Techno India NJR Institute of Technology

Course File

Power Electronics (6EC3-01)

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Syllabus:

RAJASTHAN TECHNICAL UNIVERSITY, KOTA
SYLLABUS
III Year - VI Semester: B.Tech. (Electronics & Communication Engineering)

6EC3-01: Power Electronics

Credit: 2   **Max. Marks: 100(IA:20, ETE:80)**
2L+0T+0P   **End Term Exam: 2 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	SEMICONDUCTOR POWER DEVICES: Introduction. Basic characteristics &working of Power Diodes, Diac, Triac, MOSFETs, IGBT, GTO, Power Transistor and SCR- Principle of operation, V-I Characteristics, Turn-On mechanism and its applications	6
3	CONVERTERS: Basic concept, Working Principles of Single phase half Wave bridge converter, Single Phase Full Bridge Converter, 3 Phase Bridge Converter	5
4	INVERTERS: Voltage Source Inverter, Current Source Inverter, PWM Control of Voltage Source Converter and applications.	5
5	INDUSTRIAL POWER SUPPLIES: Principle of operation of choppers. Step up, Step down and reversible choppers. Chopper control techniques, High frequency electronic ballast, Switch Mode Power Supply: Fly back converter, forward/buck converter, Boost converter and buck-boost converter. Uninterruptible Power Supply.	6
6	MOTOR CONTROL: Introduction to speed control of DC motors using phase controlled converters and choppers, Basic idea of speed control of three phase induction motors using voltage and frequency control methods.	5
	Total	**28**

Course Overview:

The course discusses power processing electronic circuits like rectifiers, AC voltage controllers, Frequency converters, DC-DC converters and inverters apart from introducing the basics of power semiconductor devices like SCRs, power BJTs, IGBTs and MOSFETs in this 40-hours course. The analysis of these power circuits are presented in detail along with the waveforms and control techniques. Finally, applications of power electronic technology in generation sector, transmission sector and also in day-to-day applications like battery charger, motor drives, power supplies are described.

This course will make the student ready to solve the power and energy sector problems. Also, brigs opportunities from renewable energy sector. Students will be able to solve for the steady-state voltages and currents of step-down, step-up, inverting, and other power converters and knows how to derive an averaged equivalent circuit model and solve for the converter efficiency

Course Outcome:

CO. NO.	Cognitive Level	Course Outcome
1	Synthesis	Student will be able to explain switching characteristics of various Power Semiconductor devices and able to design and simulate their base/gate drive circuits.
2	Synthesis	Student will be able to summarize and synthesize the different controlled rectifier circuits and computing their performances.
3	Analysis	Students will be able to analyze different dc-dc converter circuits (isolated and non-isolated type) and computing their performances
4	Application	Students will be able to apply knowledge of single phase and three phase Voltage Source Inverter circuit topology with SinPWM control, Space Vector PWM control and computing their performances.

Prerequisites:

1. Basic Electrical Engineering, Circuit theory, signals and systems
2. Fundamentals of basic circuit elements and their properties.
3. Students should be efficient in applying basic laws of circuit analysis.
4. Students should be proficient in solving algebraic equations.
5. Students should be proficient in drawing waveforms.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)											
CO. NO.	Domain Specific (PSO)					Domain Independent (PO)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	1	1	-	-	-	-	-	-	-
CO2	2	2	2	2	1	2	1	-	1	-	-	-
CO3	2	2	2	2	1	2	1	-	1	-	-	-
CO4	2	2	2	2	1	2	1	-	1	-	-	-

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

Course Coverage Module Wise:

Lect. No.	Unit	Topic
1	**1**	**INTRODUCTION: Objective, scope and outcome of the course**
2	**2**	**SEMICONDUCTOR DEVICES:**Introduction
3	2	Construction, Characteristics and working of Power Diode
4	2	Construction, Characteristics and working of DIAC, TRIAC
5	2	Construction, Characteristics and working of MOSFET
6	2	Construction, Characteristics and working of IGBT, GTO
7	2	Construction, Characteristics and working of Power Transistor
8	2	Construction and working of SCR
9	2	I-V Characteristics of SCR
10	2	SCR Turn-On mechanism and its applications
11	**3**	**CONVERTERS:**Basic Concepts and Categorization
12	3	Construction and working principle of Single-phasehalf bridge converter
13	3	Construction and working principle of Single-phase full bridge converter (R Load)
14	3	Working principle of Single-phase full bridge converter (RL Load)
15	3	Construction and working principle of Three-phase full bridge converter (R Load)
16	3	Construction and working principle of Three-phase full bridge converter (RL Load)
17	**4**	**INVERTERS:**Basic Concepts and Categorization
18	4	Single-phase Voltage Source Inverter
19	4	Three-phase Voltage Source Inverter (180 Degree mode)
20	4	Three-phase Voltage Source Inverter (120 Degree mode)
21	4	Current Source Inverter
22	4	PWM Control of Voltage Source Converter and applications
23	**5**	**INDUSTRIAL POWER SUPPLIES:** Principle of operation of choppers, Step-up chopper
24	5	Step-down chopper, reversible choppers
25	5	Chopper control techniques

26	5	High frequency electronic ballast, Switch Mode Power Supply Introduction
27	5	Fly back converter
28	5	forward/buck converter
29	5	Boost converter
30	5	Buck-boost converter
31	5	Uninterruptible Power Supply
32	**6**	**MOTOR CONTROL:** Introduction
33	6	Speed control of DC motors using phase-controlled converters
34	6	Speed control of DC motors using choppers
35	6	Basic idea of speed control of three-phase induction motors
36	6	Voltage Control method of three-phase induction motors
37	6	Frequency Control method of three-phase induction motors
38		Revision to course work. • It should clearly mention the type of rectifiers to be covered like semi-converter and types of loads operations • Inverter working mode should be mention like 180 Degree 120 Degree Industrial supply unit should be like Classes of chopper, Buck, Boost, Buck-boost converter, Flyback converter, Forward converter, UPS

Text/Reference Books:

1. M. H. Rashid," Power electronics: circuits, devices, and applications", Pearson Education India, 2009.

2. N. Mohan and T. M. Undeland," Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.

3. R. W. Erickson and D. Maksimovic," Fundamentals of Power Electronics", Springer Science & Business Media, 2007.

4. L. Umanand," Power Electronics: Essentials and Applications", Wiley India, 2009

Teaching and Learning resources:

NPTEL Course Link	https://nptel.ac.in/courses/108/102/108102145/
Quiz	https://quizizz.com/admin/quiz/5c9480fa0d3459001a4e41c7/power-electronics
Notes	http://www.svecw.edu.in/Docs%5CEEEPELNotes2013.pdf https://sites.google.com/site/eenotes2u/courses/power-electronics

Assessment Methodology:

1. Assignments one from each unit.

2. Midterm subjective paper where they have to solve the given problem. (Twice during the semester)

3. Final paper at the end of the semester subjective

Previous Year Question Paper:

B.Tech. VI Semester (Main&Back) Examination, April-2019
Electronics & Communication Engg.
6EC3A Industrial Electronics
(Common with AI, EC, EI)

Time : 3 Hours

Maximum Marks : 80
Min. Passing Marks : 26

Instructions to Candidates:

Attempt any five questions, selecting one question from each unit. All questions carry equal marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly).

Unit - I

1. a) Explain the need of commutation in thyristor circuits. What are the different methods of commutation schemes? Explain in brief with neat schematic and waveforms. **(10)**

   b) Describe the triggering circuit for a triac using diac. **(06)**

(OR)

1. a) It is required to operate 250A SCR in parallel with 350-A SCR with their respective on state voltage drop of 1.6V and 1.2V. Calculate the value of resistance to be inserted in series with each SCR so that they share the total load of 600A in proportion to their current ratings. **(08)**

   b) Explain the methods adopted for the protection of SCRs with over currents. **(08)**

Unit - II

2. a) A single phase full converter feeds power to RLE load with $R = 6\Omega$, L=6mh and E= 60V. The ac source voltage is 230V, 50Hz. For continuous conduction find the average value of load current for a firing angle delay of 50°. **(08)**

   b) Describe the operation of a single phase two pulse midpoint converter with relevant wave forms. **(08)**

(OR)

2. a) Discuss the principle of working of a three phase bridge inverter with circuit diagrams and wave forms. **(10)**

   b) Draw phase and line voltage waveforms in case of each thyristor conducts for 180° and the resistive load is star connected. **(06)**

Unit - III

3. a) What is a dc chopper? Describe the various types of choppers with appropriate diagrams and waveforms. (12)

b) A step-up chopper has input voltage of 220V and o/p voltage of 660V. If the non conducting time of thyristor chopper is 100μs, compute the pulse width of output voltage. (04)

(OR)

3. a) What is an UPS? Give up its industrial applications. Describe rotating-type, short break static and no break static UPS. (12)

b) Briefly explain the high frequency electronic ballast. (04)

Unit - IV

4. a) The chopper used for on-off control of a dc separately excited motor has supply voltage of 230V dc; an on time of 10msec and off time of 15msec. Calculate the average load current when the motor speed is 1500 rpm and has a voltage constant $K_v = 0.5$ v/rad per sec. The armature resistance is $3\,\Omega$. (08)

b) Briefly discuss the methods of speed control of DC motors using choppers. (08)

(OR)

4. Describe the speed control methods of three phase induction motors. (16)

Unit - V

5. Write the short note on any two: (2×8=16)

a) Permanent magnet stepper motors.

b) Induction and dielectric heating control of stepper motors.

c) Hybrid stepper motors.