



# GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)

Subject Code: [2941103](#)

POWER ELECTRONICS

4<sup>th</sup> Semester

**Type of course:** Discipline Core course.

**Prerequisite:** Semiconductor physics, Analog electronics, Electronic devices and circuits, Electrical machines

**Rationale:** This course provides a strong foundation for understanding and designing of domestic and industrial power electronics circuits. Students can understand the conversion of power from AC to variable DC, Fixed DC to Variable DC, DC to variable AC and Fixed AC to variable AC using power electronics circuits. This subject also helps to understand the speed control of DC and AC drives and design of UPS and switching power supplies

**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)	
3	0	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs
1	<b>Characteristics of Semiconductor Power Devices:</b> Thyristor, power MOSFET and IGBT- Treatment should consist of structure, Characteristics, operation, ratings, protections and thermal considerations. Brief introduction to power devices viz. TRIAC, MOS controlled thyristor (MCT), Power Integrated Circuit (PIC) (Smart Power), Triggering/Driver, commutation and snubber circuits for thyristor, power MOSFETs and IGBTs (discrete and IC based). Concept of fast recovery and schottky diodes as freewheeling and feedback diode.	12
2	<b>Controlled Rectifiers:</b> Single phase: Study of semi and full bridge converters for R, RL, RLE and level loads. Analysis of load voltage and input current- Derivations of load form factor and ripple factor, Effect of source impedance, Input current Fourier series analysis of input current to derive input supply power factor, displacement factor and harmonic factor	10
3	<b>Choppers:</b> Principle of chopper operation, control strategies, Analysis of Step-Up, Step-down and Step-Up/Down chopper. Quadrant operations of Type A, Type B, Type C, Type D and type E choppers, Control techniques for choppers – TRC and CLC, Detailed analysis of Type A chopper. Step up chopper. Multiphase Choppers	10
4	<b>Single-phase inverters:</b> Principle of operation of full bridge square wave, quasi-square wave, PWM inverters and comparison of their performance. Driver circuits for above inverters and mathematical analysis of output (Fourier series) voltage and harmonic control at output of inverter (Fourier analysis of output voltage). Filters at the output of inverters, Single phase current source inverter	10



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5	Switching Power Supplies: Analysis of fly back, forward converters for SMPS, Resonant converters - need, concept of soft switching, switching trajectory and SOAR, Load resonant converter - series loaded half bridge DC-DC converter.	09
6	Applications: Power line disturbances, EMI/EMC, power conditioners. Block diagram and configuration of UPS, salient features of UPS, selection of battery and charger ratings, sizing of UPS. Separately excited DC motor drive. P M Stepper motor Drive.,DC Chopper drives,Speed control of Induction Motors .cooling and thermal	08

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
05	15	20	20	05	10

## Suggested Specification table with Marks (Theory):

**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 Book

1. Muhammad H. Rashid, "Power electronics" Prentice Hall of India.
2. Ned Mohan, Robbins, "Power electronics", edition III, John Wiley and sons.
3. Abraham I.Pressman, Keith Billings, Taylor Morey ,,"Switching Power Supply Design", edition III,McGraw Hill
4. M.D. Singh and K.B. Khanchandani , "Power Electronics", Tata McGraw Hill, New Delhi, Second Edition,2008.
5. P.C. Sen., " Modern Power Electronics", edition II, Chand& Co.
6. V.R.Moorthi, "Power Electronics", Oxford University Press.
7. Cyril W., Lander," Power Electronics", edition III, McGraw Hill.
8. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
9. George Chryssis "High Frequency Switching Power Supplies : Theory And Design ,McGraw Hill



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## Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the power semiconductor devices with terminologies , characteristics and ratings	
CO-2	Design and analyze SCR firing and commutation methods.	
CO-3	Build and test circuits using power devices such as SCR	
CO-4	Analyse ,design and comprehend the operation of controlled rectifiers for possible configurations with different loads	
CO-5	Analyze the operation and performance characteristics of choppers and DC to AC inverters, switching power supplies for different topologies	
CO-6	To realize drive and control circuits for power converters used for the control of DC and AC drives	
CO-7	Evaluate the operation and applications such as power conditioners,UPS,battery chargers ,drives	

## List of Experiments:

1. To study & plot characteristics of SCR, DIAC and TRIAC
2. To study & plot of characteristics of IGBT.
3. To study the various forces commutation methods of SCRs.
4. Resistance and RC triggered circuits of SCRs.
5. UJT as a relaxation oscillator and SCR firing circuits using UJT.
6. To study & observe the waveform of single phase half and semi converter with resistive and reactive load.
7. To study & observe the waveform of single phase full converter with resistive and reactive load
8. To study and observer the waveforms of series and parallel inverters.
9. To study and observe the waveforms of single phase cycloconverter.
10. To study the step up and step down choppers.
11. To study the speed control of AC and DC drives.
12. To study and measurement of various parameters of UPS.
13. Design of Different switching Power supplies
14. To analyse the characteristics and performance of power devices ,converters and inverters

## Major Equipment:

Electronic work bench, AC & DC regulated Power Supplies, Earthed and Un Earthed Oscilloscopes, Power Electronics Trainer Kits, Digital multi meters, Clip on meters , Regular and 1:10 CRO probs.

## List of Open Source Software/learning website:

### Open Source Software:

- Fritzing (<http://fritzing.org/home/>)
- TINA-TI for circuit simulation (<http://www.ti.com/tool/tina-ti>)



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- OSCAD for CAD application (<http://www.oscad.in/downloads>)
- Multisim for circuit simulation (<http://www.ni.com/multisim>)
- <http://sourceforge.net/projects/ktechlab/>
- <http://www.cburch.com/logisim>

## Learning website:

- <http://www.datasheetcatalog.com>
- <http://nptel.iitm.ac.in/courses.php>
- <http://ocw.mit.edu>
- <http://www.smpstech.com>
- <http://www.ni.com/white-paper/14676/en/>
- [http://www.irf.com/product/\\_/N~1nje1m](http://www.irf.com/product/_/N~1nje1m)
- [http://www.allaboutcircuits.com/vol\\_3/chpt\\_3/4.html](http://www.allaboutcircuits.com/vol_3/chpt_3/4.html)
- <http://www.deltapowersolutions.com/en/tps/rectifiers.php>
- <http://www.electrical-engineering-portal.com>

To realize drive and control circuits for power converters, • To develop power converters used for the control of DC and AC • To conceptualise and analyse the issues related to recent converter operation