GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170906
Semester – VII
Subject Name: Advanced Power Electronics

Type of course: Professional Elective Course

Prerequisite: Power Electronics (3140915)

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	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

Content:

Sr. No.	Content	Total Hrs
1	**Switching Voltage Regulators** Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters, Flyback and Forward Converter (2 -3Hrs); Other converter configurations like Half bridge, Full bridge configurations, Push-pull converter, C'uk converter, Sepic Converter; Design criteria for SMPS; Multi-output switch mode regulator; Design of Inductor and high frequency transformer	**10**
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**
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 and SVPWM for Multilevel converters	**7**
4	**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**
5	**HVDC Transmission** Introduction, Operation of 12-pulse converter as receiving and sending terminals of HVDC system, Equipment required for HVDC System and their	**5**

	significance, Comparison of AC and DC transmission, Control of HVDC transmission	
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**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**30**	**15**	**10**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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 Outcomes:

After learning the course the students should be able to:

Sr. No.	CO statement	Marks % weig4tage
CO-1	Evaluate different dc-dc voltage regulators	24
CO-2	Simulate and analyze resonant converters	16
CO-3	Evaluate various multi-level inverter configurations and Select appropriate phase shifting converter for a multi-pulse converter	27
CO-4	Describe and simulate HVDC transmission system	09
CO-5	Compare various FACTS devices for VAR compensation	24

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 for a Buck Converter with ZVS/ZCS to regulate the output voltage Vo with a given input voltage Vin.
3. Carrier based Sine PWM control of a CHB multilevel inverter and study of harmonic spectrum.
4. Study the operation and performance of half-bridge, full-bridge, push-pull 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.

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