SARVAJANIK UNIVERSITY
SarvajanikCollege of Engineering and Technology
Bachelor of Technology

B.Tech. Semester VI

Subject Name: Advanced Power Electronics **Subject Code: BTEL14622**

Type of course: Professional Elective course (PEC)

Prerequisite: Power Electronics

Rationale: The power electronic converters are widely used in domestic applications as well as in industrial applications like Electrical Drives, Power Systems, Renewable Energy based power generation, heating applications etc. The course is aimed to provide exposure of advanced power electronic converters that are utilized by the industries and utilities for various applications.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**Switching Voltage Regulators** Review of basic dc-dc voltage regulator: Buck, Boost, Buck-Boost converters, C'uk converter, Sepic Converter, closed loop control for voltage regulation, Isolated dc-dc converters: Flyback and Forward Converter, Half bridge, Full bridge configurations, Push-pull converter, Design criteria for SMPS, Multi-output switch mode regulator; Design of Inductor and high frequency transformer.	7	15
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	20
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, Carrier based PWM technique for control of multi-level converters.	8	20

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4.	**Multi-pulse 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	15
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	5
6.	**Matrix converter:** 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.	4	5
7.	**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, 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.	9	20

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**30**	**30**	**15**	**10**	**0**

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

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

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	Power electronics: converters, applications, and design	Mohan, Ned, Tore M. Undeland, William P. Robbins	John Willey & sons	2003	Third

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2.	Power electronics: circuits, devices, and applications	M. H. Rashid,	Prentice Hall of India	2009	Third
3.	High Power Converters and AC Drives	Bin Wu	John Willey & sons, Inc.	2006	
4.	Power electronics handbook	Rashid, Muhammad H.	Elsevier	2011	
5.	Power Electronic Converter Harmonics – Multi-pulse Methods for Clean Power	Derek A. Paice	IEEE Press	1996	
6.	Fundamentals of Power Electronics	R. W. Erickson and D. Maksimovic	Springer Science & Business Media,	2007	
7.	Power Electronics: Essentials and Applications	L. Umanand	Wiley India,	2009	
8.	Control in Power Electronics	Marian P. Kazmierkowski, R. Krishnan and F. Blaabjerg	Academic Press, Elsevier Science	2002	
9.	HVDC and FACTS Controllers Applications of Static Converters in Power Systems	Vijay K. Sood	Kluwer Academic Publishers, Boston,	2004	
10.	Power Electronics	P.S. Bimbhra	Khanna Publishers	2012	

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Evaluate performance of different dc-dc voltage regulators.	15
CO-2	Simulate and analyze the operation of resonant converters.	20
CO-3	Evaluate various multi-level inverter configurations and analyse carrier based PWM schemes.	20
CO-4	Select appropriate phase shifting transformer for a multi-pulse converter used in HVDC transmission system.	20
CO-5	Compare various FACTS devices for VAR compensation.	20
CO-6	Learn the principle of matrix converter, commutation and protection issues.	05

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Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	3	2	2	-	-	-	1	1	-	3	3	2	1
CO-2	3	3	3	2	3	-	-	-	1	1	-	3	3	2	-
CO-3	3	3	3	2	3	-	1	-	2	-	-	3	3	2	-
CO-4	3	3	3	3	3	-	1	-	3	-	-	3	3	1	2
CO-5	3	3	3	3	3	2	-	-	3	2	1	3	3	2	2
CO-6	3	3	3	2	2	-	-	-	-	-	-	2	2	-	-
Rationale *															

LIST OF PRACTICALS:

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. Simulate/Design a circuit for a Buck Converter with ZVS/ZCS to regulate the output voltage Vo with a given input voltage Vin.
2. Evaluate the performance and operating modes of SLR/PLR dc-dc converter with the change in switching frequency.
3. Simulate carrier based Sine PWM control of a CHB multilevel inverter and study of harmonic spectrum.
4. Simulate carrier based Sine PWM control of a diode clamed multilevel inverter and study of harmonic spectrum.
5. Study the operation and performance of flyback and forward converters.
6. Study the operation and performance of half-bridge, full-bridge, push-pull converters etc.
7. Study the operation and performance of fourth order converters like C'uk/Sepic converters
8. Evaluate the performance of FACTS devices such as STATCOM/SVC as a shunt compensator.
9. Study of harmonic spectrum for 12 and 18 pulse converters.

Major Equipment:

Simulation software like MATLAB, PSIM, Scilab, Power Electronic Converters kits, CRO/DSO, meters, Current/Voltage Probes, Isolation transformer etc. as demanded by the course.

List of Open Source/learning website:

ocw.mit.edu/courses/electrical.../6-334-power-electronics-spring-2007
Courses available through NPTEL - website: https://nptel.ac.in

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