**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM**

**Course Title: ELECTRICAL INSTRUMENTION**
**(Code: 3330903)**

| Diploma Programme in which this course is offered | Semester in which offered |
|---|---|
| Electrical Engineering | Third Semester |

## 1. RATIONALE :

Various types of instrumentation system have to be maintained and operated by diploma electrical engineering holders. This requires the students to understand the theory and the practical related to regarding the working. Therefore this course is designed these needs to work efficiently and effectively in the industry.

## 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:

- **Maintain different types of electrical instrumentation systems**

## 3. 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 | 150 |
| 04 | 00 | 02 | 06 | 70 | 30 | 20 | 30 | |

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

**Note:** It is the responsibility of the institute heads that marks for **PA of theory & ESE and PA of practical** for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

## 4. COURSE DETAILS

| Unit | Major Learning Outcomes | Topics and Sub-topics |
|---|---|---|
| **Unit – I**<br>**Fundamentals of measurement & instrumentation** | 1a.Explain the different terms related to measurement<br>1b.Differntiate between different types of errors<br>1c Identify sources of errors | 1.1 Fundamentals of measurement<br>1.2 Aims of measurement<br>1.3 Basic methods of measurement like direct and indirect methods.<br>1.4 Definitions of basic terms related to measurement : range , true value, indicated value, correction, sensitivity, repeatability, reproducibility, precision, significant figure, etc<br>1.5 Types and sources of error : gross error, systematic error , random error |
| **Unit – II**<br>**Potentiometers and Bridges** | 2a.Explain the working principle of DC potentiometer<br>2b.Explain the working principle of various bridges<br>2c. Select a bridge to determine various electrical parameters | 2.1 DC potentiometer, principle, working and list of applications<br>2.2 Different types of potentiometer like dial type and Crompton type.<br>2.3 Measurement of unknown resistance by Wheatstone bridge and Kelvin's bridge and Wien bridge for measurement of capacitance<br>2.4 Universal impedance bridge<br>2.5 Balanced bridges<br>2.6 Unbalanced bridges: single, two and four variable arm unbalanced Wheatstone bridge.<br>2.7 Self balancing bridges: ac and dc type. |
| **Unit – III**<br>**Electromechanical Instruments** | 3a. Explain the construction, working and features of various instruments.<br>3b. Select different types of electro-mechanical instruments for different kind of measurement.<br>3c.Derive the formula for shunt and multipliers | 3.1 Classification of instruments based on: absolute and secondary instrument, principal of operation, quantity instrument measure, kind of current, role of instrument, accuracy.<br>3.2 Essential torques in indicating instruments : deflecting , controlling and damping<br>3.3 Cconstruction , working, common errors and applications of<br>(a) Moving iron instruments: ammeter, voltmeter, frequency meter, power factor meter.<br>(b) PMMC instrument: ammeter, voltmeter, galvanometer.<br>(c) Dynamometer type meter: ammeter, voltmeter, wattmeter, power factor meter.<br>(d) Multimeter<br>(e) Energy meter (single phase, three phase)<br>(f) Trivector meter |

| Unit | Major Learning Outcomes | Topics and Sub-topics |
|---|---|---|
| | | (g) Maximum demand meter<br>(h) Megger<br>(i) Earth tester<br>(j) Phase sequence indicator<br>(k) Solid state energy meter<br>(l) Clip on meter<br>3.4 Extension of range of measuring instruments using shunt, multipliers and derive equation for them.<br>3.5 Extension of range using instrument transformer like CT and PT |
| **Unit – IV Calibration and Testing** | 4a. Explain the necessity of calibration<br>4b.Calibrate various electrical instruments | 4.1 Calibration and its importance.<br>4.2 Calibration of ammeter, voltmeter and wattmeter as per IS<br>4.3 Calibration of single phase energy meter and its adjustments as per IS code |
| **Unit – V Transducers** | 5a.Explain transducer<br>5b.Select transducer for various non-electrical quantities measurement | 5.1 Definitions of Transducer<br>5.2 Classification of Transducer: self generating analog, variable parameter analog, frequency generating and digital type.<br>5.3 Types of error in Transducer : non-linearity, repeatability, ageing etc<br>5.4 Selection of Transducer<br>5.5 Application of Transducer for measurement of<br>(a) Displacement: LVDT, capacitive, etc.<br>(b) Pressure: strain gauge, inductive, pirani, etc.<br>(c) Weight : LVDT, strain gauge, etc<br>(d) Viscosity: resistive, capacitive, etc.<br>(e) Moisture content: resistive, capacitive, etc.<br>(f) Liquid level: LVDT, resistive, etc.<br>(g) Speed: magnetic, photo pulse, etc.<br>(h) Thickness: capacitive, inductive, etc.<br>(i) Flow : hot wire anemometer, strain gauge, etc<br>(j) Density of liquid : photo cell and LVDT<br>(k) Length: LVDT, resistive, etc.<br>(l) Force : piezo electric,<br>(m) Light intensity<br>(n) PH measurement<br>(m) Temperature : thermocouple , thermister, etc<br>5.6 Selection of Transducer for specific application |

| Unit | Major Learning Outcomes | Topics and Sub-topics |
|---|---|---|
| **Unit – VI**<br><br>**Three phase power measurement** | 6a. Perform measurement of active power and reactive power<br>6b. Select different methods to measure three phase power in circuits | 6.1 Measurement of Active power using one watt meter (single phase), two watt meter method considering effect of load power factor (three phase), and three watt meter method (three phase).<br>6.2 Measurement of Reactive power in single phase and three phase circuit.<br>6.3 Two wattmeter method for measurement of three phase power |

## 5. 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 | Fundamentals of measurement and instrumentation | 06 | 3 | 3 | 1 | 7 |
| II | Potentiometers and Bridges | 10 | 4 | 7 | 3 | 14 |
| III | Electromechanical Instruments | 16 | 7 | 8 | 6 | 21 |
| IV | Calibration and Testing | 06 | 1 | 3 | 3 | 7 |
| V | Transducers | 12 | 5 | 5 | 4 | 14 |
| VI | Three phase power measurement | 06 | 1 | 2 | 4 | 7 |
| **Total** | | **56** | **21** | **28** | **21** | **70** |

**Legends:** R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

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

## 6. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills so that students are able to acquire the competency. Following is the list of experiments for guidance.

| S. No. | Unit No. | Practical/Exercise | Apprx. Hrs. Required |
|---|---|---|---|
| 1 | II | Test the medium resistance using Wheatstone bridge | 2 |
| 2 | II | Test the low resistance using Kelvin bridge | 2 |

| S. No. | Unit No. | Practical/Exercise | Apprx. Hrs. Required |
|---|---|---|---|
| 3 | II | Test the inductance by using Universal Impedance bridge | 2 |
| 4 | II | Test the capacitance by using Universal Impedance bridge | 2 |
| 5 | II | Use DC ammeter and voltmeter for different ranges | 4 |
| 6 | II | Use Moving Iron voltmeter and ammeter for different ranges | 4 |
| 7 | II | Measure maximum demand using Maximum demand meter | 2 |
| 8 | II | Use Megger for finding resistance of winding insulation | 2 |
| 9 | III | Calibrate Ammeter as per IS | 2 |
| 10 | III | Calibrate Voltmeter as per IS | 2 |
| 11 | III | Calibrate Single phase energy meter as per IS | 2 |
| 12 | III | Use clip on meter for measuring different electrical parameters | |
| 13 | V | Measure Linear displacement using LVDT. | 2 |
| 14 | V | Use Thermocouple to control the temperature of a furnace . | 2 |
| 15 | V | Test the Automatic Control of speed control for D.C. motor using tachogenerator | 2 |
| 16 | V | Test the strain using strain gauge. | 2 |
| 17 | VI | Test Power and Power factor(using power factor meter) using two wattmeter method for three phase circuits | 4 |
| | | **Total** | **36** |

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

i. Prepare chart for understanding various electro-mechanical instruments
ii. Seminar
iii. Search various latest measuring instruments available in market
iv. Ratings of current transformer and potential transformer

## 8. SUGGESTED LEARNING RESOURCES

### (A) List of Books:

| S. No. | Title of Books | Author | Publication |
|---|---|---|---|
| 1 | Electrical and electronic instruments | Sawhney, A .K . | Dhanpat Rai Publications, New Delhi, 2010 |
| 2 | Electrical Measurements: fundamentals, concepts, applications | Reissland, M.U. | New Age International publishers, New Delhi, 2008 |
| 3 | A course in electronics & electrical measurement & instrumentation | Gupta ,J.B. | S.K. Kataria and Sons, New Delhi, 2011 |
| 4 | Principles of measurement & Instrumentation | Morris ,Alan. S | PHI publication, New Delhi, 2011 |
| 5 | Electrical Instrumentation | Bakshi, U.A., Bakshi A.V. | Technical Publication, Pune,2009 |
| 6 | Mechanical and industrial measurements , | Jain ,R.K. | Khanna Publication, New Delhi, 2010 |
| | | | |

| S. No. | Title of Books | Author | Publication |
|---|---|---|---|
| 7 | Electrical Measurements and measuring instruments | Golding, E.W., Widdis, F.C. | Reem publications New Delhi, 2011 |
| 8 | Electronic Measurements and Instrumentation | K. Lal Kishore | Pearson, New Delhi, 2011 |

## B. List of Major Equipment/Materials with Broad Specification

i. DC potentiometer : *0 - 1.1V D.C, TEST TERMINALS, COARSE & FINE adjustment*

ii. Wheatstone bridge : *Measuring Range- 1.000Ω to 10.00MΩ, Measuring Arm- x 1mΩ, x 10Ω + 10Ω x 10 + 100Ω x 10 + 1000Ω x10 (min. one step: 1Ω),* ***Ratio Arms-*** *x 0.001 x 0.01, x 0.01, x 0.1, x 1, x 10, 100, x 1000 (M10, M100, M1000 Murray & Varley loop testing),* ***Galvanometer Power Source*** *-Three 1.5V batteries (built-in), Range, ±0.1% of reading on 100Ω to 100kΩ Range,* ***Accuracy-*** *±0.3% of reading on 10Ω to 1MΩ Range, ±0.6% of reading on 1Ω to 10MΩ Range*

iii. Kelvin double bridge : *Range : 0.2 Micro - Ohms to 11 ohms, Accuracy : 0.1% (or ±1 Slide wire division whichever is greater), Multiplier : 5 Ranges (0.01, 0.1, 1, 10 & 100)*

*iv.* Weins bridge : *Biasing Voltage : +12V, -12V DC etc..*

*v.* Universal impedance bridge: *Basic accuracy- 0.3%, Versatile , portable , compact LCR Meter for L-Q , C-D , R-Q, |Z|-Q measurements, Measurement frequencies 100 Hz, 120 Hz and 1 kHz*

*vi.* LCR meter : *Basic accuracy- 0.3%, Versatile , portable , compact LCR Meter for L-Q , C-D , R-Q, |Z|-Q measurements, Measurement frequencies 100 Hz, 120 Hz and 1 kHz*

*vii.* Energy meter : *1Ø and 3Ø analog and digital meters with latest specifications*

viii. Power factor meter : *Analog and digital meters with latest specifications*

ix. Trivector meter : *With latest specifications*

x. Two element wattmeter : *With latest specifications*

xi. Three phase power factor meter : *Analog and digital meters with latest specifications*

*xii.* Megger : *Mains / battery pack operated ( Capable of continuous duty for P.I. measurement of large Generators ) analog/ digital insulation tester with selectable ranges of 50V, 250V, 500 V, 1000 V, 2500 V , 5000 V.*

xiii. Phase sequence indicator: *Analog and digital meters with latest specifications*

xiv. Clip on meter : *Analog and digital meters with latest specifications* With true-rms ac voltage and current measurements, the Fluke 373 Clamp Meter reads up to 600 A ac and 600 V ac or dc.

xv. Current transformer:

xvi. Decade resistance box: *Accuracy: ± 1%, Max. D.C. voltage : 400 volts, jack-topped binding posts are used as output terminals*

*xvii.* Range extension board : *+12V D.C. at 50mA I.C.regulated Power Supply for Sine wave Oscillator*

xviii. Shunts with ammeters: *Accuracy: ± 1%, Measuring Range in ohms like - x 0.001 x 0.01, x 0.01, x 0.1, x 1, x 10, 100, x 1000*

*xix.* Linear variable differential transducer : *±12V D.C. at 50mA I.C.regulated Power Supply for Sine wave Oscillator*

*xx.* Strain gauge: *±12V D.C. at 50mA I.C.regulated Power Supply for Sine wave Oscillator*

xxi. Thermo-couple : *Types B, E, J, K, R, S, T and C thermocouples*

*xxii.* Thermistor :*as per standard specification and latest configurations*

xxiii. PH meter:

*xxiv.* Multiple transducer kit: *Inbuilt power supply , measurement facility, expansion facility and with latest features like computer interface etc.*

**C List of Software/Learning Websites**

i. Electronics work bench

ii. www.scientechworld.com

iii. www.ni.com/labview/

iv. www.scientificindia.com/home/scientificindia.asp

v. http://electricalandelectronics.org/

vi. www.electrical-electronics.co.in/

**9. INSTRUCTION STRATEGY** :

i. Use Power point presentation
ii. Use Over-head projector
iii. Use case study
iv. Make field visit

## 10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

**Faculty Members from Polytechnics**

- Shri S.S.Mehta, Sr. Lecturer, Electrical Engineering Department, B&B Institute of Technology,Vallabhvidyanagar.
- Ms.V.R.Kotdawala, Sr. Lecturer, Electrical Engineering Department, Govt. Polytechnic, Himmatnagar.
- Prof. A.A. Parmar, Sr. Lecturer, Electrical Engineering Department, B&B Institute of Technology,Vallabhvidyanagar
- Prof. J.K. Rathod, HOD, Electrical Engg. Dept., Tolani F.G. Polytechnic, Adipur

**Coordinator and Faculty Members from NITTTR Bhopal**