	PO1, PO3	3
AEE109.08	CLO 8	Describe the working principle and operation of single phase AC voltage controller with R and RL loads	PO3, PO4	2
AEE109.09	CLO 9	Demonstrate the four quadrant operation of single phase dual converter with R and RL loads.	PO3, PO4	3
AEE109.10	CLO 10	Discuss the operation of Single phase cycloconverter with R and RL loads.	PO2, PO4	2

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's mapped	Strength of mapping
AEE109.11	CLO 11	Demonstrate the operation of three phase half converter with R and RL loads	PO3, PO4	2
AEE109.12	CLO 12	Analyze the principle of Operation of step down chopper using MOSFET	PO1, PO4	2
AEE109.13	CLO 13	Analyze the operation of three phase full converter & PWM inverter with R and RL loads by using MATLAB	PO3, PO5	3
AEE109.14	CLO 14	Analyze the operation of boost, buck, buck boost converter with R and RL loads by using MATLAB	PO3, PO4, PO5	3
AEE109.15	CLO 15	Apply the concept of solid state electric drives to solve real time world applications	PO1, PO2	2
AEE109.16	CLO 16	Explore the knowledge and skills of employability to succeed in national and international level competitive examination	PO1, PO2	2

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)				
	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3			2	
CO 2	2	2	2	2	
CO 3	2	2	2	2	
CO 4	2	2	2	2	
CO 5			2	2	3

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	2	2													
CLO 2		2	2												
CLO 3	3			3										2	
CLO 4			3	3											
CLO 5	2			2										2	
CLO 6	3		3											2	
CLO 7	3		3											2	
CLO 8			2	2											

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 9			3	3										2	
CLO 10		2		2											
CLO 11			2	2											
CLO 12	2			2											
CLO 13			3		3									2	
CLO 14			3		3									2	
CLO 15	2	2													
CLO 16	2	2													

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT:

CIE Exams	PO1 PO2 PO3 PO4 PO5	SEE Exams	PO1 PO2 PO3 PO4 PO5	Assignments	-	Seminars	-
Laboratory practices	PO1 PO2 PO3 PO4 PO5	Student viva	PO1 PO2 PO3 PO4 PO5	Mini project	-	Certification	-
Term paper	-						

XIV. ASSESSMENT METHODOLOGIES – INDIRECT:

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

XV. SYLLABUS:

LIST OF EXPERIMENTS	
Exp-1	**SCR, MOSFET AND IGBT**
Study the characteristics of SCR, MOSFET and IGBT.	
Exp-2	**GATE FIRING CIRCUITS**
Gate firing circuits of SCR.	
Exp-3	**HALF CONTROLLED CONVERTER**
Single phase half controlled converter with R and RL loads.	
Exp-4	**FORCED COMMUTATION CIRCUITS**
Forced commutation circuits (Class A, Class B, Class C, Class D and Class E).	
Exp-5	**FULLY CONTROLLED BRIDGE CONVERTER**
Single phase fully controlled bridge converter with R and RL loads.	

Exp-6	**SERIES INVERTER**
Single phase series inverter with different loads.	
Exp-7	**PARALLEL INVERTER**
Single phase parallel inverter with different loads.	
Exp-8	**VOLTAGE CONTROLLER**
Single phase AC voltage controller with R and RL loads.	
Exp-9	**DUAL CONVERTER**
Single phase dual converter with R and RL loads.	
Exp-10	**CYCLOCONVERTER**
Single phase cycloconverter with R and RL loads.	
Exp-11	**THREE PHASE CONVERTERS**
Three phase half converter with R and RL loads.	
Exp-12	**MOSFET BASED CHOPPERS**
Operation of step down chopper using MOSFET.	
Exp-13	**SIMULATION OF THREE PHASE FULL CONVERTER AND PWM INVERTER**
Simulation of three phase full converter and PWM inverter with R and RL loads by using MATLAB.	
Exp-14	**SIMULATION OF BUCK – BOOST CHOPPER**
Simulation of boost, buck, buck boost converter with R and RL loads by using MATLAB.	

Text Books:

1. M D Singh, K B Kanchandhani, "Power Electronics", Tata Mc Graw Hill Publishing Company, 2nd Edition, 1998.
2. Dr. P S Bimbhra, "Power Electronics", Khanna Publishers, 5th Edition, 2012.
3. M H Rashid, "Power Electronics, Circuits, Devices and Applications", Pearson, 3rd Edition, 2001.

Reference Books:

1. Vedam Subramanyam, "Power Electronics", New Age International Limited, 2nd Edition, 2006.
2. P C Sen, "Power Electronics", Tata McGraw-Hill Publishing, 1st Edition, 1987

XVI. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Week No	Topics to be covered	Course Learning Outcomes (CLOs)	References
1	Study the characteristics of SCR, MOSFET and IGBT.	CLO 1	T2: 4.1 R2: 1.6
2	Gate firing circuits of SCR.	CLO 2	T2: 4.12 R2: 1.15
3	Single phase half controlled converter with R and RL loads.	CLO 3	T2:6.1.1

Week No	Topics to be covered	Course Learning Outcomes (CLOs)	References
4	Forced commutation circuits (Class A, Class B, Class C, Class D and Class E).	CLO 4	T2: 5.3 R2: 1.7
5	Single phase fully controlled bridge converter with R and RL loads.	CLO 5	T2: 6.3.1 R2: 5.2
6	Single phase series inverter with different loads.	CLO 6	T2: 8.9 R2: 9.2
7	Single phase parallel inverter with different loads.	CLO 7	T2: 8.10 R2: 9.6
8	Single phase AC voltage controller with R and RL loads.	CLO 8	T2: 9.1 R2: 8.1
9	Single phase dual converter with R and RL loads.	CLO 9	T2: 6.8 R2: 6.11
10	Single phase cycloconverter with R and RL loads.	CLO 10	T2: 10.1 R2: 9.41
11	Three phase half converter with R and RL loads.	CLO 11	T2: 6.6.2 R2: 6.1
12	Operation of step down chopper using MOSFET.	CLO 12	T2: 7.2
13	Simulation of three phase full converter and PWM inverter with R and RL loads by using MATLAB.	CLO 13	T2: 6.6.3 R2: 6.4
14	Simulation of boost, buck, buck boost converter with R and RL loads by using MATLAB.	CLO 14	T2: 7.3 R2: 9.40.2

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Design real time inverter	Hands-on	PO5	PSO2
2	Design of Power converter to MPPT of Solar panel	NPTEL	PO5	PSO2

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