# **GUJARAT TECHNOLOGICAL UNIVERSITY**

## INSTRUMENTATION & CONTROL ENGINEERING (17) POWER ELECTRONICS SUBJECT CODE: 2161708 B.E. 6<sup>th</sup> 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		
L	Т	Р	С	Theor	TheoryMarks			PracticalMarks		Marks
				ESE	PA(M)		ESE (V)		PA	
				(E)	PA	ALA	ESE	OEP	(I)	
3	0	2	5	70	20	10	20	10	20	150

## **Content:**

Sr. No.	Content	Total	%	
		Hrs	Weight age	
1	<ul> <li>POWER SEMICONDUCTOR SWITCHES : Ideal switch;</li> <li>Diodes: Static and Dynamic Characteristics, Diode classifications, Diode parameters; Surge current.</li> <li>Bipolar power transistors: Static and Dynamic characteristics, Calculation of power dissipation; Safe operating area; Paralleling of transistors.</li> <li>Power MOSFETs:</li> <li>Static and Dynamic characteristics, Paralleling, Handling, Power dissipation, Model of MOSFET.</li> <li>Insulated Gate Bipolar Transistor (IGBT)</li> <li>Static and Dynamic characteristics, Remarks.</li> <li>Thyristor Family:</li> </ul>	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:	10	15-25
	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.		
5	DC-AC SWITCHED MODE CONVERTERS:	9	15-20
	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.		

## 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 1 to 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.