



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140915
Semester – IV
Subject Name: Power Electronics

Type of course: Engineering – Professional Core Course

Prerequisite: Fundamental knowledge of Electrical Engineering and Analog Electronics.

Rationale: The power electronic devices and converters employing power electronics devices are now widely used in domestic applications as well as in industrial applications like Electrical Drives, Power Systems, Renewable Energy based power generation, heating applications etc. The course is aimed to provide exposure about the commonly used power electronic devices and the power electronic converters.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		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; Static characteristics of these devices; Operation of power devices as switches and switching losses, Single-quadrant switches, two-quadrant and bidirectional switches; Firing circuit for thyristors; Gate drive circuits for MOSFET and IGBT.	06
2	DC-DC converters - Switching Voltage Regulators Linear voltage regulator, Concept of switching voltage regulators and advantages, Operation and Principle of Basic DC-DC converter topologies like Buck, Boost and Buck-Boost converter, Various control techniques for output voltage control, Mathematical analysis for these converters for steady state, Concept of CCM and DCM and factors affecting them, Closed loop control for voltage regulation, Isolated converters: Forward converter and Flyback converter; Multi-quadrant operation of DC-DC converters; Applications	12
3	DC-AC converters – Inverters Classification of Inverters, Half-bridge and full-bridge 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, three-phase sinusoidal modulation, Three phase bridge inverter – 180° and 120° conduction mode, SPWM control, Third harmonic injection, SVPWM, Output voltage and frequency control, Harmonic spectrum, Harmonics and its effects, Applications	12
4	AC-DC Converters Concept of phase control using half-wave single phase ac-dc converter, Single phase and	11



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	three phase half wave and full wave, 1-phase and 3- phase half controlled and fully controlled converters, Analysis with R & RL load, Performance parameters for converters, Operation in continuous and dis-continuous mode, Reactive power considerations, Operation in conversion and inversion mode, Effect of source inductance, Power factor improvement techniques, Dual Converters, Applications	
5	AC Voltage Controller Triac characteristic and operating modes, Triac as Single-phase AC voltage controller, Principle of Phase Control, On-off Control, Mathematical analysis related to single-phase AC voltage controller, Three-phase AC voltage controller configurations: Operations, Waveforms, Analysis;	7
6	Miscellaneous Frequency Control: Introduction to cycloconverter and matrix converter; basic power circuit and their operating principle (2 Hrs) Datasheet interpretation, Ratings of the devices and Selection of switches (2 Hrs) Overvoltage, overcurrent and short-circuit protection; Electromagnetic interference and its remedies; Snubber circuit and its design (3 Hrs)	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	30	10	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, T. M. Undeland, W.M. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Edition, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. P.S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi, 2012..
5. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.



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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. To analyse the performance of single phase and three-phase full bridge thyristor rectifier for R and RL load.
4. Duty ratio control for regulating the output voltage of DC-DC Buck/Boost/Buck-Boost converter
5. Modeling and simulation of closed-loop control of DC-DC Buck/Boost/Buck-Boost converter.
6. To study the effect of inductance, switching frequency, duty cycle, load current on the output ripple voltage of a step-down chopper (using simulation platform like MATLAB/Simulink)
7. Performance of 1-phase bridge inverter with R and R-L load
8. Study of harmonic spectrum of output voltage for unipolar and bipolar PWM controlled half-bridge and full bridge converter.
9. Performance of 3-phase bridge inverter operating with 120° and 180° conduction mode.
10. Simulation of SVPWM and to study its effectiveness over SPWM
11. Output AC voltage control of SCR based 1-phase ac voltage controller using ON-OFF and phase-control principle
12. Output AC voltage control of SCR based 3-phase ac voltage controller using ON-OFF and phase-control principle
13. To study the performance of single-phase fully controlled and semi-controlled converter for R and R-L load
14. To study the performance of three-phase fully controlled and semi-controlled converter for R and R-L load

Major Equipment:

Power semiconductor devices, power electronic converter kits, CRO/DSO, choke coil, load bank, voltage and current probes, Simulation software like Scilab, MATLAB, PSIM etc. along with necessary toolbox.

List of Open Source Software/learning website:



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ocw.mit.edu/courses/electrical.../6-334-power-electronics-spring-2007
Courses available through NPTEL - website: <https://nptel.ac.in>