GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: ELECTRONIC AND PNEUMATIC INSTRUMENTATION
(COURSE CODE:3351701)

Diploma Programmers in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	5th semester

1. RATIONALE

In spite of the massive transition of the process control industry from the pneumatic to an electronic and digital age ,the study of pneumatic instrumentation is significantly essential since pneumatics are still widely used in the control valves of the control loops. Through this course the students will acquire sound theoretical and practical knowledge of the various pneumatic and electronic instruments widely deployed in the process industries.

2. LIST OF COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that students are able to acquire following competency.

- **Operate and Maintain electronic and pneumatic instruments.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes..

i. Classify and identify the instrument according to signal type.
ii. State standard signal units and ranges and perform signal conversion.
iii. Select and operate pneumatic and electronic instrument
iv. List application of electronics and pneumatic instrument
v. Differentiate pneumatic vs. electronic instrumentation and control systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
3	0	4	7	70	30	40	60	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (Outcomes in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of Measurement	1a Classify and list electronic instrument based on laboratory/testing/ Field instruments. 1b Describe working principle, construction of electric meters/instruments with neat schematic diagram (1.2.1 to 1.2.4). 1c Enlist applications of electric meters/instruments (1.2.1 to 1.2.4). 1d Draw block diagram of basic instruments and explain operation in detail.(1.3.1 to 1.3.5) 1e Enlist application of listed test instruments (1.3.1 to 1.3.5) 1f Enlist additional features of DSO with reference to CRO. 1g Classify and list types of Measurement Bridge. 1h State Uses of bridges in Instrumentation 1i Explain the circuit diagram of Wheatstone bridge and derive the expression for unknown resistance. 1j Explain the circuit diagram of Kelvin Bridge. 1k Enlist applications of Wheatstone bridge and Kelvin Bridge. 1l Describe working principle and construction of AC bridge with neat diagram(1.4.2) 1m Discuss importance of isolation. 1n Describe isolation technique in detail.	1.1 Classification of electronic instruments as under • Laboratory- / Testing instruments. • Field instruments. 1.2 Electrical meters/Instruments 1.2.1 PMMC type 1.2.2 Rectifier type 1.2.3 Moving Iron type 1.2.4 Electro dynamic type 1.3 Test instruments 1.3.1 Standard signal generator (S.S.G.). 1.3.2 Ramp type DVM 1.3.3 CRO 1.3.4 Digital storage oscilloscope(DSO) 1.3.5 Electronic calibrator 1.4 Classification of measuring Bridge 1.4.1 DC bridges (for resistance measurement) • Wheatstone Bridge • Kelvin Bridge 1.4.2 AC bridges(for inductance/capacitance measurement) • Maxwell's Bridge • Anderson's bridge • Desauty's's bridge 1.5 Isolation and its techniques 1.6 Need for standardization of signals-Current, voltage, and pneumatic signal standards

	1o State need for standardization of signals. 1p State standard unit and range for pneumatic signal used in instrumentation. 1q State standard unit and range for electronic signal used in instrumentation.	
UNIT II Pneumatic Instrumentation	2a Enlist components of a self-balancing instruments. 2b Explain self-balancing principle of pneumatic instruments with neat schematic diagram. 2c Explain the construction and working of flapper nozzle system with neat diagram. 2d State the needs of Pilot relay. 2e Explain construction and working of Pilot relay with schematic diagram. 2f Describe construction and working of pressure regulator with neat sketch. 2g Explain different types of balancing principle with schematic diagram. 2h Explain construction and operation of various pneumatic controller with the help of neat sketch. (2.6.1 to 2.6.6).	2.1 Self-balancing instruments 2.2 Flapper Nozzle Mechanism (For Revision) 2.3 Pilot Relay Bleed & Non Bleed type 2.4 Pressure Regulator. 2.5 Different types of balancing Principles 2.5.1 Moment balance 2.5.2 Motion balance 2.5.3 Force balance 2.6 Pneumatic Controllers 2.6.1 On-Off Controller 2.6.2 P Controller 2.6.3 I Controller 2.6.4 P+I Controller 2.6.5 P+D Controller 2.6.6 P+I+D Controller
UNIT-III Electronic Instrumentation	3a Compare electronic and pneumatic instruments. 3b Describe function of electronics instruments. (3.2.1 To 3.2.5) in brief. 3c State uses of listed electronics instruments (3.2.1 to 3.2.3) 3d Draw general block diagram of different types of electronic controller and explain each block in detail. 3e Explain operation of various types of electronic controller with the help of op amp circuit diagram (3.6.1 to 3.6.6). 3f Define Proportional Band and	3.1 Electronic Instruments versus Pneumatic instruments 3.2 Electronics instruments 3.2.1 Instrumentation amplifier. 3.2.2 Integrator. 3.2.3 Differentiator. 3.3 Electronics controllers 3.6.1 On-Off Controller 3.6.2 P Controller 3.6.3 I Controller 3.6.4 P+I Controller 3.6.5 P+D Controller 3.6.6 P+I+D Controller 3.4 Controller tuning and alignment. 3.4.1 Tuning Methods:

	Offset Error. 3g Draw output response of P, I, D, P+I, P+D, P+I+D for step, pulse, ramp and sinusoid input. 3h State mathematical expression for P, I, D, P+I, P+D, P+I+D control action. 3i List out steps to be followed for controller tuning and alignment. 3j Explain in brief tuning methods for controller.	• Process Reaction Curve (open loop) • Ziegler Nichols (closed loop)
UNIT-IV Pneumatic and Electronic transmitters	4.a Describe need of transmitter. (Concept of field area & control room area). 4.b State types of transmitter. 4.c With the help of neat diagram, describe construction and working of force balance type pneumatic transmitter. 4.d With the help of neat diagram, describe construction and working of motion balance type pneumatic transmitter. 4.e Describe construction and working of force balance type electronic transmitter with the help of neat diagram. 4.f Describe construction and working of Motion balance type electronic transmitter with the help of neat diagram. 4.g State the features of intelligent transmitter. 4.h Draw and explain basic block diagram of smart transmitter. 4.i Compare conventional transmitter with smart transmitter.	4.1 Need of transmitter (concept of field area & control room area) 4.2 Types of transmitters • Pneumatic Transmitter • Electronic Transmitters 4.3 Pneumatic Transmitter 4.3.1 Force Balance Transmitter 4.3.2 Motion Balance Transmitter 4.4 Electronic Transmitters 4.4.1 Force Balance Transmitter 4.4.2 Motion Balance Transmitter 4.4.3 Intelligent and SMART Transmitter
UNIT-V Signal Converters and instrument transformer	5.a Explain the operation of current transformer with the schematic diagram. 5.b Explain the operation of potential transformer with schematic diagram. 5.c Describe the characteristics of current transformer and potential transformer.	5.1 Current Transformer. 5.2 Potential Transformer. 5.3 Converters 5.3.1 Electrical converter • Resistance to Current Converter • Resistance to Voltage Converter • Voltage to Current Converter

	5.d Enlist types of converter. 5.e Describe the construction and working of converters (5.3.1). 5.f Explain the working of Pneumatic to Electronic (P/I) converter with the schematic diagram. 5.g Explain the working of Electronic to pneumatic (I/P) converter with the schematic of diagram.	• mV to Current Converter for thermocouples • AC to DC Converter for mA 5.3.2 Pneumatic to Electronic (P/I) converter. 5.3.3 Electronic to Pneumatic (I/P) converter.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS(THEORY)

7.

UNIT NO.	TITLE	TEACHING HOURS	DISTRIBUTION OF THEORY MARKS			
			R LEVEL	U LEVEL	A LEVEL	TOTAL MARKS
I	Fundamentals of Measurement	10	02	08	04	**14**
II	Pneumatic Instrumentation	08	02	06	06	**14**
III	Electronic Instrumentation	08	02	06	06	**14**
IV	Pneumatic and Electronic transmitters	08	02	06	06	**14**
V	Signal Converters and instrument transformer	08	02	06	06	**14**
TOTAL		**42**	**10**	**32**	**28**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's Revised 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/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as*

given in a common list at the beginning of curriculum document for this programme) would be assured.
Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

SR NO.	UNIT	PRACTICAL EXERCISE (outcomes in psychomotordomain)	APPROXIMATE HRS REQUIRED
1.	I	Measure controller output current using PMMC type instrument.	2
2.	I	Obtain wave form of S.S.G.	2
3.	I	Measure single phase ac voltage using DVM.	2
4.	I	Measure ac load current using DVM.	2
5.	I	Measure dc output voltage of thermocouple using DVM.	2
6.	I	Measure supply frequency using CRO.	2
7.	I	Measure output voltage using CRO.	2
8.	I	Compare two supply frequencies and phase using CRO.	2
9.	I	Compare amplitudes of two signals using CRO.	2
10.	I	Develop lissajous figures on CRO.	2
11.	I	Check function and features of DSO	2
12.	I	Find resistance of a RTD using Wheatstone bridge.	2
13.	I	Find resistance of a RTD using Kelvin double bridge.	2
14.	I	Find Inductance of a given inductor using Maxwell bridge.	2
15.	I	Find Inductance of a given inductor using Anderson bridge.	2
16.	I	Find capacitance of a given capacitor using Desauty's's bridge.	2
17.	II	Test flapper nozzle mechanism.	2
18.	II	Plot input-output characteristics of flapper nozzle system.	2
19.	II	Test output response of pilot relay.	2
20.	II	Set 20 psig Instrument air supply system using pressure regulator.	2
21.	II	Control pneumatic control valve using pneumatic P controller.	2
22.	II	Control pneumatic control valve using pneumatic P+I controller.	2
23.	II	Control pneumatic control valve using pneumatic P+D controller.	2
24.	II	Control pneumatic control valve using pneumatic P+I+D controller.	2

25.	III	Develop a circuit of an electronic integrator using op-amp.	2
26.	III	Develop a circuit of an electronic differentiator using op-amp.	2
27.	III	Build and test Instrumentation amplifier circuit using op-amp.	2
28.	III	Build circuit for instrumentation amplifier to convert for given input and output value.	2
29.	III	Build and test electronic on-off controller using operational amplifier for step input.	2
30.	III	Develop electronic P controller using operational amplifier for step input.	2
31.	III	Develop electronic I controller using operational amplifier for step input.	2
32.	III	Develop electronic P+I controller using operational amplifier for step input	2
33.	III	Develop electronic P+D controller using operational amplifier for step input	2
34.	III	Develop electronic P+I+D controller using op amp for step input.	2
35.	III	Tune given electronic controller for optimum output for step input.	2
36.	IV	Install and check functions of pneumatic transmitter	2
37.	IV	Install and check functions of electronic transmitter.	2
38.	IV	Install and check functions of SMART transmitter.	2
39.	V	Develop signal conditioning circuit to convert resistance to current.	2
40.	V	Develop signal conditioning circuit to convert resistance to voltage.	2
41.	V	Develop signal conditioning circuit to convert voltage to current.	2
42.	V	Develop signal conditioning circuit to convert thermocouple output mV into current.	2
43.	V	Plot characteristics of Pneumatic to Electronic converter.	2
44.	V	Observe the output response of Electronic to Pneumatic converter for a given input and plot its characteristics.	2
TOTAL Hrs. (practical for 56 hours from above representing each unit may be selected)			**88**

8. SUGGESTED LIST OF STUDENT ACTIVITIES:

i. Present a seminar on listed technical topics in EPI syllabus.
ii. Set up electronic apparatus on their own during practical hour under the guidance of lecturer as mini project.

iii. Debate on merits and demerits of pneumatic and electronic instruments.
iv. Prepare a poster on any one topic related of course.
v. Collect the extracurricular information related with the course from internet and share it with other students.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Display animation videos of controller response to different types of Standard inputs.
ii. Visit to nearby industry to observe realtime electronic and pneumatic loops.
iii. Facilitate the students to set up practical apparatus on their own.
iv. Compliment student for his/her work done during the practical in order to motivate him/her.
v. Regularly check the practical file maintained by student and instruct him/her remedies to improve the work if required.

10. SUGGESTED LEARNING RESOURCES

A.) LIST OF BOOKS

Sr No.	BOOK	AUTHOR	PUBLICATION
1	Instrument Engineers Handbook	Bela G Liptak	ISA
2	Applied Instrumentation in the process industries	W G Andrews H B Williams	ISA
3	Process Control Instrumentation Technology	Curtis D Johnson	PHI
4	A Course in Electrical and Electronic Measurements and Instrumentation	A K Sawhney	DHANPATRAI
5	Electronic Instrumentation Techniques	W D Cooper	PHI
6	Instrumentation Training Course	D B Taraporewala	D.B. Taraporevala Sons
7	Industrial Instrumentation and Control	S K Singh	TATA MCGRAW HILL
8	Process Instrumentation and Control	A P Kulkarni	Nirali Prakashan
9	Electronics measurement and instrumentation	K. Lal Kishore	Pearson
10	Process dynamics and control	Surekha bhanot	PHI

B.) LIST OF MAJOR EQUIPMENTS/INSTRUMENTS:

i. Electronic Controller Trainer Kit(on-off, P , I, D, P+I, P+D, P+I+D)
ii. Function generator(step, pulse, ramp, sine)
iii. CRO.
iv. DSO.
v. DVM
vi. SMART transmitter.
vii. mA / mV source.
viii. Electronic DP transmitter.

ix. Electronic temperature transmitter.
x. I to P converter
xi. P to I converter
xii. Pneumatic controller trainer Kit(on-off,P, P+I, P+D, P+I+D)
xiii. Compressor (cut off : 7 kg/cm2)(cut in:3.5 kg/cm2)
xiv. Pressure regulator (to maintain 20 psig)
xv. Quarter inch copper pipe (minimum 20 meter per semester)
xvi. Copper pipe bender and cutter
xvii. Teflon tape for sealing
xviii. Multi process control loop using pneumatic control.
xix. Multi process control loop using electronic control.
xx. Pneumatic & Electronic Calibrator

C.) LIST OF SOFTWARES/LEARNING WEBSITES

i. Multisim Software
ii. Ktechlab Software
iii. Logisim Software
iv. Jcircuits Software
v. Circuitmaker Software
vi. Coolspice Software
vii. Psimsoftware
viii. Simone Software
ix. Partsim Software
x. Docircuits Software
xi. www.nptel.ac.in
xii. logiccircuit software
xiii. http://www.deltapower.com/wpcontent/uploads/2013/12/pump.pdf
xiv. http://www.faa.gov/regulations_policies/handbooks_manual /aircraft/amt_airframe_handbook/media/ama_ch12.pdf

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

FACULTY MEMBERS FROM POLYTECHNICS

- **Prof. H. P. Patel** Lecturer(IC), Government Polytechnic, Ahmedabad.
- **Prof. N. J. Dehlvi** Lecturer(IC), Government Polytechnic, Gandhinagar
- **Prof. Manan Modi** Lecturer(IC), Government Polytechnic, Palanpur

CO ORDINATOR AND FACULTY MEMBER FROM NITTTR BHOPAL

- **Prof. Joshua Earnest.** Professor, Department of Electrical and Electronics Engineering
- **Prof. N.P.Patidar.** Professor, Department of Electrical and Electronics Engineering