Syllabus for Diploma Engineering

Electrical Engineering

Semester –V

Subject Name: Power Electronics and Electrical Drives

Subject Code: 09EE2503

Diploma Branch in which this subject is offered: Electrical Engineering

Objective:

The aim of this subject is to understand various power electronics devices, source conversion using various power electronics converter and application of electric drives.

Credits Earned: 4 Credits

Course Outcomes: After completion of this course, student will be able

1. To identify terminals of power semiconductor device.
2. To understand construction, working and characteristics of power semiconductor device.
3. To understand circuit diagram, waveform and operation of rectifier and chopper.
4. To understand circuit diagram, waveform and operation of inverter and cycloconverter.
5. To apply knowledge of power electronics converter for Dc and Ac drives.

Pre-requisite of course: DC circuit, AC circuit, basic electronics, electrical machine and transformer, electrical power system.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE	IA	CSE	Viva	Term work	
2	0	4	4	50	30	20	25	25	150

Contents:

Unit	Topics	Contact hours	Weightage (%)
1	**Characteristics, protection and commutating circuits of semiconductor devices** • Introduction • Classify diode, transistor and thyristor family • Structure and I-V characteristics of various devices: power diode,	9	32

	SCR, Diac, UJT, Triac, IGBT, MCT and GTO • Turn on and turn off process of GTO and MCT • Two transistor analogy of SCR • Protections of SCR: snubber circuit, overvoltage protection, over current protection, gate protection. • Triggering methods of SCR: forward voltage triggering, gate triggering, dv/dt triggering, thermal triggering and light triggering • Commutation of SCR: natural commutation and forced commutation • Method of forced commutation of SCR : load commutation, resonant-pulse commutation, complementary commutation, impulse commutation, external pulse commutation, line commutation • Applications of SCR, series-parallel connection of SCR • Specification of SCR, • Heat transfer of SCR, cooling of SCR • Mounting of SCR		
2	**Uncontrolled and controlled rectifier** • Introduction • Single phase uncontrolled rectifier • Three phase uncontrolled rectifier: half wave and full wave • Derivation of electrical quantities : half wave uncontrolled rectifier and full wave uncontrolled rectifier • Effect of transformer inductance on uncontrolled rectifier and secondary utilization factor • Methods to control SCR triggering • Single phase controlled rectifiers: half wave and full wave, derivation of electrical quantities	**4**	**14**
3	**DC-DC converter (Chopper)** • Introduction • Principle of DC-DC converter • Control techniques of DC-DC converter: time ratio control and current limiting control • Step down DC-DC converter, step up DC-DC converter • Types of chopper: Class A, Class B, Class C, Class D and Class E • Jones chopper, Morgan chopper • Application of DC chopper	**4**	**14**
4	**DC-AC converter (Inverter)** • Introduction • Principle of DC-AC converter • Classification of DC-AC converter • Single phase series inverter • Single phase parallel inverter • Single phase bridge inverter: half bridge and full bridge • Method of voltage control: external control, internal control and series inverter control	**4**	**14**

	• Pulsed width modulation control: Single pulse width modulation, multiple pulse width modulation and sinusoidal pulse width modulation.		
5	**AC-AC Converter (Cycloconverters)** • Introduction • Principle of AC-AC converter • Types of cycloconverter : single phase and three phase, step down and step up , mid-point and bridge • Application of cycloconverter	**3**	**12**
6	**Electrical Drives** • Introduction • Need of electric drives, • Functional block diagrams of an electric drives • Starting and braking of DC motors • DC drives: Half-wave converter drive, semi converter drive, full converter drive • AC drives: variable voltage drive, variable frequency drive, variable voltage and frequency drive	**4**	**14**

Suggested Theory distribution:

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyse	Evaluate	Create
35%	35%	15%	15%	0%	0%

Suggested List of Practical/Exercise/Tutorial:

Sr. No.	**Unit No.**	**Name of Topics**	**Contact Hours**
1	1	To identify the terminals of SCR and TRIAC also plot static I-V characteristics.	4
2	1	To identify the terminals of MOSFET and IGBT also plot static I-V characteristics.	4
3	1	To understand and compare ratings of SCR and TRIAC from datasheet.	4
4	2	To design half wave rectifier and observe input and output waveform.	4
5	2	To design full wave rectifier and observe input and output waveform.	4

6	3	To design class A chopper and observe input and output waveform.	4
7	3	To design class B chopper and observe input and output waveform.	4
8	4	To generate PWM pulse using analog ic and observe waveform.	4
9	4	To design half bridge inverter and observe input and output waveform.	4
10	4	To design full bridge inverter and observe input and output waveform.	4
11	5	To simulate step down cycloconverter using MATLAB	4
12	5	To simulate and study step up cycloconverter using MATLAB	4
13	6	To simulate full converter fed DC drive using MATLAB	4
14	6	To simulate variable voltage AC drive using MATLAB	4

Instructional Method:

a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

e. Show video or animation of working of various types of wiring system and electrical transmission and distribution network

References:

1. P S Bimbhara, "*Power electronics* ", Khanna publishers, 2012
2. V R Moorthi, "*Power electronics devices, circuits and industrial applications* ", Oxford university press, 2011
3. Jai P. Agrawal, "*Power electronics systems, theory and design*", Dorling Kindersley (India) Pvt. Ltd., 2011.
4. P C Sen, *"Power electronics"*, Tata Mc-Grawe hill, 2012
5. Mohan, Underland, Robbins, *"Power Electronics: Converters, Applications, and Design",* wiley publication,2002
6. Krause, Wasynczuk, Sudhoff, *"Analysis of electric machinery and drive system",* wiley publication,2002

Supplementary Resources:

1. https://archive.nptel.ac.in/courses/108/102/108102145/
2. https://www.allaboutcircuits.com/technical-articles/a-review-on-power-semiconductor-devices/
3. https://www.circuitstoday.com/choppers-an-introduction
4. https://www.elprocus.com/power-electronics-projects/
5. https://www.electricaltechnology.org/2015/11/what-are-dc-drives-types-of-electrical-dc-drives.html
6. http://www.acdrive.org/ac-drive-working-principle.html
7. https://onlinecourses.nptel.ac.in/noc21_ee01/preview