GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Electrical Engineering and Allied Branches)
Subject Code: BE05000541
Subject Name: Fundamentals of Power Electronics

w.e.f.Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC

Prerequisite:	Basic knowledge of Electrical and Electronics Engineering
Rationale:	The syllabus of Fundamentals of Power Electronics introduces non- circuit branch students to the basic concepts and role of Power Electronics in the present industrial scenario. Power Electronics enables efficient conversion, control, and conditioning of electric power using semiconductor devices. It underpins renewable energy systems, electric vehicles, consumer electronics, power supplies, robotics, automation, and smart grids. For non–power-electronics engineering students, this course builds the essential conceptual foundation required to understand how power converters function and are applied in real-world systems, strengthening interdisciplinary skills for modern technology and automated manufacturing processes.

Course Outcomes:

Sr.No.	CO statement	Marks% weightage
CO-1	Explain the fundamental concepts, scope, applications, and classifications of power electronics systems.	15
CO-2	Describe characteristics, construction, and working principles of power semiconductor devices and passive components.	15
CO-3	Analyze the operation of rectifier circuits with different loads and switching devices.	20
CO-4	Illustrate the working principles, types, and applications of inverter circuits.	20
CO-5	Explain the topology, operation, and applications of DC–DC and AC–AC converters.	30

Teaching and ExaminationScheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL *	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	0	0	15	60	2	70	30	00	30	0	130

**** Problem-Based Learning (PBL) aims to accommodate learning beyond the syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End Semester Examination, PA = Progressive Assessment.

Content:

Sr.No.	Content	Total Hrs
1	**Introduction to Power Electronics & Power Semiconductor Devices:** Basics of Power Electronics, Power Electronics Systems, applications, control vs power circuits.Device classification: Diodes, SCR, TRIAC, DIAC, BJT, MOSFET, IGBT, Device structure & operation (conceptual)- Ratings, switching frequency, thermal considerations.	8
2	**Other Components in Power Electronics**: Passive components: Resistors: types, ratings, roles, Inductors: types, filtering, energy storage, Capacitors: ESR, ripple, filtering, snubbers, Transformers: isolation, pulse transformers. Protective components like MOV, Fuse, Thermistor, etc., their construction, working and applications.	5
3	**Power Rectifiers** Diode rectifiers: half/full wave, bridge., Controlled rectifiers: half / fully controlled, firing angle, Effect of R, RL loads, Applications of Power Rectifiers like power supplies, battery charging etc.	8
4	**Inverters** Need for DC–AC conversion, inverter types, VSI and CSI: square wave inverter, Introductory PWM, 3-phase inverter basics, Applications of inverters like UPS, EV drives, solar inverters, industrial motor drives etc.	8
5	**DC–DC Converters:** DC Power supply basics, Linear power supply, Concept of switching power supply, Duty cycle and switching principles, Buck, Boost, Buck–Boost converters, Flyback and Forward converter basics, isolated and non-isolated power supply, Applications: SMPS, EV subsystems, battery chargers, industrial power supply etc.	10
6	**AC–AC Converters** Need for AC voltage/frequency control, AC voltage controllers, phase control, Cycloconverters, Applications: light dimmers, fan regulators, soft starters.	6
	TOTAL	45

Suggested Specification table withMarks(Theory):(ForB.E.only)

Distribution of Theory Marks					
RLevel	ULevel	ALevel	NLevel	ELevel	CLevel
30	**25**	**20**	**15**	**10**	**==**

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.Theactual distribution of marks in the question paper may vary slightly from the above table.

The Fundamentals of Power Electronics syllabus has a direct alignment with SDGs 7 (Affordable and Clean Energy), 9 (Industry, Innovation and Infrastructure), and 13 (Climate Action), and contributes indirectly to SDGs 8, 11, and 12.

SDG 7	Affordable and Clean Energy— Direct Alignment Topics like inverters, DC–DC converters, and rectifiers enable efficient energy conversion in solar systems, EV drives, and battery charging, making clean energy usable and cost-effective.
SDG 8	Decent Work and Economic Growth — Indirect Alignment Use of **power electronics in industrial drives, EV systems, and power supplies** enhances productivity and supports growth in emerging energy and electronics sectors.
SDG 9	Industry, Innovation, and Infrastructure — Direct Alignment Study of power semiconductor devices (IGBT, MOSFET, SCR) and converters (AC–AC, DC–DC) supports industrial automation, motor drives, and modern electrical infrastructure development.
SDG 11	Sustainable Cities and Communities — Indirect Alignment Applications of inverters (UPS), AC voltage controllers, and DC–DC converters improve energy
SDG 12	Responsible Consumption and Production — Indirect Alignment Concepts like device ratings, thermal management, and passive/protective components promote efficient design, reduced energy waste, and longer equipment lifespan.
SDG 13	Climate Action — Direct Alignment Efficient operation of switching devices and converters reduces energy losses and supports renewable energy integration and EV systems, directly lowering carbon emissions.

ReferenceBooks:

1. Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education, New Delhi
2. Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics: Converters, Applications and Design, John Wiley & Sons, Inc., New York
3. L Umanand, Power Electronics, Essentials & Applications, Wiley India
4. B. K. Bose, *Power Electronics and Motor Drives: Advances and Trends*, Academic Press (an imprint of Elsevier), Waltham, MA.
5. P. S. Bhimra, "*Power Electronics*", Khanna Publishers
6. Research Papers on IEEE/IET/Science Direct etc

List of Experiments: NA
Major Equipment: NA
List of Open-SourceSoftware:

1. Scilab (https://www.scilab.org/) – An open-source alternative to MATLAB
2. PSIM (Free Version) / OpenModelica (https://openmodelica.org/) – For modelling and simulating power electronics circuits

List of learning websites:

1. MIT OpenCourseWare (https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/)
2. CircuitLab (Free with limited access) (https://www.circuitlab.com/) – Web-based circuit

simulator

3. Virtual Labs by IITs (Government of India Initiative) (https://vlab.co.in/) – Simulations and experiments related to Power electronics.
4. Reputed Research Journal Website

Listofsuggested activities for Problem-based Learning (PBL):

Sr. No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Industry/Research laboratory Visit (Power converters/electronics/drives company)	Visit = 5hrs, Report preparation = 5hrs Total = 10hrs	Based on the report submitted. The report should contain observations and calculations based on industry/ lab data.
2	Video-Based Learning	Technical Video-based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5hrs Report preparation = 5hrs Total = 10hrs	Report /presentation based on the video learning outcomes.
		Self-learning online course	Minimum duration of the course should be 10 hours.	Examination-based assessment at the end of the course. Based on the certificate produced.
		Annotated Video Explanation of Concept/Problem	10hrs (Preparation + Recording + Submission)	Based on the accuracy of explanation, clarity, and presentation style.
3	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical-based assignment is preferable.	5 assignments of 2 hours each. Total = 10hrs	Based on the assignment submitted.
		Blog or Technical Article Writing	10hrs (Research – 6hrs, Writing – 4hrs)	Based on originality, technical content, references cited, and clarity of communication.
4	Complex Problem-Solvingtargeting relevant SDGs.	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total = 15 hrs	Based on the depth of the solution submitted.
5	Research Paper Review / Analysis	Discussion on a research paper based on a relevant subject (SCOPUS Index/any reputed Journal)	5 research paper = 20 hrs	Summarize research paper and the evaluation of critical parameters
6	Poster/ Chart/PowerPoint presentation	Poster/chart/PowerPoint preparation on technical topics	Duration = 6 hrs	Based on poster/chart preparation and presentation skills
7	MicroProject	Working/non-working model on technical topics	Working = 10hrsnon-working = 10hrs	Based on inter-department/external evaluation
8	Group Discussion /	Group Discussion on emerging/trending	Duration = 1 hrs each	Based on performance in group discussion, technical

Sr. No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
	Quiz / Simulation	technical topics based on the subject		depth,knowledge etc.
		Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10 hours	Based on quiz scores and the reflection report after each quiz.
9	Case Study Analysis / Seminar	Real-world case studies-based learning	Duration of data collection/study = 5hrs Report preparation = 5hrs Total = 10hrs	Based on an in-depth study, technical depth, data collected, fact-finding, etc.
10	Other	Patent Search and Innovation Gap Identification	10hrs (Search + Report)	Based on the number of relevant patents analyzed and the identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Fundamentals of Power Electronics** incorporates various activities as integralProblem-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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