GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Electrical Engineering / Renewable Energy

Subject Code: DI05000171

Subject Name: Power Electronics Converters

w. e. f. Academic Year:	2026-27
Semester:	5th
Category of the Course:	PCC

Prerequisite:	Basic knowledge of electrical circuits, electronic devices (diodes, transistors), and fundamentals of AC/DC systems.
Rationale:	Power Electronics Converters is a core subject that deals with efficient conversion and control of electrical power using semiconductor devices. It provides knowledge of various converters such as rectifiers, choppers, and inverters, which are widely used in industrial and domestic applications. The subject helps students understand switching techniques, control methods, and performance parameters of power electronic systems. It also introduces modern devices like MOSFETs, IGBTs, and wide band gap materials used in high-efficiency applications. The concepts learned are essential for applications such as motor drives, renewable energy systems, UPS, SMPS, and electric vehicle chargers. This subject builds a strong foundation for design, analysis, and troubleshooting of power electronic circuits. It also enhances practical and industry-oriented skills required for electrical engineering professionals.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Understand and explain the operation, characteristics, and selection of power semiconductor devices.	R
02	Analyze the working and performance of single-phase and three-phase line-commutated converters.	U
03	Apply steady-state principles to design and evaluate DC-DC converters.	A
04	Explain the operation and control of single-phase and three-phase inverters.	U
05	Demonstrate knowledge of practical power electronics applications.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	30	20	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Power Semiconductor Devices & Driver circuits** Contents: ➢ Structure, working and static characteristics of MOSFET, IGBT, SCR, Concept of wide band gap (WBG) semiconductor materials: GaN, SiC. ➢ Realization of ideal and practical power electronics switches ➢ Protection of power semiconductor devices (Over voltage, short circuit current, dv/dt, di/dt etc.), cooling & heatsink for power semiconductor devices, Design of Snubber circuit ➢ Commutation of SCR ➢ Gate & Base Driver circuits: requirements and preliminary design considerations, Driver circuit with transformer isolation and opto isolation with examples. ➢ Function of freewheel diode. ➢ Ratings and interpretation of datasheet of power semiconductor devices ➢ Basics of Harmonics & its effects on performance	12	27%
2.	**Line Commutated Converters** Contents: ➢ Single phase half wave& full wave bridge rectifier with R, RL and RLE load ➢ Working Principle and Analysis of Three phase half wave and full wave uncontrolled rectifierwith RLoad. ➢ Single phase full wavecontrolled rectifier with R & RL load	10	22 %

	and its examples ➢ Principle of AC voltage controller: Integral cycle control and Phase control ➢ Single phase Integral control and Phase control AC Voltage controller with R load.		
3.	**DC – DCSwitched Mode Converters** Contents: ➢ Chopper: Block schematic, SPDT representation & realization using semiconductor switches ➢ DC steady state principles: volt-sec balance, amp-sec balance ➢ Design of Buck, Boost and Buck-Boost converters: Topology, Working, modes of operation, Derivation of L and C and its examples ➢ Selection of Power switches: Device selection, Electrical stress rating, Thermal stress rating ➢ Isolated DC – DC converters: Forward converter, Flyback converter	08	18 %
4.	**INVERTERS** Contents: ➢ Basic working principle of Inverter ➢ Terminology: HF, THD, DF, LOH etc. ➢ Working & Design of single-phasehalf bridge and full bridge voltage source inverters with R & RL load with examples ➢ Voltage control in single phase inverters: single pulse, multiple pulse and Sinusoidal PWM control ➢ Unipolar and Bipolar PWM switching techniques on single phase full bridge inverters ➢ Construction and working of three phase inverters: 120˚ mode and 180˚ mode.	10	22 %
5.	**Power Electronics Applications** Contents: ➢ Soft starter of three phase induction motors ➢ Variable voltage Variable frequency control of three phase I.M. ➢ Electronics fan regulator, Induction heaters, UPS, SMPS ➢ Simple battery charger & automatic battery charger ➢ EV car charger	05	11 %

	➢ Active power factor correction (APFC) using TSC		
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25 %	**35 %**	**40 %**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. **Power Electronics** – Dr. P.S. Bimbhra, Edition: Fifth Edition (2012), ISBN: 978-8131724668, Publisher: Khanna Publishers
2. **Power Electronics: Essentials & Applications** – L. Umanand, Edition: First Edition (2009), ISBN: 978-8126521837, Publisher: Wiley India
3. **Power Electronics: Converters, Applications and Design** – Ned Mohan, Tore M. Undeland, William P. Robbins, Edition: Third Edition (2003), ISBN: 978-0471226932, Publisher: Wiley
4. **Power Electronics: Circuits, Devices and Applications** – Muhammad H. Rashid, Edition: Third Edition (2004), ISBN: 978-0131011403, Publisher: Pearson Education
5. **Power Electronics Handbook** – Issa Batarseh, Ahmad Harb, Edition: Second Edition (2018), ISBN: 978-0128114070, Publisher: Academic Press
6. **Fundamentals of Power Electronics** – Robert W. Erickson, Dragan Maksimovic, Edition: Second Edition (2001), ISBN: 978-0792372707, Publisher: Springer

(b) Open-source software and website:

- https://nptel.ac.in/courses/108108036
- https://nptel.ac.in/courses/108101126
- https://www.allaboutcircuits.com/video-lectures/
- https://www.ieee-pels.org/
- https://www.coursera.org/learn/power-electronics
- https://vilab.co.in/

Suggested Course Practical List:

Sr. No.	Practical Outcome/Title of Experiment	CO1	CO2	CO3	CO4	CO5
1	Build circuit on breadboard / PCB & test gate drive circuit MOSFET / IGBT (Any one method)	√				
2	To Perform different triggering circuit of SCR (R, RC and UJT) and observe waveform on DSO	√				
3	To perform and plot static characteristics of SCR / MOSFET / IGBT.	√				
4	Wire the three-phase half wave & full wave uncontrolled rectifier & test the performance		√			
4	Simulate three phase half wave and full wave uncontrolled rectifier.		√			
5	Simulate single phase-controlled rectifier with RL load and freewheel diode at different firing angle.		√			
6	To perform single phase-controlled rectifier with RL load and freewheel diode at different firing angle.		√			
7	To perform single phase AC voltage controller using SCR / Triac with R and RL load		√			
8	Build circuit on breadboard / PCB & test performance of Buck converter on DSO.			√		
9	Build circuit on breadboard / PCB & test performance of Boost converter on DSO.			√		
10	Build circuit on breadboard / PCB & test performance of Buck - Boost converter on DSO.			√		
11	Build circuit on breadboard / PCB & test performance of single-phase inverter circuit.				√	
12	Perform / Simulate single phase half and full bridge inverter circuit.				√	
13	Simulate single pulse, multiple pulse & Sinusoidal PWM voltage control of single-phase inverter.				√	
14	Perform / Simulate three phase inverter operation of mode 120 degree and 180 degree.				√	
15	To Perform DC Motor speed control using Chopper circuit.					√
16	To Perform speed control of three phase induction motor by V/F control method.					√

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications
1	Buck, Boost and Buck-Boost DC-DC Converter practical trainer kit.
2	Single-phase half bridge and full bridge inverter trainer kit with R and RL load, capable of generating square wave, quasi-square wave, and multi-pulse waveforms.
3	Single-phase controlled rectifier trainer kit with firing angle variation facility.
4	Power semiconductor device characteristic kits for MOSFET, IGBT, and SCR.
5	Three-phase inverter trainer kit with 120° and 180° conduction modes.
6	Single-phase AC voltage controller trainer kit.
7	Various types of SCR triggering circuit kits (R, RC, UJT, and pulse triggering methods).

Suggested Project List:

1. Design and development of isolated MOSFET gate driver circuit using opto-coupler.
2. Design and fabrication of gate driver circuit using pulse transformer isolation.
3. PCB design and implementation of single-phase bridge rectifier with filter circuit.
4. Design and implementation of DC-DC Buck converter for voltage regulation.
5. Design and implementation of Boost converter for step-up voltage application.
6. Single-phase inverter using MOSFET/IGBT for AC load.
7. Design of simple UPS system for low power applications.
8. EV battery charger (basic model) using controlled rectifier.

Suggested Activities for Students:

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course. Students should perform following activities in group (or individual) and prepare reports of about 5 pages for each activity. They should also collect/record physical evidence for their (student's) portfolio which may be useful for their placement interviews:

1. Prepare charts/models of different power semiconductor devices and their characteristics.

2. Collect and study datasheets of MOSFET, IGBT, and SCR and present key parameters.
3. Perform simulation of rectifier, chopper, and inverter circuits using LTspice/Scilab.
4. Identify power electronics applications used in home appliances and industry.
5. Visit nearby industry or workshop to observe power electronic equipment (drives, UPS, chargers).
6. Prepare presentation on protection techniques and cooling methods of power devices.
7. Study and compare different PWM techniques used in inverters.

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