GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (07)

ADVANCED POWER CONVERTORS

SUBJECT CODE: 2720709

SEMESTER: II

Type of course: Engineering

Prerequisite: Power Electronics (2710702)

Rationale: The course is aimed to provide detailed knowledge of some advanced power electronic converters that are not covered in the basic course on 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)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Resonant Converters Introduction, Classification of resonant converters, basic resonant circuit concepts, load resonant converters, resonant switch converters, zero-voltage switching, clamped voltage topologies, resonant dc link inverters with zero voltage switching, high-frequency-link integral-half-cycle converters	**9**	20
2	Multi-pulse converters Concept of multi-pulse, 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	**7**	15
3	Multi-level converters Need for multi-level inverters, Concept of multi-level 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, 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 and Applications	**10**	23
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 AC-AC	**6**	12

	frequency Converter and Indirect AC-AC frequency conversion without DC link energy storage		
5	Flexible AC Transmission Systems Introduction, Principle of power transmission, Principle of shunt compensation, Shunt compensators: Thyristor controlled reactor, Thyristor switched capacitor, Static VAR compensator; Principle of series compensation; Series compensators: Thyristor switched series capacitor, Thyristor controlled switched capacitor, Forced commutated controlled switched capacitor; Series static VAR compensator, Advanced SSVC, Phase angle compensator, UPFC	**9**	15
7	Converters for some special applications Solar Photovoltaic Systems : Basics of PV cell, PV array and Characteristics, Maximum Power Point Tracking (MPPT), Need for Power Electronic Converter for MPPT and Power Processing, Some basic configurations Wind Energy Generation System (WEGS): Basics of wind energy, wind turbines and their characteristics, types of generators for WEGS, Power Electronics Converter for WEGS HVDC : Configuration, Harmonic Cancellation and Harmonic Spectrum, Filter Requirements, Converter ratings, Control Scheme	**8**	15

Reference Books:

1. Ned Mohan, Tore M. Undeland and William P. 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., 2009.
3. Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2006.
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. Derek A. Paice "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE Press, 1996.
6. Muhammad H. Rashid , "Power Electronics Handbook", Elsevier, 3rd ed., 2011.
7. Marian P. Kazmierkowski, R. Krishnan and F. Blaabjerg, "Control in Power Electronics", Academic Press, Elsevier Science, 2002.
8. P.C.Sen, "Modern Power Electronics ", S. Chand and Co. Ltd., New Delhi, 2000.
9. Vijay K. Sood, "HVDC and FACTS Controllers Applications of Static Converters in Power Systems", Kluwer Academic Publishers, Boston, 2004.
10. M.R. Patel, "Wind and Solar Power Systems", CRC Press, 1999.
11. Recent Literature

Course Outcome:

After learning the course the students should be able to:

Simulate and design resonant converters.
Select and design the appropriate phase shifting converter for a multi-pulse converter.
Evaluate various multi-level inverter configurations and design control schemes for them.
Apply the knowledge of power electronic converters in the area of Power Systems, Renewable Energy Sources and other industrial applications.

List of Experiments:

Lab experiments shall be based on the course content and few experiments shall involve the analyzing and designing skills besides the basic understanding of the subject. A list provided here is to indicate the type of experiments that can be included.

1. Evaluate the performance and operating modes of SLR/PLR dc-dc converter with the change in switching frequency.
2. Simulate/Design a circuit to for a Buck Converter with ZVS/ZCS to regulate the output voltage Vo with a given input voltage Vin.
3. Compare the different carrier based PWM control strategies for CHB multilevel inverter and comment on the harmonic spectrum.
4. Study the operation and performance of Matrix converter.
5. Evaluate the performance of STATCOM/SVC as a shunt compensator.
6. For a given stand-alone load, compare the performance of basic DC-DC converters in tracking the maximum power point.

Design based Problems (DP)/Open Ended Problem:

Course coordinator can assign the design based problem/open ended problem.

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

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.