Marwadi University

Syllabus for Diploma Engineering

Electrical Engineering

Semester – IV

Subject Name: Power Electronics and Electrical Drives

Subject Code: 09EE0503

Diploma Branch in which this subject is offered: Electrical Engineering

Objective: Nowadays electrical energy is widely used form of energy. This lead to use the energy more efficiently. For efficient use or conversion of electrical energy power electronics devices are used in form of different types of converters. Industry demands power electronics converters for controlled operation and efficient operation of motors, heating load, power quality improvement devices, etc. Power electronics converters are high in demand, so it is important for diploma students to have knowledge of power electronics.

Credits Earned: 6 Credits

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

1. To identify terminals of power semiconductor device.
2. To explain construction, working and characteristics of power semiconductor device.
3. To show circuit diagram, waveform and explain operation of rectifier and chopper.
4. To show circuit diagram, waveform and explain operation of inverter and cycloconverter.
5. To explain working of dc and ac drives.

Pre-requisite of course: DC circuit, AC circuit, Basic electronics, electrical machines, 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	6	50	30	20	25	25	150

Contents:

Unit	Topics	Contact hours	Weightage (%)
1	**Characteristics, protection and commutating circuits of semiconductor devices** • Introduction	**9**	**32**

	• Structure and I-V Characteristics of power diode and diac • Structure of UJT, I-V characteristics of UJT • Structure of SCR, Two transistor analogy of SCR, I-V characteristics of SCR • Protections of SCR Snubber circuit, overvoltage protection, overcurrent protection, gate protection. • Rating of SCR, Heat transfer of SCR, Cooling of SCR, Mounting of SCR • 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 • Techniques for 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 • Structure of GTO, I-V characteristics of GTO • Turn on and Turn off process of GTO, MCT • Structure of triac, I-V characteristics of triac • Structure of IGBT, I-V characteristics of IGBT		
2	**Uncontrolled and controlled rectifier** • Introduction • Single phase uncontrolled rectifier • Three phase uncontrolled rectifier Half wave uncontrolled rectifier and full wave uncontrolled rectifier • 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 controlled rectifier and full wave controlled rectifier, 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, current limiting control	**4**	**14**

	• Step down DC-DC converter, Step up DC-DC converter • Types of DC-DC converter Class A DC-DC converter, Class B DC-DC converter Class C DC-DC converter, Class D DC-DC converter Class E DC-DC converter, Class F DC-DC converter • Jones chopper, Morgan chopper • Application of DC-DC converter		
4	**DC-AC converter (Inverter)** • Introduction • Principle of DC-AC converter • Single phase series DC-AC converter • Single phase Parallel DC-AC converter • Single phase Bridge DC-AC converter Half bridge and full bridge DC-AC converter • Voltage control of DC-AC converter External control of ac output voltage, external control of dc input voltage, internal control of DC-AC converter • Pulsed width modulated DC-AC converter Single pulse modulation, multi pulse modulation and sinusoidal pulse modulation.	**4**	**14**
5	**AC-AC Converter (Cycloconverters)** • Introduction • Principle of AC-AC converter • Step down AC-AC converter, Step up AC-AC converter • Mid-point AC-AC converter and bridge AC-AC converter • Mid-point AC-AC converter and bridge AC-AC converter	**3**	**12**
6	**Electrical Drives** • Introduction • DC Drives • Half-wave converter drive, semiconverter 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:

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 wire half wave rectifier and observe input and output waveform.	4
5	2	To wire full wave rectifier and observe input and output waveform.	4
6	3	To generate PWM pulse using analog ic and observe output.	4
7	3	To wire half bridge inverter and observe input and output waveform.	4
8	3	To wire full bridge inverter and observe input and output waveform.	4
9	4	To wire class A chopper and observe input and output waveform.	4
10	4	To wire class B chopper and observe input and output waveform.	4
11	5	To simulate and study step down cycloconverter.	4
12	5	To simulate and study step up cycloconverter.	4
13	6	To simulate full converter DC drive.	4
14	6	To simulate variable voltage AC drive.	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://www.brighthubengineering.com/commercial-electrical-applications/58051-characteristics-and-applications-of-scr-thyristors/
2. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-3/rectifier-circuits/
3. http://www.circuitstoday.com/choppers-an-introduction
4. https://www.mpptsolar.com/en/how-does-an-inverter-work.html
5. https://www.elprocus.com/cycloconverters-types-applications/
6. https://www.electricaltechnology.org/2015/11/what-are-dc-drives-types-of-electrical-dc-drives.html
7. http://www.acdrive.org/ac-drive-working-principle.html