Name of Faculty	:	Faculty of Engineering & Technology
Name of Program	:	Master of Technology (M. Tech)
Course Code	:	2MPS04
Course Title	:	Application of Power Electronics to Power System
Type of Course	:	Professional Core (PC)
Year of Introduction	:	2023-24

Prerequisite	:	Advanced Power Electronics
Course Objective	:	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 act as a foundation block and to provide exposure about various aspects (construction, characteristics, operation, ratings etc.) of power electronic devices. It also covers power electronic converters that provide variable DC voltage.
Course Outcomes	:	At the end of this course, students will be able to:
	CO1	**To Understand** the construction and characteristics of Power semiconductor devices and fundamental of thyristors and family.
	CO2	**To Analyse**, operate and design ac-to-dc converters.
	CO3	**To Analyse**, operate and design dc-to-dc converters.
	CO4	**To Apply** the knowledge of power electronic converter for speed control of AC motors.

Teaching and Examination Scheme

Teaching Scheme (Contact Hours)			Credits	Examination Marks				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**SEE**	**CIA**	**SEE**	**CIA**	
4	0	2	5	70	30	30	20	150

Legends: ***L****-Lecture;* ***T****–Tutorial/Teacher Guided Theory Practice;* ***P*** *– Practical,* ***C*** *– Credit,* ***SEE*** *– Semester End Examination,* ***CIA*** *- Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.))*

Course Content

Unit No.	Topics	Teaching Hours	Weightage	Mapping with CO
1	**Power Semiconductor Devices:** Construction and Characteristics of Power diodes, Power Transistors, Power MOSFET, Insulated Gate Bipolar transistors (IGBTs) Introduction to Thyristor family: SCR, DIACs, TRIACs, Light Activated SCRs (LASCRs), Reverse Conducting Thyristor, (RCT), Asymmetrical SCR (ASCR), Gate turn-off Thyristors (GTOs), Integrated Gate-Commutated Thyristors (IGCTs), MOS controlled Thyristors (MCTs) Power Integrated circuits (PICs), Intelligent Modules.	06	08 %	CO1
2	**Phase Controlled (AC to DC) Converters:** Review of half-wave and full-wave diode rectifier (with RL load); Principle of phase controlled converter operation; Operation of 1-phase half wave converter with R, RL and RLE load; Significance of freewheeling diode ; 1-phase full wave converter : Center-tapped and Bridge Configuration; Operation and analysis with R,RL, RLE load; Analysis; Gating Requirements; Conversion (Rectification) and Inversion mode of operation; Operation and analysis of 1-phase Semi-converter/ Half controlled converter: Asymmetric and Symmetric Configurations; 3-phase converters : Operation of half wave converter; Full wave fully controlled converters: Analysis and operation with different type of loads; Rectification and Inversion Mode; Semi-controlled converter; Dual Converter: Principle and operation; 1-phase and 3-phase configurations; Simultaneous and Non-simultaneous operation Effect of source and load inductances, Power factor improvement techniques, Applications of AC-DC converters.	12	20 %	CO2
3	**DC to DC Converters:** The chopper, Basic principle of DC chopper, Classification of DC choppers, Control strategies Basic DC-DC converter (switch	10	16 %	CO3

	regulator) topologies: Principle, operation and analysis for Step-down (Buck), Step-up (Boost), Step up/down (Buck-Boost), Continuous conduction and Discontinuous conduction operation Chopper configurations: Voltage Commutated, Current Commutated, Load Commutated Chopper Multi-phase chopper, Application of DC-to-DC converters.			
4	**DC Drives with DC-DC Converters:** Principle of power control (motoring control) of separately excited and series motor with DC-DC Converter; Steady- state analysis Principle of Regenerative Braking; Chopper configuration for Regenerative braking; Analysis for minimum and maximum speed for Regenerative Braking; Combined regenerative and rheostatic brake control; Two and four quadrant DC-DC converter drives.	06	08 %	CO3, CO4
5	**DC to AC Converters - Inverters:** Performance parameters of Inverters; Classification of Inverters: Voltage source inverters and Current source inverters; Single phase inverters: series, parallel and bridge type (Half wave and Full wave) inverters; Forced Commutated, Line commutated and Self-Controlled Switches based Inverters; Three phase bridge inverters: 180 degree conduction, 120 degree conduction and their comparison PWM Inverters: Principle of PWM control, PWM techniques classifications, Unipolar and Bipolar PWM, Effect of Switching frequency on Harmonic Spectrum, Sinusoidal PWM, Third harmonic PWM, Selective Harmonic Elimination, Hysteresis band current control PWM, Space vector pulse width modulation technique, Comparison of PWM techniques, Voltage and frequency control of single phase and three-phase inverters, Harmonic Cancellation techniques Gating circuits for switches of inverter.	18	32 %	CO3

6	**Cycloconverters:** Introduction; Basic Principle; Single to single-phase cycloconverters; Three-phase half-wave cycloconverters; Cycloconverters for three phase output; Output voltage equation; Output harmonics in cycloconverter; Comparison between cycloconverter and DC link Converter; Load Commutated cycloconverter.	08	16 %	CO4

Suggested Distribution of Theory Marks Using Bloom's Taxonomy						
Level	Remembrance	Understanding	Application	Analyse	Evaluate	Create
Weightage	**20**	**25**	**20**	**20**	**10**	**05**

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

Suggested List of Experiments/Tutorials

Sr. No.	Name of Experiment/Tutorial	Teaching Hours
1	Static and dynamic characteristics of an SCR.	02
2	Output characteristics and transfer characteristics of Power MOSFET.	02
3	Performance 1- Φ semi-converter & 1- Φ fully controlled (bridge) converter with R and RL load.	02
4	Time ratio control for regulating the output voltage of a step-down chopper.	02
5	Time ratio control for regulating the output voltage of a step-up chopper.	02
6	Performance of three phase fully controlled and half-controlled converter with R and R-L load.	02
7	Speed control of DC separately excited motor with phase-controlled converter or DC-DC converter.	02
8	Harmonic spectrum of output voltage for unipolar and bipolar PWM controlled half-bridge and full bridge converter.	02
9	Performance of V/F controlled induction motor drive.	02
10	Simulation of 1-phase bridge type cycloconverter in MATLAB.	02

Major Equipment/ Instruments and Software Required

Sr. No.	Name of Major Equipment/ Instruments and Software
1	MATLAB / Simulink
2	PSCAD
3	ORCAD

Suggested Learning Websites

Sr. No.	Name of Website
1	www.vlabs.co.in
2	www.powerind.in

Reference Books

Sr. No.	Name of Reference Books
1	M D Singh and K. B. Khanchandani, "Power electronics", TMH, New Delhi, 2nd ed., 2007.
2	Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2003.
3	P. S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi, 2012.
4	V. R. Moorthi, "Power Electronics", Oxford University press, 2005.