GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
POWER ELECTRONICS
SUBJECT CODE: 2161708
B.E. 6th SEMESTER

Type of course: Core **(**Compulsory)

Prerequisite: Basic knowledge of semi-conductor theory, rectifiers

Rationale: The subject of Power Electronics shall create understanding and strong basic concepts in power devices and their applications in industry

Teaching and Examination Scheme:

TeachingScheme			Credits	Examination Marks						Total Marks
L	T	P	C	TheoryMarks			PracticalMarks			
				ESE (E)	PA(M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weight age
1	POWER SEMICONDUCTOR SWITCHES : Ideal switch; Diodes: Static and Dynamic Characteristics, Diode classifications, Diode parameters; Surge current. Bipolar power transistors: Static and Dynamic characteristics, Calculation of power dissipation; Safe operating area; Paralleling of transistors. Power MOSFETs: Static and Dynamic characteristics, Paralleling, Handling, Power dissipation, Model of MOSFET. Insulated Gate Bipolar Transistor (IGBT) Static and Dynamic characteristics,Remarks. Thyristor Family: Silicon Controlled Rectifier(SCR),DIACs and TRIACs.	**9**	15-25
2	DRIVE CIRCUITs: Turn On and Turn Off Behavior, Different BJT drive circuits, Different MOSFET drive circuits, Turn on and Turn off Snubber circuits.	**8**	15-20
3	RECTIFIERS: Single phase and Three phase uncontrolled Rectifier Circuits, Capacitor input filter: Design of capacitor input filter rectifier, Turn on currents and surge limiting, Power factor. Rectifier LC filter: Output ripple, Turn on current. Single and Three phase controlled rectifier circuits.	**9**	15-25

4	DC-DC SWITCHED MODE CONVERTRS: Single pole double throw switch, The Chopper, DC steady-state principles. Basic converters: Step down (Buck), Step up (Boost), Step Up-Down (Buck-Boost) converters. Selection of power devices, Electrical and Thermal stress ratings. Isolated Converters: Forward converters, Switch, Waveforms, Equations .Forward converters with demagnetizing winding, Dual switch forward converter, Push-Pull converter, Half bridge converter, Flyback converter.	**10**	15-25
5	DC-AC SWITCHED MODE CONVERTERS: Inverter Topologies: Single and Three phase topologies. Self driven inverters: Saturable core inverter, Saturable base drive inverter. Driven inverter: Push-Pull, Half-Bridge and Full-Bridge configuration. Quasi square wave inverter. Three phase inverter topologies: six step inverter, current controlled inverter.	**9**	15-20

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
21	**21**	**14**	**7**	**7**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Power Electronics Essentials and applications-by L UMANAND. WIELY.
2. Power Electronics by M.D. Singh and Khanchandani K.B., T.M.H., 2nd Edition,2001
3. Power Electronics: Circuits, Devices and Applications by M.H. RASHID, PHI, Ed (1994)
4. Thyristorized Power Controllers by G.K. DUBEY, Wiley Eastern, Ed (1990).
5. Power Electronics by P. C. SEN, TMH Publication, 1/e, 11th reprint, 1997.

Course Outcome:

After learning the course the students should be able to:

1. CO1 explain construction and characteristics of power semiconductor devices
2. CO2 analyze and design ac-to-dc converters
3. CO3 analyze, design and implement power electronic circuits using modern tools.

List of Experiments:

1. To study SCR characteristics
2. To study MOSFET characteristics.

3. To study DIAC characteristics and its application
4. To study single phase half controlled bridge rectifier.
5. To study full wave controlled rectifier.
6. To study various methods of gate triggering. R, RC-half, RC-full, UJT triggering.
7. To study TRIAC firing in four operation mode.
8. To study different types of commutation techniques. Class A, Class B, Class C, Class D.
9. To study IGBT characteristics.
10. To study three phase rectifiers with help of psim simulation software.

Design based Problems (DP)/Open Ended Problem:

The students can work in a group to design a power electronic converter and its control scheme to target different applications. As per example,

1. Design a regulated power supply that converters 230 V AC to 1-12 V DC with 2A current capacity.

2. Design a DC-DC converter to convert fixed 30V DC into regulated 1to 20 V variable DC with load. (same concept can be used for speed control of DC motor)

Major Equipment:

Trainer kits for device characteristics, converters, commutation and triggering methods, breadboard, equipment, accessories and instruments etc. to be provided to conduct the above practical in a group of max. 4 students.

List of Open Source Software/learning website:

Open Source Software:

-basic version of GeckoCIRCUITS

- LTSpice for circuit simulation,

learning website:

http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.