GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering
Level: PG
Branch: Power Electronics
Course / Subject Code: ME01000221
Subject Name: Power Electronics Devices, Circuits and Components

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PCC

Prerequisite:	-NA-
Rationale:	Power Electronics is a rapidly growing field within electrical engineering as the enabling technology for most of the industry. New materials and technology have been introduced in electronics which has boosted new devices, and structures of devices used in Power Electronics. This is the core subject which serves to introduce new development in the power electronics device technology.

Course Outcome:

After Completion of the Course, the student will be able to:

No	Course Outcomes
01	Illustrate the construction, working, characteristics of Passive devices, Active devices and Converter topologies used in Power Electronics, along with material used for the power switch
02	Apply appropriate measuring equipment and required accessories for Power Electronics application for measurement purpose in Power Electronics.
03	Apply Printed Circuit Board (PCB) design rules for designing a simple PCB for Power Electronics circuits with appropriate grounding techniques in PCB layout.
04	Decide cooling method for thermal management in Power Electronic circuits and applications.

Teaching and Examination Scheme:

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

Course Content:

Unit No.	Content	No. of	% of Weightag
1.	**Passive Devices:** Passive devices R, L, C etc. used for power electronics circuits, their classification, types, construction, characteristics, material used for these devices etc., Operation of passive devices at high temperature and effect of temperature, High energy density capacitors, super capacitor, Magnetic materials for high and low frequency operation, their characteristics, Ferrite and powdered cores, Power inductors.	06	15

2.	**Batteries:** Battery technology and advancements, Different advanced batteries used like Li-ion, Li-Polymer, Fuel Cell, etc. Characteristics of battery, charging and discharging, battery life, protections required etc.	05	10
3.	**Review of Active Power Electronics Devices and Power Electronic Circuits:** Review of Various Power Semiconductor Devices like Power Diode, Power BJT, Thyristor (SCR), MOSFET, IGBT etc., Principle of operation, Static and Dynamic switching characteristics, A general comparison of Power Semiconductor Devices, Driver Circuits, Device	06	15
4.	Converter Topologies: Power Electronic Converter types (AC-DC, DC-DC, AC-AC, DC-AC), various AC-DC controlled converter topologies, DC-DC converters, AC-AC converters, Various inverter topologies like half bridge, full bridge, basics of	06	15
5.	**Advanced materials used for Active Devices:** Advanced semiconductor materials for power electronics devices, WBG materials for power semiconductor devices like SiC, GaN etc., their characteristics, properties, various types of power semiconductor switch available, their driver	04	10
6.	**Measurement:** Various equipment used for measurement of electrical quantities in high power, high frequency operation of power electronics circuits, types of probes and oscilloscopes used: passive and active probes, isolated and non-isolated probes and scopes, their calibration	04	10
7.	**Ground Technique and PCB Design:** Different types of grounds in a circuit, care to be taken while selection of equipment for measurement of signals with different grounds, Issue of HF noise in signal measurement at high power high frequency operation and its minimization techniques like shielding, Galvanic isolation etc., PCB design, importance of PCB design on product performance and noise, PCB design for digital circuits, PCB design for mixed signal circuits, PCB design for power electronics etc.	06	10
8.	**Thermal Management:** Importance of cooling in power electronics applications, cooling requirements in power electronic systems, Heat sinks and thermal management, forced cooling using cooling fan, Static and transient thermal model, Thermal design for Power Switching device.	05	10
9.	**Latest trends in devices and materials used in power electronics products:** MOS Turn off Thyristor (MTO), Emitter Turn off Thyristor (ETO), Integrated Gate-Commutated Thyristor (IGCT), MOS-controlled Thyristor (MCT), Static Induction Thyristor.	03	5
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
40	20	20	15	05	0

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:

Sr. No	Title of Book
1	B.J. Baliga, "Power Semiconductor Devices", First Edition, Pws Pub Co, 1995.
2	B.J. Baliga, "Fundamentals of Power Semiconductor Devices", First Edition, Springer, 2008
3	Ian Sinclair, "Passive Components for Circuit Design", Newnes, 2001
4	B.W. Williams, "Power Electronics: Devices, Drivers, Applications and Passive Components", McGraw Hill Higher Education; 2nd edition, 1992.
5	Muhammad H. Rashid, "Power Electronics: Devices, Circuits, and Applications", Pearson Education, 4th edition, 2017.

(b) Open-source software and website:

1. https://nptel.ac.in/
2. https://www.mathworks.com/
3. https://powersimtech.com
4. 5https://www.scilab.org/
5. https://www.murata.com
6. https://www.mag-inc.com
7. https://en.tdk.eu

Suggested Course Practical List:

Sr.No.	Experiment
1	Passive devices (Resistive, Capacitive Elements) and their construction along with characteristics.
2	Magnetic material used for Inductor and its characteristics.
3	Li-ion battery.
4	Advanced materials for power electronics devices and their characteristics
5	Basic and advanced power devices (Power BJT, Power MOSFET, Power FET, IGBT, SCR, TRIAC etc.) and their characteristics, switching, driver requirements etc. (Any one device for each student)
6	AC-DC Controlled Converters.
7	Grounding techniques
8	Measurement of high voltage, high current and other parameters in Power Electronics Experimentation.
9	Heatsink design

Above is a suggested list of experiments. The experiments can be decided and set according to the syllabus as per the guidance of the concerned laboratory faculty.

List of Laboratory/Learning Resources Required:

PC with necessary open source or licensed simulation software

Suggested Activities for Students: If any

Each student can be given 1-2 case studies for different topics given in syllabus, prepare a report, presentation and give presentation. (As per suggestion of concerned Faculty)

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