SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

B.Tech. – II Semester IV (Working Professional Course)

Subject Name: **Power Electronics** **Subject Code:BTEL13482**

Type of course: **Professional Core Course**

Prerequisite: Fundamental knowledge of Electrical Engineering and Analog Electronics

Rationale: The power electronic devices and converters employing power electronics devices are now 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 about the commonly used power electronic devices and the power electronic converters**.**

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
4	0	2	5	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	**Power switching devices** Diode, TRIAC, Thyristor, MOSFET, IGBT; Static characteristics of these devices; Operation of power devices as switches and switching losses, Single-quadrant switches, two-quadrant and bidirectional switches; Firing circuit for thyristors; Gate drive circuits for MOSFET and IGBT.	**10**	**15**
2	**DC-DC converters** Switching Voltage Regulators, Linear voltage regulator, Concept of switching voltage regulators and advantages, Operation and Principle of Basic DC-DC converter topologies like Buck, Boost and Buck-Boost converter, Various control techniques for output voltage control, Mathematical analysis for these converters for steady state, Concept of CCM and DCM and factors affecting them, Closed loop control for voltage regulation, Isolated converters: Forward converter and Flyback converter; Multi- quadrant operation of DC-DC converters; Applications.	**12**	**20**

3	**DC-AC converters– Inverters** Classification of Inverters, Half-bridge and full-bridge single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage, three- phase sinusoidal modulation, Three phase bridge inverter – 180◦ and 120◦ conduction mode, SPWM control, Third harmonic injection, SVPWM, Output voltage and frequency control, Harmonic spectrum, Harmonics and its effects, Applications	**12**	**20**
4	**AC-DC Converters** Concept of phase control using half-wave single phase ac-dc converter, Single phase and three phase half wave and full wave, 1-phase and 3- phase half controlled and fully controlled converters, Analysis with R & RL load, Performance parameters for converters, Operation in continuous and dis-continuous mode, Reactive power considerations, Operation in conversion and inversion mode, Effect of source inductance, Power factor improvement techniques, Dual Converters, Applications	**12**	**20**
5	**AC Voltage Controller** Single-phase AC voltage controller, Principle of Phase Control, On-off Control, Mathematical analysis related to single-phase AC voltage controller, Introduction to Three-phase AC voltage controller configurations:	**8**	**15**
6	**Miscellaneous** Frequency Control: Introduction to cyclo-converter and matrix converter; basic power circuit and their operating principle. Datasheet interpretation, Ratings of the devices and Selection of switches. Introduction to Silicon Carbide Devices.	**6**	**10**

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**30**	**30**	**10**	**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 able 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.

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks% weightage
CO-1	To understand the differences between signal level and power level Devices.	10
CO-2	Acquire knowledge about fundamental concepts and techniques used In power electronics.	30
CO-3	To analyze the operation of power converters.	30
CO-4	Develop skills to build, and troubleshoot power electronics circuits.	10
CO-5	Develop ability to understand the use of power converters in commercial And industrial applications.	20

Mapping with PO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	P O 12	PS O1	PS O2	PS O3
CO-1	**3**	**2**				**3**	**2**					**2**			
CO-2	**3**	**3**	**3**	**3**		**3**	**2**					3	**2**	**3**	3
CO-3	**2**	**2**	**3**	**3**		**2**	**3**					2	**2**	**2**	3
CO-4	**3**	**3**	**3**	**3**		**3**	**3**					3	**2**	**2**	3
CO-5	**2**	**2**	**3**	**3**		**2**	**2**					3	**3**	**2**	3

Rationale*

Rationale*: Explaining why it is matching this particular program outcome 00

LIST OFPRACTICALS:

1. To obtain the static and dynamic characteristics of SCR, MOSFET, and IGBT.
2. To perform R, RC, and UJT-based triggering circuits of SCR.
3. To analyze the performance of single-phase and three-phase full-bridge thyristor rectifiers for R and R-L loads.
4. To perform an experiment on a DC-DC converter (Buck/Boost/Buck-Boost converter).
5. To perform a single-phase bridge inverter with R and R-L loads.
6. To perform a three-phase bridge inverter in:
   a. 120° mode of conduction
   b. 180° mode of conduction
7. To perform an SCR-based single-phase AC voltage controller.
8. To perform an SCR-based three-phase AC voltage controller.
9. To develop a Simulink model of a step-down chopper to study the effect of inductance, switching frequency, duty cycle, and load current on the output voltage.
10. To simulate a closed-loop control of a DC-DC converter (Buck/Boost/Buck-Boost converter).
11. To simulate single-phase and three-phase inverters for R and R-L loads.
12. To study the harmonic spectrum of the output voltage for unipolar and bipolar PWM-controlled half-bridge and full-bridge converters.
13. To simulate single-phase and three-phase controlled converters for R and R-L loads.

14. To simulate single-phase and three-phase AC voltage controllers.
15. To study the performance of a single-phase fully controlled and semi-controlled converter for R and R-L loads.
16. To study the performance of a three-phase fully controlled and semi-controlled converter for R and R-L loads.

Reference Text Books:

Sr. No	Title of book/ Article	Authors(s)	Publishers and details like ISBN	Year of publication	Publication Edition
1	Fundamentals Of Power Electronics	ERICKSON R.W	Springer Science & Business Media	2020	Third
2	Power Electronics Circuits Devices and Applications	Muhammad.H.Rashid	Pearson	2014	Forth
3	Power Electronics	P. S. Bimbhara	Khanna Publishers	2012	
4	Power Electronics: Essentials & Applications	L. Umanand	Wiley	2009	
6	Power Electronics: Converters Applications and Design, 3ed Paperback – 1	Robbins Mohan, Undeland	Media Enhanced,	J2007	Third

Major Equipment:

Power semiconductor devices, power electronic converter kits, CRO/DSO, choke coil, load bank, voltage and current probes, Simulation software like Scilab, MATLAB, PSIM etc. along with necessary toolbox.