EE208: POWER ELECTRONICS - I
CREDITS = 6 (L=4, T=0, P=2)

Course objective:

The subject aims to provide the student of electrical engineering discipline with:

C1. An understanding of basic abstractions of power electronics components and circuits.

C2. The capability to use abstractions to comprehend and analyze power electronics for DC-DC converters

C3. The capability to use abstractions to comprehend and analyze power electronics for DC-AC (Inverters) converters.

C4. The capability to incorporate the knowledge of power electronics in other fields of engineering.

Teaching and examination scheme:

Teaching Scheme			Credit	Marks Distribution				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
4	0	2	6	ESE	CE	ESE	CE	150
				70	30	30	20	

Course contents:

Unit No.	Topics	Teaching Hours
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
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	15

the effect of mis-match Isolation of gate and base drive using pulse transformer and Opto-couplers Gate Drive/Triggering circuits: R trigger, RC trigger, Cosine Triggering, UJT and Programmable UJT as an oscillator and triggering circuit based on them Ratings, Cooling and Heat sinks, Thermal Modeling, di/dt and dv/dt protection, Design of Snubber Circuit, Over Voltage and Over Current protections, Gate protections, Electro Magnetic Interference(EMI) and Shielding.

3 **Phase Controlled (AC to DC) Converters:** 11

Review of half-wave and full-wave diode rectifier (with RL load);Principle of phase controlled converter operation; Operation of 1-phasehalf wave converter with R, RL and RLE load; Significance of free-wheeling 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.

4 **DC to DC Converters:** 11

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), Continuous conduction and Discontinuous conduction operation Chopper configurations: Voltage Commutated, Current Commutated, Load Commutated Chopper Multi-phase chopper, Application of DC to DC converters.

5 **DC Drives with phase controlled converters:** 06

Basic characteristics of DC motors, Two zone operation, Four quadrant operation (Operating modes), Principles of DC motor speed control Single phase separately excited drives: Half Wave converter, Semi- converter and Fully Controlled converter based drives; Braking operation of separately excited drive Single phase Series DC motor drive: Semi-converter and Fully Controlled converter based drives 3-phase separately excited drives: Half Wave converter, Semi-converter and Fully Controlled converter based drives.

6	**DC drives with DC-DC converters:**	06
	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.	
	TOTAL	**55**

List of references:

1. M D Singh and K B Khanchandani, *"Power electronics",* TMH, New Delhi, 2 nd ed., 2007.
2. Muhammad H. Rashid, *"Power Electronics - Circuits, Devices and Applications",* Prentice Hall of India, 3rd ed., 2003.
3. Vedam Subramanian*, "Power Electronics – Devices, Converters and Applications",*New Age International Publishers Pvt. Ltd., Bangalore, 2 nd ed. 2006
4. P.S. Bimbhra, *"Power Electronics",* Khanna Publishers, New Delhi, 2012.

5. Ned Mohan, Undemand and Robbins, "*Power Electronics – Converters, Applications and Design*", John Willey & sons, Inc., 3rd ed., 2003
6. V.R.Moorthi, "*Power Electronics*", Oxford University press, 2005.
7. G.K. Dubey, S.R. Doradla, A. Joshi, and R.M.K. Sinha, "T*hyristorised Power Controllers*", New Age International Ltd. Publishers, 1986 (Reprint 2008).
8. P.T. Krein, *"Elements of Power Electronics",* Oxford University Press, 1998.
9. G.K. Dubey, *"Fundamentals of Electrical Drives", Narosa Publishing House,* New Delhi, 2 nd ed.2001.

Course outcome (COs):

After learning the course the students will be able to:

CO1. Demonstrate the knowledge about the power electronics devices & circuits and their applications.

CO2. Assess the theory and practices of power electronics DC-DC converters

CO3. Assess the theory and practices of power electronics DC-AC converters

CO4. Determine the applications of power electronics devices for other electrical systems.