GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Instrumentation and Control Engineering

Subject Code: DI03017021

Course / Subject Name: Electronics and Pneumatic Instrumentation

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	**1.** Basic understanding of electronics, including resistors, capacitors, transistors, and circuits. **2.** Knowledge of basic physics, particularly electricity and magnetism. **3.** Familiarity with control systems and signal conversion. **4.** Understanding of pneumatic systems and their operation. **5.** Basic mathematical and algebraic skills for advanced topics.
Rationale:	The course on Electronic and Pneumatic Instrumentation is designed to provide students with a comprehensive understanding of the principles, operation, and applications of electronic and pneumatic measurement systems used in industrial and laboratory settings. The course bridges fundamental concepts in electronics, pneumatics, and instrumentation, providing students with a solid foundation to handle real-world measurement and control tasks. It focuses on key measurement instruments, sensors, controllers, and transmitters that are widely used across various industries. By exploring both traditional electronic systems and pneumatic measurement systems, students will gain insights into the advantages and limitations of each and learn how to ensure safety and efficiency in instrumentation. This course is crucial for students aspiring to work in fields like process control, automation, instrumentation, and manufacturing.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Operate various electronic laboratory and field instruments for analyzing electrical signals.	A
02	Describe the principles and components of pneumatic measurement systems.	U
03	Operate electronic and pneumatic controllers in process control applications	A
04	Identify types and functions of pneumatic and electronic transmitters	R
05	Test basic signal converter circuits	R, U, A

**Revised Bloom's Taxonomy (RBT): R: Remember; U: Understanding; A: Application*

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Fundamentals of Electronic Measurement**	**12**	**30**
	1.1 Classification of electronic instruments as under • Laboratory/Testing instruments. • Field instruments. **1.2** Electrical meters/Instruments • PMMC (Permanent • Magnet Moving Coil) type • Rectifier type • Moving Iron type • Electro dynamic type **1.3** Test instruments • Function generator • Digital multi-meter • CRO (Cathode Ray Oscilloscope) • DSO (Digital storage Oscilloscope) **1.4** LCR meter **1.5** Data Acquisition System (DAS) • Basic block diagram of Analog and Digital DAS **1.6** Need of Standardization **1.7** Standard current and voltage signal ranges **1.8** Conversion formula of Sensor Output to Standard Pneumatic Signal Range (4-20 mA)		
2.	**Fundamentals of Pneumatic Measurement**	**6**	**15**
	2.1 Basic Block diagram of Pneumatic system		

	2.2 Self-balancing pneumatic instrument principles • Force balance principle, Motion balance principle, Moment balance principle **2.3** Flapper-Nozzle Mechanism and its Role in Pneumatic Measurement **2.4** Standard pneumatic signal range **2.5** Conversion formula of Sensor Output to Standard Pneumatic Signal Range (3-15 psi); Compare Electronic and Pneumatic instruments		
3.	**Electronic & Pneumatic Controllers**	**12**	**25**
	3.1 Basic block diagram Operational Amplifier (Op-amp) **3.2** Pin diagram of Op-amp 741 **3.3** Operational Amplifier Applications • Inverting amplifier • Non-inverting amplifier • Buffer amplifier • Integrator • Differentiator • Comparator **3.4** Process terminologies: Process equation, Process load, Process lag, Self-regulation, Measurement lag, control lag, Transportation lag, Dead time, Cycling, Proportional Band, Offset **3.5** Electronic Controllers • Proportional (P) Controller • Integral (I) controller • P+I Controller • P+D Controller • P+I+D Controller **3.6** Pneumatic Controllers • P+I+D Controller **3.7** Ensuring Safety in Instrumentation IEC 61010-1 for Electronics and ISO 4414 for Pneumatics		
4.	**Electronic and Pneumatic Transmitters**	**7**	**20**
	4.1 Need of transmitter **4.2** Types of transmitters • Pneumatic Transmitter • Electronic Transmitters **4.3** Pneumatic Transmitter		

	• Force Balance Transmitter • Motion Balance Transmitter **4.4** Electronic Transmitters • Force Balance Transmitter • Motion Balance Transmitter **4.5** Ensuring Safety in Instrumentation: IEC 61010-1 for Electronics and ISO 4414 for Pneumatics		
5.	**Signal Converters and instrument transformer**	**8**	**10**
	5.1 Current Transformer **5.2** Potential Transformer **5.3** Converters • Resistance to Current Converter • Resistance to Voltage Converter • Voltage to Current Converter • mV to Current Converter for thermocouples • AC to DC Converter for mA		
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
32	**44**	**24**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	A Course in Electrical and Electronic Measurements and Instrumentation	A K Sawhney	DHANPAT RAI
2	Instrument Engineers Handbook	Bela G Liptak	ISA

3	Applied Instrumentation in the process industries	W G Andrews H B Williams	ISA
4	Op-Amps and linear Integrated Circuits	Ramakant A. Gayakwad	Asoke k. Ghosh, PHI Learning Private Limited, Rimjhim House,111, Patparganj industrial Estate, Delhi-
5	Process Control Instrumentation Technology	Curtis D Johnson	PHI
6	Instrumentation Training Course	D B Taraporewala	D.B. Taraporevala Sons
7	Industrial Instrumentation and Control	S.K.Singh	Tata, McGraw-Hill, New Delhi ISBN: 9789351340102,
8	Electronics measurement and instrumentation	K. Lal Kishore	Pearson

(b) Open-source software and website:

1. https://kicad.org
2. https://www.scilab.org
3. www.nptel.ac.in
4. www.vlab.co.in
5. https://www.arduino.cc/en/software

Suggested Course Practical List:

A **minimum of 10-12 practical** is to be performed out of the listed practical or any other during laboratory sessions. These practicals should be selected in such a way that **all Course Outcomes (COs) are adequately addressed**. The selection must ensure balanced coverage of theoretical and practical understanding aligned with the course objectives.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	COs	Approx. Hrs. Required
1	Check the function and features of CRO (Cathode Ray Oscilloscope).	1	1	02
2	Obtain various waveforms using function generator.	1	1	02
3	Measure the DC output voltage of thermocouple using DMM (Digital Multimeter).	1	1	02
4	Check the function and features of DSO (Digital Storage	1	1	04
5	Measure and record the values of resistance (R), capacitance (C), and inductance (L) of given components using an LCR meter.	1	1	02
6	Simulate Flapper-Nozzle Mechanism and Standard Pneumatic Signal	1	2	04
7	Study and Compare Self-Balancing Pneumatic Instruments: Force Balance, Motion Balance & Moment Balance Principles	1	2	02
8	Test Inverting and Non-inverting amplifier circuit using op-amp	1	3	02
9	Test Inverting and Non-inverting amplifier circuit using op-amp	1	3	02
10	Test integrator circuit using op-amp.	1	3	02
11	Test differentiator circuit using op-amp.	1	3	02
12	Test comparator circuit using op-amp	1	3	02
13	Develop electronic P (Proportional) controller using an operational	1	3	02
14	Develop electronic PI (Proportional Integral) controller using an operational amplifier.	2	3	02
15	Develop electronic PD (Proportional Derivative) controller using an operational amplifier.	2	3	02
16	Develop electronic PID (Proportional, Integral, and Derivative)	2	3	4
17	Study and Compare Pneumatic and Electronic Transmitters with Emphasis on Force and Motion Balance Principles	2	4	02
18	Interpretation and Application of Safety Standards in Instrumentation – IEC 61010-1 and ISO 4414	2	4	02
19	Construct and Test a Resistance to Current Converter Using Op-Amp	2	5	02
20	Construct and Test a Resistance to Voltage Converter Circuit	2	5	02

***Minimum 10-12 Practical need to be performed during laboratory**	**Total**	**30 Hrs.**

List of Laboratory/Learning Resources Required:

1. Digital Multimeter (DMM)
2. Cathode Ray Oscilloscope (CRO)
3. Digital Storage Oscilloscope (DSO)
4. Function Generator
5. LCR Meter
6. Power Supply (Dual channel, variable)
7. Operational Amplifier ICs (e.g., 741)
8. Breadboards and PCB boards
9. Connecting wires and probes
10. Resistors, Capacitor and Inductor

Suggested Project List:

1. Build and test op-amp based parameter control circuits.
2. Demonstrate Working of Pneumatic Transmitter Using a Cut-Section or Poster Model
3. Simulate a Basic PID Control Loop Using free software
4. Create a Poster on ISO 4414 and IEC 61010-1 Safety Standards
5. Create a Mini Report on Smart Transmitters Used in Industry 4.0 Applications

Suggested Activities for Students:

Other than the classroom and laboratory learning, the following are the suggested student- related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in

this course: Students should perform the following activities in group and should also collect/record physical evidence for their (student's) portfolio which may be useful for their placement interviews

1. Prepare a case study presentation on industrial applications of transmitters and signal converters in process control systems.
2. Create DIY projects or working models using op-amps, signal converters, or basic pneumatic systems and present them in class.
3. Develop tutorial videos or posters explaining principles like the flapper-nozzle mechanism or controller types and share them with peers.
4. Join an online certification course or workshop on industrial instrumentation offered by renowned platforms.

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