

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

**COURSE TITLE: INDUSTRIAL ELECTRONICS**  
**(Code: 3341105)**

| <b>Diploma Programme in which this course is offered</b> | <b>Semester in which offered</b> |
|--|----------------------------------|
| Electronics and Communication Engineering                | 4th Semester                     |

### 1. RATIONALE

Exposure to application oriented electronic circuits commonly used in the industries are very essential for Diploma holder of Electronics and Communication Engineering. This course will enable the students to understand the construction, working, and applications of various types of power electronic components like SCR, DIAC, TRIAC, IGBT and applications based circuits such as fan regulator, photo-electric relay, AC/DC power controller, Polyphase rectifier, Inverters etc. Hence study of this course will enable the students to test and troubleshoot the Industrial electronic circuits and components.

### 2. COMPETENCY (Programme outcome according to NBA Terminology)

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:

- Maintain the industrial electronic equipments.

### 3. COURSE OUTCOMES

1. Choose relevant thyristor for the given application
2. Troubleshoot AC & DC power control circuits employing thyristors
3. Troubleshoot inverter, chopper and cyclo-converters
4. Use photoelectric devices in relevant applications
5. Use different types of timers in specific applications
6. Maintain induction heating and dielectric heating equipment

### 4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme<br>(In Hours) |    |    | Total<br>Credits<br>(L+T+P) | Examination Scheme |    |                    |    | Total<br>Marks |
|-------------------------------|----|----|-----------------------------|--------------------|----|--------------------|----|----------------|
|                               |    |    |                             | Theory Marks       |    | Practical<br>Marks |    |                |
| L                             | T  | P  | C                           | ESE                | PA | ESE                | PA |                |
| 04                            | 00 | 02 | 06                          | 70                 | 30 | 20                 | 30 | <b>150</b>     |

**Legends:** **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

## 5. COURSE DETAILS

| Unit  | Major Learning Outcomes   | Topics and Sub-topics  |
|---|---|--|
| <b>Unit-I</b><br>Introduction to Thyristors | 1a Describe working of Thyristors with the help of characteristic curve.                    | 1.1 Construction, characteristics, working and applications of SCR, DIAC, TRIAC, PUT, IGBT                           |
|   | 1b Draw the characteristic curve of SCR,IGBT,DIAC etc.                                      | 1.2 Working of SCR using transistor analogy  |
|   | 1c Explain the turn ON – turn OFF method of thyristor                                       | 1.3 Triggering methods of SCR<br>1.4 Commutation techniques of SCR   |
|   | 1d Describe working of Opto-couplers, Opto-Isolators, Opto-TRIAC, Opto-SCR, Opto-transistor | 1.5 Construction, characteristics, working and applications of Opto-Isolators, Opto-TRIAC, Opto-SCR, Opto-transistor |
| <b>Unit-II</b><br>Thyristor Applications    | 2a Explain working of various types of control rectifier circuits using SCR.                | 2.1 Half & Full wave control bridge rectifiers using SCR<br>2.2 SCR as a static switch                               |
|   | 2b Describe function of AC power control circuit using DIAC-TRIAC.                          | 2.3 AC power control using DIAC-TRIAC  |
|   | 2c Describe function of DC power control circuit using SCR and UJT in triggering circuit .  | 2.4 UJT Triggered SCR power control.   |
|   | 2d Select the appropriate Photoelectric devices for switching in power control application  | 2.5 Photo electric relay/switch using LDR, LASCR, photodiode   |
|   | 2e Explain the working of various Solid State relays  | 2.6 Solid state relay using Opto-TRIAC, Opto-SCR, Opto-transistor  |
| <b>Unit-III</b><br>Power Converters         | 3a Compare single and Poly-phase rectifier circuits.  | 3.1 Comparisons of Single phase rectifiers and Polyphase rectifiers  |
|   | 3b Explain working of Three-phase H.W. & Three-phase F.W. rectifiers.                       | 3.2 Three-phase H.W. & Three-phase F.W. rectifiers   |
|   | 3c Explain the working of various types Inverter circuits.                                  | 3.3 Principle, working and applications of Series, Parallel and bridge Inverters                                     |
|   | 3d Describe the working of Cyclo converter circuits   | 3.4 Principle, working and applications of Single phase cyclo-converters   |
|   | 3e Explain the working of Chopper circuits.   | 3.5 Principle, working and applications of chopper   |

|  |   |   |
|--|---|---|
|  | <p>3f Describe the working of UPS &amp; SMPS with the help of block diagram.</p> <p>3g List the technical specifications of UPS and SMPS.</p> | <p>3.6 UPS - Block diagram, working and applications</p> <p>3.7 SMPS - Block diagram, working and applications</p>  |
| <b>Unit-IV</b><br>Timers and High Frequency applications | <p>4a Explain basic time constant circuit.</p> <p>4b Simulate various timing circuits using IC 555 and IC 556 for relevant application.</p>   | <p>4.1 Principles of RC timing circuits</p> <p>4.2 Timer using IC555</p> <p>4.3 Sequential timer using IC555, IC556</p> <p>4.4 SCR Delay timer</p> <p>4.5 Programmable timer using IC XR-2240</p>   |
|  | <p>4c Describe the principle of Induction heating.</p> <p>4d List application of Induction heating.</p>                                       | <p>4.6 Principle, working, merits-demerits and applications of Induction heating</p>  |
|  | <p>4e Describe the principle of Dielectric heating.</p> <p>4f List application of Dielectric heating</p>                                      | <p>4.7 Principle, working, merits-demerits and applications of Dielectric heating</p>   |
|  |   |   |
| <b>Unit-V</b><br>Solid State Controls                    | <p>5a Describe the working of Open loop and close loop control</p>  | <p>5.1 Definition, block diagram, working and comparison of open loop and close loop control system.</p>  |
|  | <p>5b Explain the working of various types of Motors i.e. Series, Shunt, Universal, Servo and Stepper motor.</p>                              | <p>5.2 Single phase DC shunt motor and its speed control using thyristors</p> <p>5.3 Single phase Induction motor (AC motor) and its speed control using thyristors</p> <p>5.4 Universal motor and its speed control</p> <p>5.5 Stepper motor – construction, working and applications</p> <p>5.6 Servo motor - construction, working and its applications.</p> |
|  | <p>5c Explain the working of Synchronos</p>   | <p>5.7 Synchronos - construction, working and its applications.</p>   |
|  | <p>5d Draw the block diagram of Programmable Logic Control and explain the function of each block</p>   | <p>5.8 Programmable Logic Control - block diagram, working, advantages, applications.</p> <p>5.9. Scan time of PLC</p>  |

## 6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

| Unit  | Unit Title                             | Teaching Hours | Distribution of Theory Marks |         |         |             |
|-------|--|----------------|------------------------------|---------|---------|-------------|
|       |  |                | R Level                      | U Level | A Level | Total Marks |
| I     | Introduction to Thyristors             | 12             | 6                            | 6       | 4       | 16          |
| II    | Thyristor Applications                 | 10             | 2                            | 4       | 6       | 12          |
| III   | Power Converters                       | 12             | 3                            | 4       | 8       | 15          |
| IV    | Timers and High Frequency applications | 10             | 6                            | 4       | 2       | 12          |
| V     | Solid State Controls                   | 12             | 3                            | 4       | 8       | 15          |
| Total |  | 56             | 20                           | 22      | 28      | 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/PRACTICAL

| S. No | Unit No. | Practical/Exercise (Outcomes' in Psychomotor Domain) | Approx Hrs. Required |
|-------|----------|--|----------------------|
| 1     | I        | Plot V/I Characteristics of SCR                      | 2                    |
| 2     | I        | Plot V/I Characteristics of DIAC                     | 2                    |
| 3     | I        | Plot V/I Characteristics of TRIAC                    | 2                    |
| 4     | I        | Plot Characteristics of Opto-Isolator                | 2                    |
| 5     | I        | Perform R-C phase shift control of SCR               | 2                    |
| 6     | II       | Demonstrate dv/dt limitation of SCR                  | 2                    |
| 7     | II       | Test Half control bridge rectifier with filter       | 2                    |
| 8     | II       | Test Light operated Relay/Photo-electric switch      | 2                    |
| 9     | II       | Obtain Characteristics of LASCR                      | 2                    |
| 10    | III      | Measure efficiency of Poly phase Rectifier           | 2                    |
| 11    | III      | Measure Load/Line regulation of SMPS                 | 2                    |
| 12    | IV       | Implement RC Timer using Zener diode & Transistor    | 2                    |
| 13    | IV       | Perform Sequential Timer operation using IC-555      | 2                    |
| 14    | IV       | Implement On-delay timer using IC-555                | 2                    |
| 15    | IV       | Implement Delay timer using SCR                      | 2                    |
| 16    | IV       | Implement Programmable Timer IC-XR2240               | 2                    |

|    |   |   |   |
|----|---|---|---|
| 17 | V | Measure Speed of DC shunt motor controlled by open loop–close loop control system | 2 |
| 18 | V | Measure Speed of Universal Motor controlled by SCR/TRIAC                          | 2 |
| 19 | V | Test Characteristics of Solid State Relay   | 2 |
| 20 | V | AC Single phase Servomotor FW/REV control   | 2 |
| 21 | V | Perform the position control using synchro transmitter & synchro receiver.        | 2 |

### 8. SUGGESTED LIST OF STUDENT ACTIVITIES

1. Find Specifications and package of SCR, TRIAC, DIAC, PUT from datasheet.
2. Find Specifications and package of Opto-TRIAC, Opto-SCR, Opto-Transistor from datasheet.
3. Find Specifications and package of IC-555, IC-556, IC-XR2240 from datasheet.
4. Find Specifications and package of DC shunt motor, Induction motor, Universal motor, Synchro, Servo motor from datasheet.
5. **Mini projects: (Should be given individual basis )**
  1. Fan regulator using TRIAC/DIAC
  2. Light operated Relay
  3. Cyclic Timer using IC555
  4. Star-Delta timer using IC 555
  5. Solid State Relay using Diac-Triac
  6. SCR Firing using UJT
  7. Tone burst modulation using IC 556
  8. Project on XR2240
  9. SMPS based on IC 7840
  10. Projects on MOC3011
  11. Projects on MOC3031
  12. Zero cross detector using PC817

### 9. SPECIAL INSTRUCTIONAL STRATEGIES

1. Industrial Visit
2. Through assigned mini Project
3. Organising expert lecture

### 10. SUGGESTED LEARNING RESOURCES

1. Power point Presentation
2. Video lectures

#### A) List of Books

| No. | Title of Book                      | Author                          | Publication         |
|-----|------------------------------------|---------------------------------|---------------------|
| 1   | Industrial Electronics and Control | S.K.Bhattacharya & S.Chatterjee | TTTT,<br>Chandigarh |

|   |                                  |                                   |                   |
|---|----------------------------------|-----------------------------------|-------------------|
| 2 | Industrial Electronics           | G.K. Mithal                       | Khanna            |
| 3 | Industrial and Power Electronics | Harish C. Rai                     | Umesh Publication |
| 4 | Thyristor Engineering            | M.S. Berde                        | Khanna            |
| 5 | Electronics in Industry          | George M. Chute & Robert D. Chute | McGraw-Hill       |
| 6 | Power Electronics                | M.H. Rashid                       | PHI               |
| 7 | Industrial electronics Manual    | Paul Zbar                         | McGraw Hill       |

### B) List of Major Equipment/Materials with Broad Specifications

1. Trainer kits for
  1. SCR, DIAC, TRIAC
  2. Photo devices, LASCR, Opto-TRIAC
  3. Controlled Rectifier
  4. Polyphase rectifiers, Inverters
  5. SMPS
  6. IC-555 timer, Sequential Timer
  7. Speed control of AC/DC Motor, Universal motor, AC Servomotor
  8. Synchros
  9. Solid State Relay
2. CRO, Function Generator, Power supply, Digital multi meter, bread board
3. Consumables Component:
  - IC555/556, XR2240, MOC3011, MOC3031, PC817, MCT2E, SCR S104, TYN604, TRIAC BT136, DIAC DB32

### C) List of Software/Learning Websites

Common website for Industrial electronics:

- Datasheets: <http://www.epanorama.net/links/searchlinks.html#datasheets>
- Thyristor: (1) <http://www.epanorama.net/links/componentinfo.html#thyristor>  
 (2) <http://en.wikipedia.org/wiki/Thyristor>
- SCR: <http://www.allaboutcircuits.com>
- Opto-Electronics: <http://www.epanorama.net/links/lights.html#dimmer>
- Opto-isolator: <http://en.wikipedia.org/wiki/Opto-isolator>
- Solid State Relay: [http://en.wikipedia.org/wiki/Solid-state\\_relay](http://en.wikipedia.org/wiki/Solid-state_relay)
- UPS: <http://www.epanorama.net/links/psu.html>
- PLC: (1) <http://www.epanorama.net/links/automation.html#plc>  
 (2) [http://en.wikipedia.org/wiki/Programmable\\_logic\\_controller](http://en.wikipedia.org/wiki/Programmable_logic_controller)

Motors: <http://www.epanorama.net/links/motorcontrol.html>  
AC/DC motors: <http://en.wikipedia.org/wiki/Motor>  
Stepper motor: [http://en.wikipedia.org/wiki/Stepper\\_motor](http://en.wikipedia.org/wiki/Stepper_motor)  
Universal motor: [http://en.wikipedia.org/wiki/Universal\\_motor](http://en.wikipedia.org/wiki/Universal_motor)  
Servo motor: <http://en.wikipedia.org/wiki/Servomotor>  
Synchro: <http://en.wikipedia.org/wiki/Synchro>  
Induction heating: [http://en.wikipedia.org/wiki/Induction\\_heating](http://en.wikipedia.org/wiki/Induction_heating)  
Dielectric heating: [http://en.wikipedia.org/wiki/Dielectric\\_heating](http://en.wikipedia.org/wiki/Dielectric_heating)

## **11. COURSE CURRICULUM DEVELOPMENT COMMITTEE**

### **Faculty Members from Polytechnics**

1. Shri T. P. Chanpura, Lecturer (EC), Government Polytechnic, Ahmedabad.
2. Shri T. R. Parmar, Lecturer (EC), Government Polytechnic, , G.P. Palanpur
3. Shri S. G. Valvi, Lecturer (EC), Government Polytechnic, , G.P. Palanpur
4. Shri N M Rindani, Lecturer (EC), Government Polytechnic, AVPTI, Rajkot

### **Coordinator and Faculty Members from NITTTR Bhopal**

Dr. (Mrs.)Anjali potnis ,Assistant Professor , DEEE, NITTTR, Bhopal