GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Electrical Engineering)
Subject Code: 3720731
Semester – II
Subject Name: High Power Converters

Type of course: Program Elective

Prerequisite: Power Electronics Converters and Applications (3710713)

Rationale: The course is aimed to provide detailed knowledge of some high power converters that are not covered in the basic courses of power electronics at undergraduate or postgraduate level.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	Multi-pulse converters Concept of multi-pulse, Multi-pulse diode rectifier, Multi-pulse SCR converters (rectifiers) Need for Phase Shifting Transformer, Phase shifts with Y-Z and Δ-Z transformer configurations, Delta-Polygon and Fork type configurations, Analysis to determine phase shift and current waveforms, Harmonic Current Cancellation, Applications of multi-pulse converters	9
2	Multi-level Voltage Source Inverters Review of Two-level VSI, Concept of multi-level, Need for multi-level inverters Cascaded Multi-level Inverter, Operation with equal and unequal DC sources, Carrier based PWM Control Strategy Diode Clamped multi-level inverter configurations, Space Vector Modulation (for 3-level and higher level), Even Order Harmonic Elimination, Effect on Neutral Point Voltage, Regulation of Neutral Point Voltage, Carrier Based Control Schemes; Other Multilevel Inverter Configurations like Flying Capacitor, NPC-Hybrid etc. Features and relative comparison of these configurations, Applications	11
3	PWM Current Source Inverters PWM current source inverter configuration, Trapezoidal modulation, Selective harmonic elimination, Space vector modulation Parallel connection of CSI for high power rating, Control of parallel connected CSI	6
4	Matrix converters Fundamentals of matrix converter technology, Conventional Matrix Converter, Bi-directional switch topologies, Modulation techniques for matrix converters, Performance and control of matrix converters, Commutation and protection issues, Concept of Direct	6

	AC-AC frequency Converter and Indirect AC-AC frequency conversion without DC link energy storage	
5	Back to Back Converters Single-phase full-bridge converter based configuration; PWM strategy and control approach; Power analysis, capacitor voltage and capacitor bank design; Topologies with component count reduction, Series and Parallel connection of the converters for higher power applications, Control scheme, Application as uninterruptible power supply (UPS) Three-phase full-bridge converter based configuration, PWM strategy and control approach; Topologies with component count reduction, Series and Parallel connection of the converters for higher power applications, Control scheme	**7**
6	Design aspects of converters, protection of devices and circuits Selection of switches, Interpreting datasheets, Design of gating/driver circuit, over-current and over-voltage protection, issues related to failure like open circuit or short-circuit of the switches, etc.	**3**

Reference Books:

1. Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2006.
2. Derek A. Paice "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE Press, 1996.
3. Marian P. Kazmierkowski, R. Krishnan and F. Blaabjerg, "Control in Power Electronics", Academic Press, Elsevier Science, 2002.
4. Euzeli Cipriano dos Santos Jr. and Edison Roberto Cabral Da Silva "Advanced Power Electronics Converters - PWM Converters Processing AC Voltages", Willey – IEEE Press, 2014.
5. Muhammad H. Rashid , "Power Electronics Handbook", Elsevier, 3rd ed., 2011.
6. Recent Literature

Course Outcomes:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Analyze various phase shifting transformer configurations for multi-pulse converters	20
CO-2	Evaluate various multi-level inverter configurations and design control schemes for them.	25
CO-3	Design control scheme for current source PWM inverters	15
CO-4	Analyze various configurations of back-back converter and matrix converter for ac-ac conversion.	30

CO-5	Design basic driver/gating and protection circuit.	10

List of Experiments:

Lab experiments shall be based on the course content. A list provided here is to indicate the type of experiments that can be included.

1. Comparison of different level-shifted carrier based PWM control strategies for CHB multilevel inverter
2. Simulation of phase-shifted carrier based PWM for CHB multilevel inverter
3. Control of asymmetric CHB multilevel inverter
4. Simulation of NPC/diode clamped multi-level inverter
5. Study the operation and performance of Matrix converter
6. Elimination of harmonics in the source current using multi-pulse converter
7. Control of current source PWM inverters
8. Modeling of single-phase back-to-back converters and designing its control strategy
9. Modeling of three-phase back-to-back converters and designing its control strategy
10. Design examples

Major Equipment:

Simulation software like MATLAB, PSIM, Scilab and Power Electronic Converters as demanded by the course.

List of Open Source Software/learning website:

1. MIT OPEN COURSEWARE by Massachusetts Institute of Technology - website: ocw.mit.edu
2. Courses available through NPTEL. - website : nptel.ac.in