GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: INDUSTRIAL POWER CONTROL
(COURSE CODE: 3361702)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	Sixth

1. RATIONALE

In the present industrial scenario, role of the industrial power control instrumentation is becoming more important day by day. More advanced, precise and complex power control circuits and techniques are being employed in industry. Diploma engineers should therefore be able to identify, classify, troubleshoot and maintain the different industrial power control instrumentation systems. Therefore, this course has been designed so that students will learn to test, build, wire and troubleshoot the different types of industrial instrumentation circuits and components required for power plants mainly for the process parameter such as speed, level, pressure, frequency, phase, temperature, flow etc.

2. COMPETENCY

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

- **Maintain different types of industrial power control instrumentation system.**

3. COURSE OUTCOMES

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

i. Select relevant power control devices for the given industrial applications.
ii. Troubleshoot AC and DC power control circuits employing power devices.
iii. Troubleshoot inverter, chopper circuits.
iv. Maintain AC and DC drives.
v. Maintain Resistance welding equipment.

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**	
3	0	4	7	70	30	40	60	200

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

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. Power Semiconductor Devices	1a. Describe working of SCR, MOSFET and IGBT with the help of sketches. 1b. Analyze the characteristic curves of SCR, DIAC, TRIAC, PUT, IGBT and MOSFET. 1c. Explain SCR two transistor analogy and derive anode current equation. 1d. Explain the turn ON methods of thyristor (SCR) (triggering methods). 1e. Explain the turn OFF methods of SCR - commutation techniques of SCR. 1f. Describe working of snubber circuit for SCR. 1g. Compare the (features) characteristics of SCR, TRIAC, MOSFET and IGBT.	1.1. Industrial electronics devices :SCR,DIAC,TRIAC,PUT, MOSFET,IGBT 1.2. Triggering methods of SCR 1.3. Commutation techniques of SCR. 1.4. Snubber circuit, freewheeling of SCR.
	1h. Describe construction and working of Opto- Isolators. 1i. Describe construction and working of Opto-SCR.	1.5. Opto electronic devices concept. 1.6. Opto-Isolators, Opto-SCR.
Unit– II Power Converter and Cyclo Converter	2a. Explain working of half and full control bridge converter with resistive load. 2b. Explain working of Half and Full wave control bridge converter with R-L Load.	2.1. Control Converter using SCR.
	2c. Explain the working principle of single phase Bridge Cyclo-converter. 2d. Explain the working principle of single phase Mid-point Cyclo-converter.	2.2. Cyclo-Converter using SCR.
Unit– III Inverters and Choppers	3a. Explain the Principle and working of Series Inverter circuit. 3b. Explain the Principle and working of Parallel Inverter circuit. 3c. Explain the Principle and working of bridge type Inverter circuit.	3.1 Inverters: Series, Parallel and Bridge inverters.
	3d. Explain Basic D.C. chopper circuit. 3e. Explain the working principle of step up Chopper circuits. 3f. Explain the working principle of step down Chopper circuits.	3.2 Chopper: 3.2.1 Classification of chopper. 3.2.2 Step-up. 3.2.3 Step Down.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit IV Industrial Application of Power Electronics Devices	4a. Describe Speed control of D.C. Motor using armature voltage control with circuit. 4b. Describe stator voltage speed control for induction motor with circuit. 4c. Describe stepper motor drive circuit. 4d. Explain application like D.C. static switch, alarm circuit. 4e. Explain circuit diagram for Temperature control using mercury thermostat. 4f. Explain conductive Liquid level control circuit. 4g. Explain Ambient Light control power switch.	4.1 Speed control methods for 4.1.1 D.C motor 4.1.2 Induction motor 4.1.3 Stepper motor 4.2 Industrial Applications. 4.2.1 D.C. static switch. 4.2.2 Alarm circuit. 4.2.3 Temperature control. 4.2.4 Liquid level control. 4.2.5 Ambient Light control
	4h. Describe function of single phase AC power control circuit using DIAC-TRIAC with neat diagram. 4i. Describe function of DC power control circuit using SCR with UJT in triggering circuit with circuit diagram.	4.3 Single phase AC power control using DIAC-TRIAC. 4.4 UJT Triggered SCR power control.
Unit-V Resistance Welding Control	5a. Describe types of Resistance Welding. 5b. Explain the terms related to resistance welding. 5c. Explain duty cycle for resistance welding process. 5d. Explain basic circuit for resistance welding process. 5e. Explain SCR electronic line contactor circuit. 5f. Explain heat control using UJT and SCR. 5g. Explain electronics circuit for weld control sequences. 5h. Describe energy storage welding. 5i. Compare resistance and conventional welding Process.	5.1 Resistance Welding. 5.1.1 Classification: spot, butt, seam, projection, flash. 5.1.2 Duty cycle. 5.1.3 Resistance welding scheme. 5.1.4 Electronics Line contactor. 5.1.5 Heat control circuit. 5.1.6 Sequence Timer. 5.1.7 Energy storage welding. 5.1.8 Comparison of welding methods.

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	Power Semiconductor Devices	8	6	8	4	18
II	Power converter and Cyclo Converter	8	2	4	8	14
III	Inverters and Choppers	8	2	4	4	10
IV	Industrial Application of Power Electronics Devices	10	4	10	4	18
V	Resistance Welding Control	8	4	4	2	10
	Total	**42**	**18**	**30**	**22**	**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 EXERCISES/PRACTICALS

The practical 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. However, if these practical 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.

Sr. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Approx. Hours required
1	I	Test V/I Characteristics of SCR.	02
2	I	Test V/I Characteristics of DIAC.	02
3	I	Test V/I Characteristics of TRIAC.	02
4	I	Test Characteristics of Opto-Isolator.	02
5	I	Test Characteristics of power MOSFET.	02
6	I	Test Characteristics of UJT.	02
7	I	Test R-C phase shift control of SCR using UJT.	02
8	I	Test outputs of PUT as relaxation oscillator using MULTISIM.	02
9	I	Test outputs of Class A Load Commutation using MULTISIM.	02
10	I	Test outputs of Class A Load Commutation using physical components.	02

Sr. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Approx. Hours required
11	I	Test outputs of Class B Resonant Pulse Commutation using MULTISIM.	02
12	I	Verify outputs of Class B Resonant Pulse Commutation using physical components.	02
13	I	Test outputs of Class C Complementary Commutation using MULTISIM.	02
14	I	Test outputs of Class C Complementary Commutation using physical components.	02
15	I	Test outputs of Class D Impulse or Auxiliary SCR commutation using MULTISIM.	02
16	I	Test outputs of Class D Impulse or Auxiliary SCR commutation using physical components.	02
17	I	Test outputs of Class F Line or natural Commutation using MULTISIM.	02
18	I	Test outputs of Class F Line or natural Commutation using physical components.	02
19	II	Test Half control bridge converter.	02
20	II	Test Full control bridge converter.	02
21	III	Test parallel inverter using two SCRs	02
22	III	Test basic operation of series Inverter.	02
23	III	Test chopper circuits with load.	02
24	IV	Test speed control of A.C. Motor using DIAC-TRIAC.	02
25	IV	Test D.C motor speed control using chopper.	02
26	IV	Test alarm circuit using MULTISIM.	02
27	IV	Test D.C Static switch using MULTISIM.	02
28	V	Test Sequential Timer operation using IC-555 for resistance welding process.	02
Total			**56**

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare journals based on practical performed in laboratory.
ii. Do assignments related theory topics.
iii. Learn troubleshooting techniques and steps to troubleshoot DC motor, AC motor.
iv. Learn troubleshooting steps to troubleshoot inverter.
v. Check the performance of chopper, inverter using simulation software like MATLAB.
vi. Visit industries such as chemical industries, petroleum industries, production industries, manufacturing industries, automobile industries, power Industries etc. and study various instruments used.
vii. Take up a small technical projects based on any advance theory topic.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Show video/animation film to demonstrate the working principles, constructional features, testing and maintenance of different types of power control devices.
ii. Use Flash/Animations to explain the working of different DC, AC and stepper motor.

iii. Arrange Industrial Visit for students (chemical industries, petroleum industries, production industries, Manufacturing industries, Automobile industries, Power Industries)
iv. Ask students to explore internet about recent developments and prepare seminar presentations on relevant topics.
v. Give mini technical projects based on advance theory topics.
vi. Arrange expert lectures of instrumentation engineers working in industries.

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1.	Industrial Electronics and Control	Bhattacharya S K and Chatterjee S.	TMH Publication,New Delhi
2.	Power Electronics	Singh M D and Khanchandani K.B.	TMH Publication,New Delhi
3.	Power Electronics And Its Applications	Jain Alok	Penram International Publication, New Delhi
4.	Power Electronics	Bimmhra B S	Khanna Publication,New Delhi
5.	Industrial Electronics And Control	Paul Biswanath	PHI Learning New Delhi
6.	Power Electronics-Devices, Circuits, Systems And Applications	Rai Harish C.	Galgotia Publication,New Delhi

B) Major Equipment/ Instrument with Broad Specifications

i. Function Generator: Sine, square, triangle Wave etc. with frequency range 10 Hz to 100 kHz
ii. DC power supply: -30 →0→+30 V with at least 1A current capacity.
iii. Dual channel CRO: At least 20MHz or higher
iv. Multi meter: Capable of measuring AC and DC current, voltage and resistance.
v. Electrical tool kit: Maintenance of trainer boards.
vi. Circuit/Trainer board/ Demonstration modules: For performing relevant practical's with inbuilt power supply

C) 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. Electronics Work bench.
vii. MULTISIM.
viii. Scilab.
ix. Caspoc.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. S. Z. Shyara,** Sr. Lecturer, A.V.P.T.I. Rajkot
- **Prof R. D. Sathvara,** Sr. Lecturer, G.P. Gandhinagar
- **Prof. A. M. Patel,** Sr. Lecturer, G.P. Palanpur
- **Prof. H. P. Patel,** Lecturer, G.P. Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

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