GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Subject Code: ME02000621
Course / Subject Name: Advanced Power Converters

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

Prerequisite:	Power Electronic and power converter concepts.
Rationale:	The course on "Advanced Power Converters" is pivotal in modern applications where electrical energy is consumed. It ensures efficient and reliable electrical energy conversion across various applications. This course aims to equip students with in-depth knowledge of advanced power converters, enabling them to address the complex challenges in contemporary power electronics.

Course Outcome:

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

No	Course Outcomes
01	Understand working principles of different types of power electronic converters.
02	Analyze different types of power electronic converters.
03	Design the different types of power electronic converters.
04	Classify various types of power electronic converters.

Teaching and Examination Scheme:

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

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Resonant Converters: Introduction**, zero voltage and zero current switching, Classification of resonant converters, basic resonant circuit concepts, load resonant converters, Class E converter, resonant switch converters, zero voltage switching-clamped voltage topologies, resonant dc link inverters with zero voltage switching, high-frequency-link integral-half-cycle converters, Applications	06	15
2.	**Multi-pulse converters:** Concept of multi-pulse converter, Multi-pulse Diode and SCR Rectifiers, Need for Phase Shifting Transformer, Phase shifts with Y-Z and Δ-Z transformer configurations, Delta-Polygon and Fork type configurations, Definition of THD and PF, 6 pulse; 12 pulse; 18 pulse; 24 pulse etc. diode and SCR rectifiers, series-type and separate-type rectifiers, Analysis to determine phase shift and current waveforms, Harmonic Current Cancellation, Applications of multi-pulse converters, Harmonic current cancellation, Applications.	09	20
3.	**Multi-level converters:** Review of Two-level VSI, Concept of multi-level Inverter, Need for multi-level inverters, unipolar and bipolar	12	25

	switching, Cascaded H-Bridge Multi-level Inverter, Operation with equal and unequal DC sources, Carrier based PWM Control Strategy, Diode Clamped multi-level inverter configurations, Flying Capacitor Multi-level Inverter, Space Vector Modulation (for 3-leveland higher level), Even Order Harmonic Elimination, Effect on Neutral Point Voltage, Regulation of Neutral Point Voltage, Carrier Based PWM Schemes: Phase-Shifted and Level-Shifted Multicarrier Modulation, Staircase Modulation, Features and relative comparison of these configurations, Applications.		
4.	**Matrix converters:** Principle of matrix converter technology, Conventional Matrix Converter, Bi-directional switch topologies, Modulation techniques for matrix converters, Venturini Method and SVM Method, Performance and control of matrix converters, Commutation and protection issues, Concept of Direct AC-AC frequency Converter and Indirect AC-AC frequency conversion without DC link energy storage, Applications.	09	20
5.	**Switched Capacitor Converters (SCC):** Introduction Unidirectional power flow Switched capacitor converter: basic step-up switched capacitor converter, basic step-down switched capacitor converter, basic Inverting switched capacitor converter, N-Stage Step Up Converter – N-Stage Step Down Converter, Bi-Directional Power Flow SCC: basic B-directional converter cell, step-up and step-down operation, Switched Capacitor Luo Converter – Losses on Switched Capacitor Power Converter, advantages and disadvantages of SCC, Applications.	09	20
	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**
30	**20**	**20**	**20**	**10**	**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:

1. Rashid M.H., "Power Electronics-Circuits, Devices and Applications", Prentice Hall India, New Delhi, 2017.
2. Ned Mohan, Tore M. Undeland, "Power Electronics – Converters, Applications and Design", John Wiley & Sons, 2008.
3. L. Umanand and S. R. Bhat, "Design of Magnetic Components for Switched Mode Power Converters", New Age
4. Joseph Vithayathil, "Power Electronics – Principles and Applications", Tata McGraw-Hill edition, 2010.
5. Bin Wu, Mehdi Narimani, "High-Power Converters and AC Drives", John Wiley & Sons, 2017.

6. William Shepherd and Li Zhang, "Power Converter Circuits", Marcel Dekker Inc, New York, 2004.
7. W. G. Hurley and W. H. Wolfle, "Transformers and Inductors For Power Electronics Theory, Design And Applications", Wiley
8. Issa Batarseh and Ahmad Harb, Power Electronics Circuit Analysis and Design 2nd Ed., Springer
9. Marian K. Kazimierz, "Pulse-width Modulated DC–DC Power Converters", Wiley
10. P.R. K. Chetty, "Switch Mode Power Supply Design", BPB Publication

(b) Open-source software and website:

1. https://nptel.ac.in/

Suggested Course Practical List:

The following list is for suggestions only. The subject teacher can modify the list according to availability of resources.

1. Analysis, design and simulation of controlled rectifier
2. Analysis, design and simulation of DC-DC converter
3. Analysis, design and simulation of DC-AC Inverter
4. Analysis, design and simulation of AC voltage controllers.
5. A hardware project of analysis, design, simulation and implementation of any power converter.

List of Laboratory/Learning Resources Required:

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