INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

COURSE DESCRIPTION FORM

Course Title	**POWER ELECTRONICS**			
Course Code	**A50220**			
Regulation	**R15-JNTUH**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	**-**	**-**	**4**
Course Coordinator	S. Srikanth, Assistant Professor			
Team of Instructors	S. Srikanth, Assistant Professor			

I. COURSE OVERVIEW:

Power Electronics course introduces the basic concepts of power semiconductor devices and power converters which is the foundation for power transmission, distribution and utilization of the Electrical Engineering discipline. The course deals with the basic analysis of ac-dc, dc-ac, dc-dc, ac-ac converters.

II. PREREQUISITES:

Level	Credits	Periods	Prerequisite
UG	4	4	Knowledge of semiconductor materials and Electronic Devices and Circuits

III. COURSE ASSESSMENT METHODS:

a) Marks Distribution:

Session Marks	University End Exam Marks	Total Marks
There shall be two midterm examinations. Each midterm exam consists of subjective type and objective type test. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each semester shall contain four questions; the student has to answer two out of them. Each carrying 5 marks The objective test paper Is prepared by JNTUH, which consists of 20 questions each carrying 0.5 marks and total of 10 marks. The student is assessed by giving two assignments, one, after completion of 1 to 4 units and the second, after the completion of 4 to 8 units each carrying 5 marks. On the total the internal marks are 25. The average of two internal tests is the final internal marks. The external question paper is set by JNTUH consisting of 8 questions each carrying 15 marks out of which 5 questions are to be answered their by external examination is of total 75 mark	75	100

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I Mid Examination	90 minutes	20
2	I Assignment	--	05
3	II Mid Examination	90 minutes	20
4	II Assignment	--	05
5	External Examination	3 hours	75

V. COURSE OBJECTIVE:

At the end of the course, the students will be able to:

i. To know, identify and define the basic elements of power electronics devices and their characteristics, specifications, operation and protection.
ii. To understand fundamentals, phase controlled rectifiers (1ph and 3ph) and line commutated inverters.
iii. To have the ability to analyze and design of DC-DC converters (choppers), AC-AC converters, DC-AC converters and control strategies
iv. To determine whether a converter or waveform can deliver energy to meet specified requirements and to analyze harmonic distortion.
v. To discuss the important applications of power devices and provide critical evaluation, of the most common types of dc-dc, ac-dc and dc-ac converters

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. Understand the characteristics of various power electronic elements and able to build simple power electronic circuits.
2. Understand operation and waveforms for phase controlled converters.
3. Understand chopper operation and waveforms
4. Understand AC voltage controllers and cyclo converters operation and waveforms
5. Apply knowledge of modulation techniques for inverters in real time projects.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency Assessed By
PO1	An ability to apply the knowledge of mathematics, science and Engineering for solving multifaceted issues of Electrical Engineering.(**General Knowledge**)	H	Assignments
PO2	An ability to communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems.(**Problem Analysis**)	S	Exercise
PO3	To develop Broad theoretical knowledge in Electrical Engineering and learn the methods of applying them to identify, formulate and solve practical problems involving electrical power. (**Design / Development of Solutions**).	H	Assignments, discussion
PO4	An ability to apply the techniques of using appropriate technologies to investigate, analyze, design, simulate and/or fabricate/commission complete systems involving generation, transmission and distribution of electrical energy. (**Conduct Investigations of Complex Problems**)	S	Exercise
PO5	An ability to model real life problems using different hardware and software platforms, both offline and real-time with the help of various tools along with upgraded versions. (**Modern Tool Usage**)	N	------

PO6	An Ability to design and fabricate modules, control systems and relevant processes to meet desired performance needs, within realistic constraints for social needs.(**The Engineer and Society**)	S	Exercise
PO7	An ability To estimate the feasibility, applicability, optimality and future scope of power networks and apparatus for design of eco-friendly with sustainability (**Environment and Sustainability**)	H	Discussion, seminars
PO8	To Possess an appreciation of professional, societal, environmental and ethical issues and proper use of renewable resources.(Ethics)	N	-----
PO9	an Ability to design schemes involving signal sensing and processing leading to decision making for real time electrical engineering systems and processes at individual and team levels. **(Individual and Team Work**)	S	Discussions
PO10	an Ability to work in a team and comprehend his/her scope of work, deliverables , issues and be able to communicate both in verbal, written for effective technical presentation. **(Communication**)	S	Discussion, seminars
PO11	An ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	S	Discussions, seminars
PO12	To be familiar with project management problems and basic financial principles for a multi-disciplinary work.**(Project Management and Finance**)	S	Prototype, discussions

N= None **S=Supportive** **H=highly related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency Assessed By
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	H	Lectures, Assignments
PSO2	**Problem-Solving Skills:** Can 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.	S	Projects
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	S	Projects

N - None **S - Supportive** **H- Highly Related**

IX. SYLLABUS:

UNIT - I

Power Semi Conductor Devices & Commutation Circuits: Thyristors – Silicon Controlled Rectifiers (SCR's) – BJT – Power MOSFET – Power IGBT and their characteristics and other thyristors – Basic theory of operation of SCR – Static characteristics – Turn on and turn off methods- Dynamic characteristics of SCR - Turn on and Turn off times -Salient points. Two transistor analogy – SCR - UJT firing circuit - Series and parallel connections of SCR's – Snubber circuit details – Specifications and Ratings of SCR's, BJT, IGBT - Numerical problems – Line Commutation and Forced Commutation circuits.

UNIT - II

AC-DC Converters (1-Phase & 3-Phase Controlled Rectifiers): Phase control technique – Single phase Line commutated converters – Midpoint and Bridge connections – Half controlled converters with Resistive, RL loads and RLE load– Derivation of average load voltage and current- Active and Reactive Power inputs to the converters

without and with Freewheeling Diode-Numerical Problems. Fully controlled converters, midpoint and Bridge connections with Resistive, RL loads and RLE load - Derivation of average load voltage and current-Line commutated inverters- Active and Reactive Power inputs to the converters without and with freewheeling diode, Effect of source inductance- Derivation of load voltage and current- Numerical Problems. Three phase converters – Three pulse and six pulse converters – Mid-point and bridge connections average load voltage With R and RL loads – Effect of Source inductance–Dual converters (both single phase and three phase) - Waveforms –Numerical Problems.

UNIT - III

DC-DC Converters (Choppers): Choppers – Time ratio control and Current limit control strategies – Step down choppers Derivation of load voltage and currents with R, RL and RLE loads- Step up Chopper – load voltage expression, Jones chopper, AC Chopper, Problems.

UNIT - IV

AC-AC Converters (AC Voltage Controllers) & Frequency Changers (Cyclo-Converters): AC voltage controllers – Single phase two SCR's in anti parallel – With R and RL loads – modes of operation of Triac – Triac with R and RL loads – Derivation of RMS load voltage, current and power factor wave forms –Firing circuits - Numerical problems- Cyclo-converters – Single phase midpoint Cyclo converters with Resistive and inductive load (Principle of operation only) – Bridge configuration of single phase Cyclo-converter (Principle of operation only) – Waveforms

UNIT - V

DC-AC Converters (Inverters): Inverters – Single phase inverter – Basic series, parallel inverter-Operation and Waveforms-Three Phase inverters (180, 120 degrees conduction modes of operation) – Voltage control techniques for inverters, Pulse width modulation techniques-Numerical problems.

X. TEXT BOOKS:

1. Power Electronics, Dr. P. S. Bimbhra, Khanna Publishers.
2. Power Electronics Devices, Circuits and Industrial applications, V.R. Moorthi, Oxford University Press.

XI. REFERENCES:

1. Power Electronics: Circuits, Devices and Apllications, M.H. Rashid, Prentice Hall of India
2. Power Electronics, M.D. Singh & K.B. Kanchandhani, Tata Mc GrawHill Publishing Company.
3. Power Electronics, Vedam Subramanyam, New Age International (P) Limited, Publishers.

XII. COURSE PLAN:

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

Lecture No.	Learning Objectives	Topic To Be Covered	Reference
1	Introduce the basic elements of electronics devices	Introduction to power electronics	T1 1.1
2	Understand the Thyristors (SCR's) characteristics	Thyristors – Silicon Controlled Rectifiers (SCR's) characteristics	T1 4.1
3-4	Understand the characteristics of BJT – Power MOSFET – Power IGBT (SCR's)	BJT – Power MOSFET – Power IGBT and their characteristics	T1 2.3, 2.4
5-6	Realize the theory of operation of SCR and Turn on and turn off methods	Theory of operation of SCR – Static characteristics –	T1 4.1.1
7-8	Apprehend the Dynamic characteristics of SCR	Dynamic characteristics of SCR - Turn on and Turn off times -Salient points	T1 4.3
9-10	Understand the Two transistor analogy of SCR	Two transistor analogy – SCR	T1 4.5
11	Know the operation of UJT firing circuit	UJT firing circuit	T1 4.12.3
12-13	Understand the operation Series and parallel connections of SCR's	Series and parallel connections of SCR's	T1 4.9

Lecture No.	Learning Objectives	Topic To Be Covered	Reference
14-15	Realize the Snubber circuit for SCR	Snubber circuit details, Specifications and Ratings of SCR's, BJT, IGBT	T1 4.7.1
16	Improve the numerical skill towards the discussed topics	Specifications and Ratings of SCR's, BJT, IGBT, Numerical problems	T1 4.6
17-18	Realize the Commutation circuits for SCR	Line Commutation and Forced Commutation circuits.	T1 5.1-5.6
19	Introduce the fundamentals of phase controlled rectifiers (1ph)	Phase control technique – Single phase Line commutated converters	T1 6.1
20	Realize the operation of Half controlled converters with Resistive load	Midpoint and Bridge connections Half controlled converters with Resistive load	T1 6.1.1
21-22	Realize the operation of Half controlled converters with RL load, RLE load and Derivations for Active and Reactive power inputs to converters.	Half controlled converters with RL loads and RLE load– Derivation of average load voltage and current, Active and Reactive power inputs to the converters without and with Freewheeling Diode	T1 6.1.3
23-24	Apprehend the operation of fully controlled converters with Resistive RL loads	Fully controlled converters with Resistive, RL loads and RLE load– Derivation of average load voltage and current	T1 6.2
25	Obtain the derivations for Active and Reactive power for Line commutated converters	Line commutated converters -Active and Reactive power inputs to the converters without and with Freewheeling Diode.	T1 6.4
26	Understand the Effect of source inductance on converter	Effect of source inductance – Derivation of load voltage and current	T1 6.4.2
27	Improve the numerical skill towards the discussed topics	Numerical problems	T1 6.9
28	Understand fundamentals, phase controlled rectifiers (3ph) and line commutated inverters	Three phase converters – Three pulse and six pulse converters, Midpoint and Bridge connections	T1 6.5
29-30	Realize the operation of 3-ph Half controlled converters with Resistive RL load and necessary derivations for analysis	Half controlled converters, with Resistive, RL loads– Derivation of average load voltage and current- without and with Freewheeling Diode.	T1 6.5.1
31-32	Analyze and necessary derivations for analysis se the operation of 3-ph Half controlled converters with RLE load and necessary derivations for analysis	Half controlled converters, with RLE load– Derivation of average load voltage and current- without and with Freewheeling Diode.	T1 6.6.2
33-34	Analyze and necessary derivations for analysis se the operation of 3-ph fully controlled converters with R & RL load and necessary derivations	Fully controlled converters with Resistive & RL loads Derivation of average load voltage and current without and with Freewheeling Diode.	T1 6.6
35-36	Analyze and necessary derivations for analysis se the operation of 3-ph Half controlled converters with RLE load and necessary derivations	Fully controlled converters with RLE load– Derivation of average load voltage and current without and with Freewheeling Diode.	T1 6.6.2
37	Understand the Effect of source inductance	Effect of source inductance – Derivation of load voltage and current	T1 6.7
38	Analyze the Dual Converter Operation	Dual Converters (both single phase and three phase)-waveforms-Numerical Problems	T1 6.8
39-41	Introduce the DC-DC converters (CHOPPERS) principle and control strategies	Choppers – Time ratio control and Current limit control strategies	T1 7.2
42-43	Realize the operation of Step down choppers	Step down choppers Derivation of load voltage and currents with R, RL and RLE loads	T1 7.3
44	Realize the operation of Step down choppers	Step up Chopper – load voltage expression	T1 7.3
45	Apprehend the operation of Morgan's chopper choppers	Morgan's chopper – Jones chopper	R2 6.9

Lecture No.	Learning Objectives	Topic To Be Covered	Reference
46	Apprehend the operation of Oscillation & AC choppers	Oscillation chopper (Principle of operation only) Waveforms – AC Chopper	R2 6.10
47	Improve the numerical skill towards the discussed topics	Simple Problems	R2 6.11
48-50	Analyze the AC-AC converters (AC voltage controllers), principle of operation and control strategies	AC voltage controllers – Single phase two SCR's in anti parallel – With R and RL loads Derivation of RMS load voltage, current and power factor wave forms	T1 9.1, 9.3
51	Understand the Modes of operation of Triac	Modes of operation of Triac – Triac with R and RL loads – Derivation of RMS load voltage, current and power factor wave forms	R2 9.2
52	Problem solving	AC voltage controller -Numerical problems	T1 9.3.2
53	To analyze AC-AC converters (Cyclo-converters), principle of operation and control strategies	Cyclo converters	T1 10.1
54	Single phase midpoint Cyclo converters with inductive load (Principle of operation only)) – Waveforms	Single phase midpoint Cyclo converters with Resistive and inductive load (Principle of operation only)) – Waveforms	T1 10.1.1
55	Single phase Cyclo converter Bridge configuration (Principle of operation only) Waveforms	Bridge configuration of single phase Cyclo converter (Principle of operation only) – Waveforms	T2 10.1.2
56-58	Analyze 1ph inverter (DC-AC Converter)	Inverters – Single phase inverter	T1 8.1
59-60	Realize the operation of parallel Capacitor inverter	Basic series, parallel inverter – operation and Waveforms	R2 5.3, 5.5
61-62	Realize the operation of Three phases inverters	Three Phase inverters (180, 120 degrees conduction modes of operation)	T1 8.4
63-64	Understand the Voltage control & PWM techniques for inverters	Voltage control techniques for inverters Pulse width modulation techniques	T1 8.6
65	Improve the numerical skill towards the discussed topics	Simple Problems	T1 8.10

XIII. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I		H	H		S		H		S			H	H		S
II		S	S				S		S	S			S	H	S
III	H	H	S	S		S			S			H	H	S	
IV		H	S	S			H				S			S	
V				S				S				S	H		S

S – Supportive H= Highly related

XIV. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES:

Course Outcomes	Program Outcomes	Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		H	H	S		S	H		S			H	H		S
2			H	S		S	H		S			H	H	S	S
3	S		S				H				S		S	S	
4		H	H	S		S	H		S			H	S	S	S
5			H	S		S	H		S			H		H	
6	S		S				H				S			S	S
7	H	S	H	S		S				S		S	H	H	S
8		H	S				S						S	S	
9				S								S	H	S	
10	H	S	H	S		S				S		S	S		H
11		H	S				S						S	S	S
12				S								S		H	S

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Prepared by: Mr. S. Srikanth, Assistant Professor

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