

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	Power Electronics and Drives – I
Course Code:	1ET1090501
Pre-requisite Course:	Fundamental Knowledge of Semiconductor physics and Basic Electronic is required

Course Objectives:

1. Power Electronics is a subject where a student will learn the generalized concepts of power electronics devices, which are most commonly used in technical world specially electronics side.
2. Furthermore, a student will also learn applications of various converters in DC Electric Drives.
3. To learn operation and control of Various Choppers and Convertors.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)								
Lecture	Tutorial	Practical	Credit	Theory				Practical				Total
				University Assessment		Continuous Assessment		University Assessment		Continuous Assessment		
				Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
4	-	2	5	28	70	12	30	12	30	08	20	150

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	Power Semiconductor Devices: Characteristics of an Ideal Power Semiconductor Device (Super Conducting Device). Construction and Characteristics of Power Semiconductor Devices like Power diodes, Power Transistors, Power MOSFETs, Power IGBTs. Basic Introduction to Thyristor family: SCR, DIACs, TRIACs, Light Activated SCRs (LASCRs), Reverse Conducting Thyristor, (RCT), Asymmetrical SCR (ASCR), Gate turn-off Thyristor (GTOs).	09	16
2	Thyristor Fundamentals: Construction of SCR, Operating modes, Two transistor analogy, Static & dynamic characteristics, Gate characteristics, Turn on & turn off methods (Commutation methods), Series and Parallel operations of SCRs: Need, String efficiency, Issues, Static and Dynamic Equalizing circuit and Means to minimize the effect of mis-match, Cooling and Heat sinks, di/dt and dv/dt protection, Design of Snubber- Circuit, Over Voltage and Over Current protections, Gate protections. Gate Drive/Triggering circuits: RC-Triggering, UJT as a relaxation oscillator.	09	17

3	Phase Controlled (AC to DC) Converters: Review of half-wave and full-wave diode rectifier (with R and RL load); Principle of phase controlled converter operation; Operation of 1-phase half wave converter with RL, RLE load; Significance of free-wheeling diode; 1-phase full wave converter: Center-tapped and Bridge Configuration with RL, RLE load; 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: Dual Converter: Principle and operation; 1-phase and 3-phase configurations; Applications of AC-DC converters.	18	30
4	DC to DC Converters (Chopper): The chopper, Basic principle of DC chopper, Classification of DC choppers, Control strategies, Basic DC-DC converter (switch regulator) topologies: Principle, operation and analysis for Step-down (Buck), Step-up (Boost), Step up/down (Buck-Boost), Cuk Converter with Continuous conduction and Discontinuous conduction operation, Application of DC to DC converters.	09	17
5	DC Motor Drives: Basic characteristics of DC motors, Two quadrant operation, Four quadrant operation (Operating modes), Electric Braking, Principles of DC motor speed control Single phase separately excited drives: Half Wave converter, Semi-converter, Fully Controlled converter and dual converter based drives; 3-phase separately excited drives with Semi-converter, Fully Controlled converter and Dual converter based drives; Principle of power control (motoring control) of separately excited drive with DC-DC Converter; Chopper configuration for Motoring mode, Regenerative braking mode and Rheostatic braking mode.	12	20

Reference Books:

1. M. D. Singh and K. B. Khanchandani, "Power electronics", TMH, New Delhi, 2nd ed., 2007.
2. M. S. Jamil Asghar, "Power Electronics", PHI, New Delhi, 2004.
3. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2003.
4. P. S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi, 2012.
5. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2nd ed. 2001.
6. Dr. B. R. Gupta and V. Singhal, "Fundamentals of Electrical Drives and Control", S. K. Kataria & Sons (2014), New Delhi, 5th ed. 2001.
7. Vedam Subramanyam, "Power Electronics – Devices, Converters and Applications", New Age International Publishers Pvt. Ltd., Bangalore, 2nd ed. 2006.

List of Experiments:

1. To Derive the Static V-I Characteristics of the DIAC.
2. To Perform Gate Characteristics of the TRIAC.
3. To Perform R-C Triggering Circuit for SCR.
4. To Verify Speed Control of Universal Motor by using DIAC & TRIAC.
5. To Perform UJT as Relaxation Oscillator using PSIM.
6. To Simulate Boost Converter using PSIM.
7. To Simulate Single Phase Half-Wave Uncontrolled Rectifier using PSIM.

8. To Simulate Single Phase Half-Wave Controlled Rectifier using MATLAB/SIMULINK.
9. To Simulate Single Phase Full-Wave Controlled Rectifier using MATLAB/SIMULINK.
10. Simulate Single Phase Full-Wave Uncontrolled Rectifier using PSIM.
11. To Perform the dynamic braking of DC shunt motor at various braking resistances.
12. To Simulate the plugging method of braking for DC shunt motor and also the effect of plugging voltage and braking resistor on the braking time.

List of Open Source Software/learning website:

1. http://nptel.iitm.ac.in/coursecontents_elec.php
2. ocw.mit.edu/courses/electrical/6-334-power-electronics-spring-2007

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand the basics of power electronics.	2 Understanding
CLO2	Analyze, operate and control AC-to-DC converters (Rectifiers).	4 Analyze
CLO3	Analyze, operate and control DC-to-DC Converters (Choppers).	4 Analyze
CLO4	Knowledge of power electronic converter apply for speed control of DC motors.	1 Remembering 3 Applying
CLO5	Calculation of power electronic converters and their control scheme.	3 Applying
CLO6	Identify, formulate and solve the numerical problems related to above machines.	5 Evaluate

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1		L		H		M			L			M		L		L
CLO2	L				L			M		L			L		H	
CLO3			H	M			L				M					L
CLO4		L				L			L			M				
CLO5				M			L				M		M			
CLO6	M			H	L	M		M				M	L		H	L

H: High, M: Medium, L: Low