GANPAT UNIVERSITY

FACULTY OF DIPLOMA ENGINEERING

Programme	Diploma in Electronics and Communication Engineering		
Semester	IV	Version	1.0.0.0
Effective from Academic Year	2026-27	Effective for the batch Admitted in	JULY 2025
Course code	1EC3102	Course Name	Electronic measurement and Instrumentation

I.TEACHING-LEARNING AND ASSESSMENT SCHEME

Course Type	Course Code	Learning Scheme						Assessment Scheme										
		Actual Contact Hrs./Week			SLH	NLH	Credits	Theory				Practical				Based on SL		Total Marks
		CL	TL	LL				FA-TH	SA-TH	TOTAL		FA-PR	SA-PR	TOTAL		SLA		
								MAX	MAX	MAX	MIN	MAX	MAX	MAX	MIN	MAX	MIN	
III EC	1EC3102	3	-	2	3	8	4	40	60	100	40	30	20	50	20	20	8	170

Abbreviation:	**CL-** Classroom Learning	**TL -** Tutorial Learning	**LL -** Laboratory Learning
	SLH - Self Learning Hours	**NLH -** Notional Learning Hours	**SLA -** Self Learning Assessment
	FA - Formative Assessment (Term work +Mid Sem Exam +Attendance)		**SA -** Summative Assessment

II. PRE-REQUISITES

Basic knowledge of Semiconductor physics, Analog electronics, Electronic devices and circuits

III. INDUSTRY / EMPLOYER EXPECTED OUTCOMES

- Operate and select appropriate electronic measurement instruments for testing and troubleshooting.
- Measure and analyze electrical signals accurately in time and frequency domains.
- Identify faults, perform basic calibration, and ensure safe operation of instruments.
- Use modern tools and software for measurement, data acquisition, and reporting.
- Prepare clear technical documentation and adapt to evolving measurement technologies.

IV. COURSE LEARNING OUTCOMES

At the end of the course, students will be able to achieve the following course learning outcomes:

CO1: Analyze different types of measurement errors and evaluate their impact on accuracy, precision, and reliability of measurements.

CO2: Explain the fundamentals of measurement systems and the working principles of analog and digital measuring instruments.

CO3: Perform measurement and calibration of electrical parameters such as resistance, inductance, capacitance, voltage, frequency, and waveforms using appropriate instruments and bridge circuits.

CO4: Apply signal generation and measurement instruments to analyze electrical signals in time and frequency domains.

CO5: Apply sensors, transducers, data acquisition systems in practical and real-world engineering applications.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT:

Name of Unit	Theory Learning outcomes (TLO's) aligned to CO's	Learning Content mapped with Theory Learning outcomes (TLO's) & CO's	Marks	Hours
Unit-1 Introduction to Measurement Systems	**TLO 1.1** Define measurement and explain the need for measurement systems in engineering applications. **TLO 1.2** Explain fundamental measurement characteristics such as accuracy, precision, resolution, and sensitivity. **TLO 1.3** Classify measuring instruments based on function, method of measurement, and application. **TLO 1.4** Identify different types of errors occurring in measurements.	**1.1** Introduction to Measurement and Measurement Systems, Fundamentals of Measurement **1.2** Accuracy and Precision, Resolution and Sensitivity **1.3** Classification of Measuring Instruments **1.4** Types of Errors in Measurement (Gross, Systematic, Random)	**10**	**5**

	TLO 1.5 Analyze measurement errors and evaluate their effect on accuracy and reliability of measurements.	**1.5** Error Analysis and Minimization of Errors		
Unit-2 **Analog and Digital Instruments**	**TLO 2.1** Explain the construction and working principle of analog measuring instruments such as voltmeter, ammeter, ohmmeter, and wattmeter. **TLO 2.2** Describe the operating principle and features of digital measuring instruments. **TLO 2.3** Explain the working of Digital Multimeter (DMM) and Digital Voltmeter (DVM). **TLO 2.4** Explain the principle and application of digital frequency counters. **TLO 2.5** Compare analog and digital instruments based on accuracy, resolution, speed, and applications. **TLO2.6** Select appropriate measuring instruments for given electrical measurement applications.	**2.1** Analog Voltmeter – construction, working and applications, Analog Ammeter – principle, types and applications, Analog Ohmmeter – working and resistance measurement, Analog Wattmeter – principle and power measurement **2.2** Introduction to Digital Measuring Instruments **2.3** Digital Multimeter (DMM) – block diagram, working and applications, Digital Voltmeter (DVM) – principle and types **2.4** Digital Frequency Counter – principle, block diagram and applications **2.5** Comparison of Analog and Digital Instruments **2.6** Selection of measuring instruments for practical applications	**12**	**8**
Unit-3 **Bridge Circuits and AC/DC Measurement**	**TLO 3.1** Explain the working principle of bridge circuits used for electrical measurements. **TLO 3.2** Describe the construction and operation of Wheatstone and Kelvin bridges. **TLO 3.3** Explain the working of Maxwell bridge for inductance measurement. **TLO 3.4** Measure resistance, inductance, and capacitance using appropriate bridge methods. **TLO 3.5** Explain the working principle and applications of Q-meter. **TLO 3.6** Describe the operation and applications of LCR meter. **TLO 3.7** Select appropriate measuring instruments for accurate R, L, and C measurements.	**3.1** Introduction to Bridge Circuits **3.2** Wheatstone Bridge-principle, balance equation, applications, Kelvin Bridge – principle and low-resistance measurement **3.3** Maxwell Bridge – principle and inductance measurement, **3.4** Measurement of Resistance using bridge circuits, Measurement of Inductance using Maxwell Bridge, Measurement of Capacitance using bridge methods **3.5** Q-Meter – principle, block diagram, applications **3.6** LCR Meter – working principle and applications **3.7** Selection of appropriate R, L, C measuring instruments	**10**	**8**
Unit-4 **Oscilloscope and Signal Generators**	**TLO 4.1** Explain the construction, working principle, and applications of Cathode Ray Oscilloscope (CRO). **TLO 4.2** Describe the features and advantages of Digital Storage Oscilloscope (DSO). **TLO 4.3** Measure voltage, frequency, time period, and phase using CRO/DSO. **TLO 4.4** Explain the working principle and applications of function	**4.1** Introduction to Oscilloscopes, CRO – construction, working, controls and applications **4.2** Digital Storage Oscilloscope (DSO) – features and advantages **4.3** Measurement of voltage, frequency, time period and phase using CRO/DSO **4.4** Function Generator – principle, types of waveforms	**12**	**10**

	generators. **TLO 4.5** Describe the operation of frequency counters for precise frequency measurement. **TLO 4.6** Explain the working principle and applications of spectrum analyzers. **TLO 4.7** Interpret signal characteristics using waveform analyzers. **TLO 4.8** Select appropriate signal analysis instruments for given measurement applications.	and applications **4.5** Frequency Counter – principle and applications **4.6** Spectrum Analyzer – working principle and frequency domain analysis **4.7** Waveform Analyzer – time domain signal analysis **4.8** Selection of signal analysis instruments		
Unit-5 Sensors, Transducers, Signal Conditioning and Data Acquisition	**TLO 5.1** Classify sensors based on measurand such as temperature, pressure, light, and motion. **TLO 5.2** Explain the working principle and applications of temperature sensors. **TLO 5.3** Explain the working principle and applications of pressure, light, and motion sensors. **TLO 5.4** Explain the construction, working, and applications of LVDT. **TLO 5.5** Describe the working principle and applications of strain gauges. **TLO 5.6** Explain the operating principle of piezoelectric transducers and thermocouples. **TLO 5.7** Explain the need for signal conditioning in measurement systems. **TLO 5.8** Describe the working of signal conditioning circuits such as amplifiers and filters. **TLO 5.9** Explain the role of ADC and DAC in data acquisition systems. **TLO 5.10** Select appropriate sensors, transducers, and signal conditioning circuits for given applications. **TLO 5.11** Explain the concept, need, and basic architecture of a Data Acquisition System (DAS). **TLO 5.12** Describe the functional blocks of DAS and their roles in measurement systems.	**5.1** Introduction to Sensors and Transducers **5.2** Temperature Sensors (RTD, Thermistor, IC sensors) **5.3** Pressure Sensors, Light Sensors (LDR, Photodiode, Phototransistor), Motion Sensors (Proximity, Accelerometer basics) **5.4** LVDT – construction, working and applications **5.5** Strain Gauge – principle, gauge factor and applications **5.6** Piezoelectric Transducer – principle and applications, Thermocouple – principle, types and applications **5.7** Need for Signal Conditioning **5.8** Signal Conditioning Circuits – Amplifiers, Signal Conditioning Circuits – Filters **5.9** Analog to Digital Converter (ADC), Digital to Analog Converter (DAC) **5.10** Selection of sensors, transducers and conditioning circuits **5.11** Introduction to Data Acquisition System (DAS), Need and applications of DAS **5.12** Block diagram of DAS, Components of DAS (Sensor, Signal Conditioning, ADC, Processor, Display)	**15**	**14**

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL

Sr. No.	Practical/Laboratory Learning Outcome (LLO)	Practical Titles	Relevant COs
1	**LLO 1.1:** Identify and safely operate basic electronic measuring instruments.	Study and operation of analog and digital measuring instruments (Voltmeter, Ammeter, Ohmmeter, Wattmeter, DMM).	CO1
2	**LLO 2.1**: Perform calibration of measuring instruments and interpret calibration results.	Calibration of voltmeter and ammeter using standard instruments.	CO2
3	**LLO 3.1:** Measure resistance accurately using bridge circuits.	Measurement of resistance using Wheatstone Bridge and Kelvin Bridge.	CO3
4	**LLO 4.1:** Measure inductance and capacitance using AC bridge circuits.	Measurement of inductance using Maxwell Bridge and capacitance using bridge methods.	CO3
5	**LLO 5.1:** Determine Q-factor of inductive components.	Measurement of Q-factor using Q-Meter.	CO3
6	**LLO 6.1:** Measure R, L, and C parameters using digital instruments.	Measurement of R, L, and C using LCR Meter.	CO3
7	**LLO 7.1**: Analyze electrical waveforms and signal parameters using oscilloscope.	Measurement of amplitude, frequency, and phase using CRO/DSO.	CO4
8	**LLO 8.1:** Generate and analyze test signals using signal generators and counters.	Study of Function Generator and Frequency Counter.	CO4
9	**LLO 9.1:** Identify and use different sensors for measurement applications.	Study and characteristics of temperature, pressure, light, and motion sensors.	CO5
10	**LLO 10.1:** Measure physical parameters using transducers.	Study of LVDT, strain gauge, piezoelectric sensor, and thermocouple.	CO5
11	**LLO 11.1:** Implement basic signal conditioning circuits for sensor outputs.	Signal conditioning using amplifiers and filters.	CO5
12	**LLO 12.1 :** Interface sensors with data acquisition systems.	Interfacing sensors with DAS.	CO5

VII. SUGGESTED MICRO PROJECT / ASSIGNMENTS / ACTIVITIES FOR SELF LEARNING / SKILL DEVELOPMENT (SELF LEARNING)

Micro project

- Measure temperature of hot plate using semiconductor temperature sensor (LM35).
- Use a fire sensor to make a small electronic alarm circuit.
- Make temperature control circuit using thermistor.
- Make a small circuit using LDR as a sensing device.
- Design D.C. signal conditioning circuit using Wheatstone bridge circuit and implement on PCB.

Assignment

- Prepare a power point presentation on Spectrum analyzer.
- Prepare a chart for use of DSO in various industries.
- Prepare a chart to show the uses of DSO.
- Make a report on use of Spectrum analyzer in Telecommunication field.

VIII. LIST OF INSTRUMENTS / EQUIPMENT / TRAINER BOARD

1	Analog Voltmeter, Ammeter, Ohmmeter
2	Digital Multimeter (DMM)
3	Digital Voltmeter, Wattmeter
4	Wheatstone Bridge Trainer

5	Maxwell Bridge Trainer
6	LCR Meter
7	Q-Meter
8	Cathode Ray Oscilloscope (CRO), Digital Storage Oscilloscope (DSO)
9	Function Generator, Frequency Counter
10	Temperature Sensor Trainer (RTD / Thermocouple)
11	Pressure Sensor Trainer
12	Light Sensor Trainer (LDR / Photodiode)
13	LVDT Trainer Kit
14	Strain Gauge Trainer Kit
15	Piezoelectric Sensor Trainer
16	Signal Conditioning Trainer (Amplifiers & Filters)

IX. LIST OF REFERENCE BOOKS

Sr.No.	Title	Author	Publication
1	A Course in Electrical and Electronic Measurements and Instrumentation	A. K. Sawhney	Dhanpat Rai & Co.
2	Electronic Measurements and Instrumentation	J. B. Gupta	S. K. Kataria & Sons
3	Modern Electronic Instrumentation and Measurement Techniques	R. K. Rajput	S. Chand Publishing
	Elements of Electronic Instrumentation and Measurement	Joseph J. Carr, M. B. Patil	Pearson Education

X. LINK OF LEARNING WEB RESOURCE

1	https://archive.nptel.ac.in/courses/108/105/108105153/
2	https://onlinecourses.nptel.ac.in/noc26_ee29/preview

XI. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE

Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	Introduction to Measurement Systems	CO1	5	3	4	3	**10**
2	Analog and Digital Instruments	CO2	8	4	6	3	**13**
3	Bridge Circuits and AC/DC Measurement	CO3	8	3	4	3	**10**
4	Oscilloscope and Signal Generators	CO4	10	4	4	4	**12**
5	Sensors, Transducers, and Signal Conditioning and Data acquisition	CO5	14	5	6	4	**15**
		Grant Total	**45**	**19**	**24**	**17**	**60**

XII. COs AND POs AND PSOs MAPPING

Course outcome (Cos)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	1	0	3	2	2
CO2	3	3	2	2	1	1	0	3	2	3
CO3	3	3	3	2	2	1	1	3	3	2
CO4	2	3	2	2	2	2	1	2	2	3

Legends: - *3- High 2-Moderate/Medium 1-Slight/Low 0-None*