

GUJARAT TECHNOLOGICAL UNIVERSITY
BRANCH NAME-Electrical Engineering
SUBJECT NAME: Advanced Power Electronics
SUBJECT CODE: 2170906
B.E. 7th SEMESTER

Type of course: Engineering

Prerequisite: Power Electronics-I (2150903) and Power Electronics-II (2160902)

Rationale: The course is aimed to provide exposure of some power electronic converters that are utilized by the industries and utilities and are not taught in the basic courses on Power Electronics-I and Power Electronics-II.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
				ESE (E)	PA (M) PA ALA		ESE (V) ESE OEP		PA (I)	
3	00	02	05	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Switching Voltage Regulators Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode; Other converter configurations like Flyback converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter, C'uk converter, Sepic Converter; Design criteria for SMPS; Multi-output switch mode regulator	10	24
2	Resonant Converters Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero-voltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies	7	17
3	Multi-level converters Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations applications, Introduction to carrier based PWM technique for multi-level converters	6	15
4	Multipulse Converters	5	11

	Concept of multi-pulse, Configurations for m-pulse (m=12,18,24) converters, Different phase shifting transformer (Y- Δ 1, Y- Δ 2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Applications		
5	HVDC Transmission Introduction, Operation of 12-pulse converter as receiving and sending terminals of HVDC system, Equipment required for HVDC System and their significance, Comparison of AC and DC transmission, Control of HVDC transmission	4	9
6	FACTS devices Importance of reactive power compensation, Flow of power in AC system and conventional control mechanisms, Definition of Flexible ac Transmission Systems (FACTS) and brief description, possible benefits from FACTS, Thyristor- Controlled Reactor (TCR), Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), Thyristor-Switched capacitor and Reactor, Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSCTCR), STATCOM configuration and operating principle, Static characteristics of SVC and STATCOM Comparison of SVC and STATCOM, Principle of series compensation, Introduction to Static Synchronous Series Compensator, Advantages and limitation of SSSC, Introduction to UPFC and operating principle	10	24

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. Derek A. Paice "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE Press, 1996.
5. Muhammad H. Rashid , "Power Electronics Handbook", Elsevier, 3rd ed., 2011.
6. P.C.Sen, "Modern Power Electronics ", S. Chand and Co. Ltd., New Delhi, 2000.
7. Vijay K. Sood, "HVDC and FACTS Controllers Applications of Static Converters in Power Systems", Kluwer Academic Publishers, Boston, 2004.
8. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Ltd., 2009
9. Recent Literature

Course Outcome:

After learning the course the students should be able to:

- Evaluate different dc-dc voltage regulators
- Simulate and analyze resonant converters
- Select appropriate phase shifting converter for a multi-pulse converter
- Evaluate various multi-level inverter configurations
- Compare various FACTS devices for VAR compensation

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. About 10 experiments (from different topics) shall be included to cover the entire course.

1. Evaluate the performance and operating modes of SLR/PLR dc-dc converter with the change in switching frequency.
2. Simulate/Design a circuit for a Buck Converter with ZVS/ZCS to regulate the output voltage V_o with a given input voltage V_{in} .
3. Carrier based Sine PWM control of a CHB multilevel inverter and study of harmonic spectrum.
4. Study the operation and performance of second order converters like Buck-Boost, Flyback, Forward converters etc.
5. Study the operation and performance of fourth order converters like C'uk or Sepic converters
6. Evaluate the performance of STATCOM/SVC as a shunt compensator.
7. Study of harmonic spectrum for 12 and 18 pulse converters.

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, Power Electronic Converters, CRO/DSO, meters, Current/Voltage Probes, Isolation transformer etc. 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

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.