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

Power electronics belongs partly to Power Engineers and partly to electronics Engineers. Power Engineering is mainly concerned with generation, transmission, distribution and utilization of electrical energy at high efficiency. Power engineering is based mainly on electromagnetic principle whereas that in electronics engineering is based upon physical phenomenon and semiconductors. Power electronics is a subject that concerns the applications of electronic principles in to situation that are rated at power level rather than signal level. Many more semiconductor devices such as diac, triac thyristors, Mosfet, Transistors are available. The use of these semiconductor devices have provided the industrial applications relating to the field of electrical, electronics, instrumentation control engineering. The electrical engineers should be aware with the semiconductor technology in electrical engineering field. An effort is made to provide understanding of the construction and industrial applications of semiconductor devices, in this course to ensure that students have skills and awareness of different areas of electronics field.

2. COMPETENCY

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

- **Apply the power electronic methods of controls in Electrical Engg. field.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Use different components of thyristor family for converting ac electrical power to dc power.
ii. Protect SCR from over voltage and over current.
iii. Use commutating circuits to turn off SCR.
iv. Use chopper for controlling dc power.
v. Convert dc power to ac using inverter.
vi. Use cyclo converter for converting ac to ac electrical power.
vii. Maintain various electrical equipment which are controlled using power electronics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme1				
				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. Semi conductor devices and Controlled Rectifier	1a. Describe the working and application of Thyristor family. 1b. Justify the advantages of polyphase rectifiers. 1c. Explain various polyphase rectifiers with the help of circuits and waveforms.	**1.1** Introduction to Thyristor family. **1.2** Construction, working principle, symbol, characteristics and application of IGBT , GTO, MCT **1.3** Advantages and applications of polyphase rectifiers. **1.4** Three phase half wave rectifier. **1.5** Three phase full wave or bridge rectifier. **1.6** Six phase half wave rectifier. **1.7** Effect of transformer reactance. **1.8** Single phase half wave and full wave controlled rectifiers using SCR,UJT & phase shift circuits. **1.9** Construction and use of pulse transformer. **1.10** Understand principle of A.C. load control.
Unit– II SCR Protection & commutating Circuits	2a. Explain the need of protection of SCR. 2b. Describe the need of snubber circuit , free wheeling diode , thermistor and heat sink for SCR. 2c. State the features of different mounting methods of SCR. 2d. Interpret data sheet of SCR. 2e. State the need to turn off SCR. 2f. State and explain various types of commutation method.	**2.1** Need of protection. **2.2** Over voltage and over current protection. **2.3** dv/dt and di/dt ratings of SCR. **2.4** Use of Snubber circuit. **2.5** Use of free wheeling diode **2.6** Use of thermistor. **2.7** Use of heat sink. **2.8** Mounting of SCR. **2.9** Knowledge of different ratings of the SCR. **2.10** Need to turn off SCR **2.11** Types of commutation. **2.12** Natural commutation. **2.13** Forced commutating method. **2.14** Series Resonance/current commutation. **2.15** Voltage commutations. **2.16** Auxiliary SCR for commutation. **2.17** External pulse commutation.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit–III Choppers	3a. Explain the principle of chopper and its applications. 3b. Explain various types of chopper circuit.	**3.1** Principle of chopper. **3.2** Types of chopper circuit (A type to E-type) **3.3** Jhone's chopper circuit. **3.4** Morgans chopper circuit. **3.5** Applications of chopper.
Unit-IV Inverters & Cyclo Converter	4a. Explain the working principle of inverter. 4b. Explain inverter circuit using transistors and SCR. 4c. Explain series and parallel inverter using SCR. 4d. Use pulse width modulation technique. 4e. Explain the principle of cyclo-converter. 4f. Explain various types of cyclo-converter.	**4.1** Working principle of inverter. **4.2** Types of Inverter **4.3** Series inverter using SCR. **4.4** Parallel inverter-using SCR. **4.5** Use of pulse width modulation circuit. **4.6** Introduction to cyclo converter. **4.7** Operating principle. **4.8** Types of cyclo-converter. **4.9** Single phase to single phase cyclo converter. **4.10** Single phase to bridge cyclo converter.
Unit-V Industrial Applications	5a. Use of power electronics for speed control of various motors. 5b. Explain various power factor control method. 5c. Use of power electronics for heating control, resistance welding etc.	**5.1** Speed control of D.C. Motor using armature voltage control. **5.2** Speed control of D.C. Motor using SCR chopper circuit. **5.3** Speed control of D.C. drive using PLL method. **5.4** Speed control of universal motor. **5.5** Different types of speed control methods for induction motor such as stator voltage control, frequency control. **5.6** Power factor control method. **5.7** Application in 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 & Commutating circuits	16	12	4	4	20
III	Choppers	6	4	2	2	8
IV	Inverters & Cyclo converter	14	10	4	4	18
V	Industrial applications	8	2	2	6	10
	Total	**56**	**36**	**15**	**19**	**70**

Legends: R = Remember U = Understand; A = Apply and above levels (Bloom's revised 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/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed 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 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. required
1	I	Determine efficiency, voltage ratio and ripple factor of three phase half wave rectifier.	2
2	I	Determine efficiency, voltage ratio and ripple factor of three phase full wave rectifier or bridge rectifier.	2
3	I	Determine efficiency, voltage ratio and ripple factor of three phase six phase half wave rectifier.	2
4	I	Simulate poly phase rectifier circuit ,observe and print the various wave forms.	2
5	I	Identify the terminals of IGBT, perform test on IGBT & plot static characteristics .	2
6	I	Identify the terminals of GTO, perform test on GTO & plot static characteristics	2
7	I	Identify the terminals of MCT, perform test on MCT & plot static characteristics	2
8	I	Interpret ratings and packages of IGBT, GTO, MCT using data sheet.	2
9	I	Use TRIAC for AC load control observe various waveforms.	2
10	I	Use R-C phase shift net work for firing angle Control of single phase controlled rectifier.	2
11	II	Design a simple Snubber circuit.	2
12	II	Test any one or two SCR commutating circuits.	2
13	III	Test any one or two chopper circuits with load.	2
14	III	Perform speed control of DC motor using chopper circuit. Or any other chopper application	2
15	III	Simulate chopper circuit , observe and print the various wave forms.	2
16	IV	Build and test parallel inverter using two SCRS.	2
17	IV	Test IC TL494 for PWM.	2
18	IV	Test 1-φ Cycloconverter for different output frequencies.	2
19	V	Time delay relay circuit using UJT and SCR.	2
20	V	Perform Speed control of universal motor using SCR-UJT	2

		circuit.	
21	V	Perform Speed control of DC motor using chopper circuits.	2
22	V	Perform Speed control of 3 phase induction motor using solid state devices.	2
23	V	Perform Speed control of motor using PLL method.	2
24	V	Prepare a report on various types of drives used in nearby industries.	2

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare journals based on practical performed in laboratory.
ii. Prepare chart displaying various types of solid state devices in syllabus showing their symbols and pin diagram.
iii. Simulate various circuits in syllabus and take print out of various wave forms.
iv. Make a market survey for various types of thyristors available in market.

9. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Thyristor Engineering	M.S.Berde.	Khanna pub.
2.	Industries and power Electronics	H.C.Rai	Umesh Pub.
3.	Power Electronics	M. H. Rashid	Printice hall of India
4.	Power Electronics	P.C.Sen	
5.	Power Electronics	Dr. P.S.Bimbhra	Khanna Pub.
6.	Power Electronics	M.D.SINGH K.B.Khanchandani	

B) List of Major Equipment/ Instrument with Broad Specifications

i. Poly phase recitfier.	The kit works directly from 415V; three phase, 50Hz AC supply and all measuring meters connected externally. Loading arrangements are part of the kit. List of possible experiments on this kit are as following: 1. Three-phase half-wave uncontrolled (diode) rectifier with different types of load. 2. Three-phase full-wave uncontrolled (diode) rectifier with different types of load. 3. Three-phase half-wave controlled rectifier with R/R-L/R-L-E load. 4. Three- phase full-wave controlled rectifier with R / R-L / R- L-E load. 5. Three-phase semi-converter with R load/ R-L load / R-L-E load.
ii. Kit for characteristics.	SCR, IGBT, GTO, MCT
iii. Chopper Trainer Set.	This Chopper Trainer set should consists of the following module:

	1. IGBT Based Chopper Circuit 2. Jones Chopper Trainer Circuit 3. Morgan Chopper Trainer Circuit
iv. Different types of inverter trainer board	
v. Kit for Study of commutation methods	Different types of commutation Class A Load Commutation Class B Resonant Pulse Commutation Class C Complementary Commutation Class D Impulse or Auxiliary SCR commutation Class F Line or natural Commutation can be studied by using this module
vi. Electric DC Drive Trainer	The DC drive trainer should consist of following type of DC motor controlling schemes. 1. Speed control of dc shunt motor using single phase fully 2. Speed control of dc shunt motor using three phase fully controlled converter 3. Armature and field control of dc shunt motor 4. Speed control of dc shunt motor using scr dual converter 5. Thyristor chopper for dc motor drive 6. Dc series motor controller using jones chopper
vii. 3 Phase Power Analyzer	3 phase / 1 phase measurement True RMS Voltage 600/1200 V True RMS Current 80 A Power measurement (Active power, reactive power & 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
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

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