GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: POWER ELECTRONICS
(COURSE CODE: 3350903)

Diploma Programme in which this course is offered	Semester in which offered
Electrical Engineering	5th Semester

1. RATIONALE

Nowadays all the modern electrical machines are controlled by power electronics devices and methods. The function of power electronics is to process and control the electric power by supplying voltage and current in a form that is optimally suited to the load. With the advancement of power electronics devices the conventional control and relays are now replaced by electronic control and relays, employing solid state power semiconductor devices. This course is therefore designed so that the diploma engineers will be able to use power electronics for controlling AC and DC power in various applications. Essential theoretical and practical knowledge to use power electronics to control electrical machines in commercial and industrial sector will be achieved by this course.

2. LIST OF COMPETENCY

The course content should be taught and implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Use power electronics for controlling AC and DC Power in various applications.**

3. COURSE OUTCOMES

The theory should be taught and practical should be undertaken in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

i. Use power semiconductor devices in different applications.
ii. Maintain SCR Protection and Commutating Circuits**.**
iii. Troubleshoot chopper circuits.
iv. Maintain inverters and cyclo-converter circuits.
v. Maintain power electronic circuits used in various domestic and industrial applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	0	2	6	70	30	20	30	150

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Power Semi Conductor Devices and Controlled Rectifier**	1a. Classify Thyristor family. 1b. Explain the working of various power electronics devices with sketches 1c. Explain various polyphase uncontrolled rectifiers with sketches and waveforms 1d. Explain the Effects of transformer reactance 1e. Compare the difference in working of the single phase half wave, full wave controlled rectifiers using SCR, UJT and Phase shift circuits 1f. Explain the working Principle of A.C. load control & of pulse transformer	1.1 Classification of Thyristor family. 1.2 Working, of SCR, IGBT ,GTO, MCT, DIAC and TRIAC 1.3 Three phase half wave, full wave or bridge rectifier and Six phase half wave rectifier. 1.4 Effect of transformer reactance. 1.5 Single phase half wave and full wave controlled rectifiers using SCR, UJT & phase shift circuits. 1.6 Working of pulse transformer. 1.7 Principle of A.C. load control.
Unit– II **SCR Protection and Commutating Circuits**	2a. Justify the need of SCR protections. 2b. Describe working of snubber circuit, freewheeling diode, thermistor and heat sink for SCR. 2c. State the need to turn off SCR. 2d. Differentiate various types of commutation methods with sketches 2e. Use SCR datasheets for the given parameters	2.1 Need of SCR protections : Over voltage and over current protection. 2.2 Snubber circuit, freewheeling diode, Thermistor, heat sink. 2.3 Turn off (commutation) method and types-Natural commutation, Forced commutation, Series resonance/ current commutation, Voltage commutation. 2.4 Auxiliary SCR for commutation. 2.5 External pulse commutation. 2.6 Specifications of SCR: Voltage, current, Power, temperature, dv/dt and di/dt

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit– III **Choppers**	3a. Explain the working principle of Chopper and its applications 3b. Compare the salient features of different types of choppers 3c. With sketches compare the working of Jone's Chopper and Morgan's chopper	3.1 Function and working of choppers 3.2 Types of chopper circuits: A type to E-type 3.3 Jone's chopper circuit 3.4 Morgan's chopper
Unit– IV **Inverters and Cycloconverter**	4a. Explain basic working principle of inverter 4b. Classify inverters 4c. With sketches, explain the working of inverter circuit using transistors and SCR. 4d. Distinguish the working of series and parallel inverters using SCR. 4e. Describe pulse width modulation technique and its techniques	4.1 Working principle of inverter 4.2 Classification of inverter- • phase and 3-phase inverters, • Line commutated and forced commutated inverters • Series, Parallel and bridge inverter 4.3 Series and parallel inverter using SCR 4.4 PWM method and PWM inverter 4.5 Single pulse width, Multiple pulse width and Sinusoidal pulse width modulation
	4f. Explain the working principle of cyclo-converter. 4g. Compare the salient features of various types of cyclo-converters.	4.6 Operating principle of cyclo converter. 4.7 types of cyclo-converters : Single phase to single phase cyclo converter, Single phase to bridge cyclo converter.
Unit-V **Other Industrial Applications of Power Electronic Devices**	5a. With sketches, explain the speed control of - a DC series motor using SCR chopper circuit & D.C. Motor using armature voltage control, D.C. drive using PLL method. 5b. With sketches, describe the use of power electronics for speed control of universal motor. 5.1 With sketches, describe the use of power electronics for speed control methods of induction motor such as stator voltage control, frequency control, Power factor control method. AC drives. 5c. With sketches, describe the use of power electronics devices in heating resistance welding static circuit breaker and time-delay circuit applications.	5.2 Speed control of D.C. Motor using armature voltage control. 5.3 Speed control of D.C. Motor using SCR chopper circuit. 5.4 Speed control of D.C. drive using PLL method. 5.5 Speed control of universal motor. 5.6 Different types of speed control methods for induction motor such as stator voltage control, frequency control, Power factor control method. 5.7 Heating control, resistance welding, static circuit breaker and time delay circuits.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Semi conductor devices and Controlled Rectifier	12	8	3	3	14
II	SCR Protection and Commutating circuits	16	12	4	4	20
III	Choppers	6	4	2	2	8
IV	Inverters and Cyclo converter	14	10	4	4	18
V	Other Industrial applications of Power Electronic Devices	8	2	2	6	10
	Total	**56**	**36**	**15**	**19**	**70**

Legends: R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty members should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx Hours.
1	I	Wire the three phase half wave rectifier & test the performance.	2
2	I	Wire the three phase full wave rectifier & test the performance.	2
3	I	Wire the Bridge rectifier & test the performance.	2
4	I	Check the performance of six phase half wave rectifier.	2
5	I	Analyze poly phase rectifier circuit performance through simulation	2
6	I	Test the performance of IGBT	2

S. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx Hours.
7	I	Test the performance of GTO	2
8	I	Test the performance of MCT	2
9	I	Compare the ratings and packages of IGBT, GTO, MCT using data sheet.	2
10	I	Test the performance of TRIAC for AC load control	2
11	I	Use R-C phase shift net work for firing angle Control of single phase controlled rectifier.	2
12	II	Troubleshoot Snubber circuits	2
13	II	Troubleshoot SCR commutating circuits.	2
14	III	Troubleshoot chopper circuits with load.	2
15	III	Perform test the DC motor for speed control using appropriate chopper circuit	2
16	III	Simulate chopper circuit, observe and print the various wave forms.	2
17	IV	Build/test parallel inverter using two SCRs.	2
18	IV	Test IC TL494 for PWM.	2
19	IV	Test 1-φ Cyclo-converter for different output frequencies.	2
20	V	Build Time delay relay circuit using UJT and SCR.	2
21	V	Test the Speed control of universal motor using SCR-UJT circuit.	2
22	V	Test the Speed control of DC motor using chopper circuits.	2
23	V	Test the Speed control of 3 phase induction motor using solid state devices.	2
24	V	Test the Speed control of motor using PLL method.	2
Total Hours (perform any practical worth 28 hours from above depending upon the availability of resources so that most units are covered)			**48**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

i. Prepare journals based on practical performed in laboratory.
ii. Prepare a report on various types of drives used in nearby industries.
iii. Assignments on solving numerical
iv. Prepare chart displaying various Power semiconductor devices and their symbols
v. Simulate various circuits in syllabus and take print out of various wave forms.
vi. Make a market survey for various types of thyristors available in market.
vii. Present a dynamic animations prepared or collected from the internet to illustrate the following:

- Working principle of inverter
- Working principle of PWM inverter
- Working principle of chopper

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Visit nearby industries to see the industrial applications of Power semiconductor devices and circuits

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Power Electronics	Rashid, Muhammad H.	PHI Learning, New Delhi latest edition
2.	Power Electronics	Gupta, B. R., Singhal V.,	S.K. Kataria and sons, New Delhi
3.	Power Electronics	Singh,M. D. K. Khanchandani, B.	Tata Mc. Graw Hill, New Delhi
4.	Power Electronics	Bimbhra, P.S.	Khanna Publisher, New Delhi latest edition
5.	Industries and power Electronics	Rai, H.C.	Umesh Publications. New Delhi latest edition
6.	Fundamentals of electric drives	Dubey, G. K.	Narosa Publishing house New Delhi latest edition
7.	Electric drives-concepts and applications	Subramanyan, V.	Tata McGraw-Hill, New Delhi latest edition

B) List of Major Equipment/Instrument with Broad Specifications

S. No.	Item and Specifications
1	DIAC, TRAIC, SCR, IGBT, GTO and MCT - 5 Nos. each of current rating at least 20 amps or above
2	Trainer Kits for testing the V-I characteristics of the following - 2 Nos. each: a) DIAC b) TRAIC c) SCR d) Power transistor e) Power MOSFET f) IGBT g) GTO h) MCT
3	Trainer kit to check the performance for different types of loads of the following - 2 Nos. each: a) 3-phase uncontrolled half wave rectifier b) 3-phase uncontrolled full wave rectifier
4	Trainer kit to check the performance using R, RL and RLC Load of the following - 2 Nos. each:

S. No.	Item and Specifications
	a) Fully controlled three phase half wave converter **b)** Fully controlled three phase Full wave converter
5	Trainer kit to check the performance of Three-phase semi-converter using R, RL and RLC Load of the following - 2 Nos.
6	Chopper Trainer kit to check the performance of the following for different types of loads - 2 Nos. each: a) IGBT Based Chopper Circuit b) Jones Chopper Trainer Circuit c) Morgan Chopper Trainer Circuit
7	Trainer kit to check the performance for different types of loads of the following - 2 Nos. each: a) Offline inverter b) Online inverter
8	Trainer kit to check the performance for different types of loads of the following - 2 Nos. each: a) Class A Load Commutation b) Class B Resonant Pulse Commutation c) Class C Complementary Commutation d) Class D Impulse or Auxiliary SCR commutation e) Class F Line or natural Commutation
9	Electric DC Drive Trainer consisting of the following controlling schemes - set: a) Speed control of dc DC shunt motor using single phase fully controlled converter b) Speed control of DC shunt motor using three phase fully controlled converter c) Armature and field control of DC shunt motor d) Speed control of DC shunt motor using SCR dual converter e) Thyristor chopper for DC motor drive f) DC series motor controller using jones chopper
10	Experimental set up to perform Speed control of a 3 phase WRIM using Kramer drive - 1 set
11	Experimental set up to perform Speed control of a 3 phase induction motor using v/f method - 1 set
12	Experimental set up to perform speed control of a DC shunt motor using open loop and PID control system through computer interfacing - 1 set
13	3 Phase Power Analyzer 3 Nos. with the following specifications: • 3 phase/1 phase measurement- • True RMS Voltage 600/1200 V • True RMS Current 80 A, • Power measurement (Active, reactive and apparent power), • Power factor measurement, • Frequency Measurement, • RS-232 serial communication, • LCD display

C) List of Software/Learning Websites

i. www.nptel.iitm.ac.in
ii. www.youtube (lectures on Power electronics)
iii. www.howstuffworks.com
iv. www.alldatasheet.com
v. MATLAB/SIMULINK
vi. Psim
vii. Electronics Work bench

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. H. C. Chawda**, Lecturer in Electrical Engineering, RC Technical Institute, Ahmedabad.
- **Prof. R.D. Panchal**, Lecturer in Electrical Engineering, RC Technical Institute, Ahmedabad
- **Dr. A.S. Pandya**, HOD in Electrical Engineering**,** G.P. Rajkot.
- **Prof. K. K. Kansara**, Lecturer in Electrical Engg., NMGPI Ranpur

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr (Mrs.) C. S. Rajeshwari** Professor and Head, Department of Electrical and Electronics Engineering,
- **Prof. Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering,