# GUJARAT TECHNOLOGICAL UNIVERSITY

# ELECTRONICS (10), ELECTRONICS & COMMUNICATION (11), ELECTRONICS & TELECOMMUNICATION ENGINEERING (12)
ELECTRONICS MEASUREMENT AND INSTRUMENTATION
**SUBJECT CODE**: 2141003
B.E. 4<sup>th</sup>SEMESTER

**Type of Course: NA**

**Prerequisite:**Students are expected to have basic knowledge of analog and digital electronics .

**Rationale:**In the field of Electronics, it is essential to know the functional aspects of several instruments useful in the process of signal measurement. Prior to the measurement, the process of signal conversion to equivalent electrical quantity and conversion of electrical quantify in one or the other forms are important steps. The fundamentals of signal measurement in analog as well as digital domains both need to be emphasized for modern instruments.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | ESE (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 3 | 0 | 2 | 5 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

**Content:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1 | **Measurement Errors and Standards:**Definitions, Accuracy and Precision, Significant Figures, Types of Error, Statistical Analysis, Probability of Errors, Limiting Errors, Time and Frequency Standards, Electrical Standards | 2 | 10 |
| 2 | **Bridge Measurements**: Wheatstone Bridge, Kelvin Bridge, AC Bridge and their Applications, Maxwell Bridge, Hay's Bridge, Unbalance Conditions, Wein Bridge. Anderson's Bridge, De Sauty's Bridge, Schering Bridge. | 5 | 10 |
| 3 | **Electronics Instrument For Measuring Basic Parameters**: True RMS Responding Voltmeter, Digital Frequency Meter, Circuit for Measurement of Frequency, High Frequency Measurements, Period Measurement, Ratio and Multiple Ratio Measurements, Time Interval Measurements, Vector Impedance Meter. | 6 | 15 |
| 4 | **Cathode Ray Oscilloscope**: Introduction, Oscilloscope Block Diagram, Cathode Ray Tube, Delay Line, Multiple Trace, Oscilloscope Scope and Transducers, Oscilloscope Techniques, Digital Storage Oscilloscope. | 4 | 8 |
| 5 | **Instrument for Generation and Analysis of Waveforms**: Introduction, The Sine Wave Generator, Frequency Synthesized Signal Generator, Frequency Divider Generator, Signal Generator Modulation, Sweep Frequency Generator, Pulse and Square Wave Generator, | 6 | 15 |

| | | | |
|---|---|---|---|
| | Function Generator, Wave Analyzers, Harmonic Distortion Analyzer, Spectrum Analyzer. | | |
| 6 | **Transducers:** Electrical Transducers Selection and Considerations, Resistive, Strain Gauges, Temperature Transducers: Platinum Resistance Type, Thermistor, Thermocouples, Inductive, LVDT, Capacitive, Load Cell, Piezoelectric, Photoelectric Transducers. | 4 | 7 |
| 7 | **Signal Converters:** I To P / P To I Converter, Temperature to Voltage Converter, Conversion To Frequency, Period, or Time Duration, Measurement of Phase Difference Using X-OR and SR Flip-Flop Method, Measurement of Active And Reactive Power of Supply Line, Locking Amplifiers, Variable Oscillators, Direct Sensor-Microcontroller Interfacing. | 5 | 10 |
| 8 | **Isolation Techniques:** Transformer Isolation, Optical Isolation, Digital Techniques For Optical Isolation, Hall-Effect Principle And Measurement Of Displacement, Current And Power Using Hall Sensors, Amplifications Of Low Level Signals, Guarding, Shielding. | 5 | 10 |
| 9 | **Data Acquisition And Conversion:** Analog Signal Processing, Sample And Hold Operation, S/H Circuits Using Op-Amps, Introduction To Data Acquisition System, Various DAS Configurations, Single Channel DAS, Multi-Channel DAS, IC Based DAS, Data Acquisition, Data Acquisition in PLC. | 5 | 15 |

**Suggested Specification table with Marks (Theory):**

| Distribution of Theory Marks | | | | |
|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level |
| 15 | 15 | 10 | 15 | 15 |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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.

**Reference Books:**

1. Helfrick Albert D. and Cooper W. D., "Modern Electronic Instrumentation and MeasurementTechniques", Prentice Hall India, 1st Ed., 1990
2. Shawhney A. K. "A Course In Electrical And Electronics Measurements And Instrumentation",Dhanpat Rai & Sons, 11th Ed., 1999
3. Kalsi H. S. "Electronic Instrumentation", Tata McGraw-Hill Education, 2nd Ed., 2004 .
4. Bell David A. "Electronic Instrumentation and Measurements", PHI / Pearson Education, 2006.
5. Rangan C. S., Sarma G. R. and Mani V. S. V., "Instrumentation Devices And Systems", Tata McGraw-Hill, 2nd Ed., 2004.
6. A. J. Bouvens, "Digital Instrumentation", McGraw-Hill, 1st Ed., 1997.

**Course Outcomes:**
After successful completion of the course students should be able to:

1. Define measurement parameters and methods, standards, characteristics, errors.

2.  Graduates will be able to study the working of different ac and dc  bridges, Transformers.
3.  Gain knowledge on different voltmeters, multimeter, wave analyzers
4.  Gain knowledge on different digital meters.
5.  Gain knowledge on general purpose oscilloscopes and recorders.
6.  Gain knowledge on data acquisition and conversion.
7.  Gain Knowledge on Utilization & interpretation of various Transducers along with practical implementation.
8.  Utilization,operation and maintanance of various instruments for generation and analysis of waveforms as well as for electronic testing and measurement.
9.  To understand basics of data acquisition process and utilize for measurement.
10. To understand signal convertors for the signal measurement.
11. Use various measuring  electronics instruments and measurement methods in electronic systems.

## List of Experiments:
1.  To find the value of unknown resistor using Wheatstone bridge.
2.  To find the value of unknown capacitance and inductance using Maxwell's bridge.
3.  To find the value of unknown capacitance using Wein's series and parallel bridge.
4.  To extend the range of given voltmeter and ammeter.
5.  Measurement of frequency using Lissajous method.
6.  To study and verify characteristic of variable resistor transducer (strain gauge).
7.  To study and verify characteristic of LVDT
8.  To study and verify characteristic of Thermocouple/RTD.
9.  To study the front panel controls of storage CRO.
10. To analyze analog and digital multi meter for various measurements.
11. To verify the performance characteristics of compensated attenuator.
12. To demonstrate the functionality of function generator and its use as a test and
1.  measurement equipment.
13. Measurement of LCRQ meter.
14. To demonstrate the functionality of IC tester and test various ICs.
15. Fourier series analysis of a square wave using spectrum analyzer.
16. To study and simulate any two measurement system using LAB VIEW.
17. To generate various signals using arbitrary waveform generator.
18. To demonstrate the functionality of distortion meter.
19. Disection of Horinzontal deflection system of CRO and to measure /observe voltage/Current waveforms at each important test points.
20. **Disection of Vertical deflection system of CRO and to measure /observe voltage/Current waveforms at each important test points.**

## Design based Problems (DP)/Open Ended Problem:
1.  To design various bridges for finding the unknown quantities.(May use tools also like Labview/Pspice/MultiSim etc. for practical design and testing)
2.  To design various transducer circuits systems for measuring different non-electrical quantities.
3.  To test the probe using CRO.
4.  To test various active and passive components using CRO.
5.  To obtain Lissajous pattern and eye diagram using CRO.
6.  To measure high voltage using CRO.
7.  To design a sine wave, square wave and pulse generator as per given specification. .(May use tools also like Labview/Pspice/MultiSim etc. for practical design and testing)
8.  To design a required waveform using arbitrary waveform generator and measure various parameters using DSO.

9. To design function generator and frequency counter as per given specification..(May use tools also like Labview/Pspice/MultiSim etc. for practical design and testing)
10. Design of sample and hold circuit for required measurement as per given specification and requirement.

**Major Equipments:**

1. Function generator
2. Digital multimeter
3. D.C. power supply
4. Cathode Ray Oscilloscope
5. Digital Storage Oscilloscope
6. LCR-Q meter
7. Field strength meter(dB meter)
8. Experimental trainer kits, Bread board, Computers

**List of Open Source Software/learning website:**

i. Electronic Workbench/MultiSIM/Circuit Maker /Pspice
ii. www.ocw.mit.edu
iii. www.home.agilent.com
iv. Labview

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.