GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Subject Code: ME02000821
Subject Name: Advanced Power Converters

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Power Electronics at UG level
Rationale:	The power electronic devices and some conventional converters based on the principle of power electronics converters are now widely used in domestic applications as well as in industrial applications like Electrical Drives, Power Systems, Renewable Energy based power generation etc. The course is aimed to provide detailed knowledge of some advanced power electronic converters.

Course Outcomes:

On the completion of the course, the student will be able

Sr. No.	Course Outcome	Weightage
CO-1	Acquire the knowledge of advanced power electronics devices	10
CO-2	Analyse the switched mode rectifiers.	10
CO-3	Design and evaluate the performance of various inverter topologies.	50
CO-4	Design the performance of gate drive circuits	20
CO-5	Understand the different types of multipulse converter	10

Teaching and Examination Scheme

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE Viva (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Sr.No	Course content	Hrs	% weightage
1	**Modern Power Semiconductor Devices**: Modern power semiconductor devices: Symbol, Structure and equivalent circuit of Insulated Gate Bipolar Transistor (IGBT), MOSFET, Integrated Gate-Commutated Thyristor (IGCTs), Introduction to Wide Bandgap Devices (SiC, GaN) addressing high voltage, high current application (HVDC, MVDC), Comparison of their features.	4	10
2	**Switched Mode Rectifier** - Operation of Single/Three Phase bilateral Bridges in Rectifier Mode . Control Principles. Control of the DC Side Voltage. Voltage Control Loop. The inner Current Control Loop. Single phase boost type APFC and control	5	10
3	**Pulse Width Modulated Inverters**: Principle and operation of Single phase and three phase inverter, Evaluation of output voltage and current with load, Voltage control of inverters, Single PWM, Multiple PWM, Sinusoidal PWM, Modified PWM, Advanced modulation techniques for improved performance, Harmonic injection and Delta modulation, Advantages, Applications & Problems.	10	25
4	**Multilevel Inverters:** Multilevel concept, Classification of multilevel inverters, Principle of operation, main features and comparison of Diode clamped, Improved diode Clamped, Flying capacitors, Cascaded multilevel inverters, Multilevel inverter applications, DC link capacitor voltage balancing, Introduction and operation of Modular Multilevel Inverter (MMC).	10	25

5	**Gate and Base drive circuits:** Preliminary design considerations; DC coupled drive circuits with unipolar and bipolar outputs; Importance of isolation in driver circuits; Electrically isolated drive circuits; Some commonly available driver chips (based on boot-strap capacitor); Cascade connected drive circuits; IGBT and Thyristor gate drive circuits; Protection in driver circuits	10	20
6	**Multipulse Converters**: Concept of multi-pulse, Configurations for m-pulse (m=12,18,24 ….) converters, Different phase shifting transformer (Y-Δ1, Y-Δ2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Applications	6	10
	TOTAL	**45**	**100**

Lab Experiment

1. To study the static/dynamic characteristics of power electronics device
2. Design of gate/base driver circuits for power electronic converter
3. To evaluate the performance of unipolar and bipolar pulse width modulation technique
4. To simulate the Carrier based Sine PWM control of a CHB multilevel inverter and study of harmonic spectrum.
5. To study Single phase boost type APFC and control technique.
6. To simulate the 12 pulse converter and analyse the performance of output voltage and current.
7. To study and simulate the hysteresis current control of single phase and three phase inverter.
8. To study the various protection circuit of driver circuits used in converters.
9. To design and perform three phase multi-carrier based PWM inverter.
10. To perform the harmonic analysis of three phase NPC MLI.
11. To design and perform the isolated gate drive circuit for single phase Inverter.
12. To perform the harmonic analysis of three phase CHB MLI.

Reference Books:

1. Mohan, Undeland and Robbins, “Power Electronics – Converters, Applications and Design”, John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, “Power Electronics - Circuits, Devices and Applications”, Prentice Hall of India, 3rd ed., 2003.
3. P.C.Sen, “Modern Power Electronics ”, S. Chand and Co. Ltd., New Delhi, 2012.

4. L. Umanand and S. Bhat, “Design of Magnetic Components for Switched Mode Power Converters”, New Age International Ltd., New Delhi, 2001.
5. G.K. Dubey, S.R. Doradla, A. Joshi, and R.M.K. Sinha, “Thyristorised Power Controllers”, New Age International Ltd. Publishers, 1986 (Reprint 2008).
6. R.W. Erickson, D. Maksimovic, “Fundamentals of Power Electronics”, Kluwer Academic Publisher, 2nd ed., 2001.
7. P.T. Krein, “Elements of Power Electronics”, Oxford University Press, 1998.
8. B. Jayant Baliga, “Fundamentals of Power Semiconductor Devices”, Thomson, 2008.
9. Joseph Vithayathil , “Principles of Power Electronics”, Tata Mc-Graw Hill, 2010.
   William Shepherd, Li Zhang, “Power Converter Circuits”, Marcell Dekker, New York, 2005.

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