GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)
Subject Code: 2930904
Semester – III (Electrical Engineering)
Subject Name: Power Electronics

Type of course: Professional Core Course

Prerequisite: Basic concepts of Electrical Engineering.

Rationale: The course has been designed to introduce fundamental principles of circuit theory used in engineering. Techniques and principles of electrical circuit analysis, resistive circuits, transient and steady-state responses of circuits; circuits with DC and sinusoidal sources, steady-state power and three-phase systems, including Laplace transforms applications for solving circuit problems**.**

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Power switching devices** Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristors; Voltage and current commutation of a Thyristor; Gate drive circuits for MOSFET and IGBT.	**7**
2	**Thyristor rectifiers** Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.	**7**
3	**DC-DC buck converter** Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.	**5**
4	**DC-DC boost converter** Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage. Buck-boost converter, Application of DC-	**5**

	DC converter, Modular DC-DC converter specifications, datasheet of DC-DC converter.	
5	**Single-phase voltage source inverter** Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage, SVPWM.	10
6	**Three-phase voltage source inverter** Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation, three phase bridge inverter – 180^0 and 120^0 conduction mode, AC voltage controller – On-Off control, Phase control, Matrix converter.	**8**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**20**	**20**	**10**	**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. M. H. Rashid, "*Power electronics: circuits, devices, and applications*", Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Course Outcomes: At the end of this course, students will be able to clarify

Sr. No.	CO statement	Marks % weightage
CO-1	To understand the differences between signal level and power level devices.	15

CO-2	To understand the construction of power converters.	25
CO-3	To analyse the operation of power converters.	30
CO-4	To understand the applications of power converters	30

List of Experiments: The following are suggested list of experiments.

1. Static and dynamic characteristic of SCR, MOSFET and IGBT
2. R, RC and UJT triggering of SCR
3. Analyse the performance of single phase full bridge thyristor rectifier for R and RL load.
4. Analyse the performance of three phase full bridge thyristor rectifier for R and RL load.
5. Duty ratio control for regulating the output voltage of DC-DC buck converter.
6. Duty ratio control for regulating the output voltage of DC-DC boost converter.
7. Duty ratio control for regulating the output voltage of DC-DC buck-boost converter.
8. Performance of 1-phase bridge inverter with R and R-L load
9. Harmonic spectrum of output voltage for unipolar and bipolar PWM controlled half-bridge and full bridge converter.
10. Performance of 3-phase bridge inverter operating with 120° and 180° conduction mode.
11. Simulation of SVPWM and its effectiveness over SPWM
12. SCR based 1-phase ac voltage controller

Major Equipment:

Experiment Kits, Multi-meter, AC/DC Sources, AC/DC Meters etc.

List of Open Source Software/learning website:

1. Simulation software like Scilab, MATLAB, PSIM along with necessary toolbox.

2. Courses available through NPTEL - website: https://nptel.ac.in/downloads/108105066/

9. http://ngspice.sourceforge.net/