GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

CONTROL COMPONENTS
(Code: 3331704)

Diploma Programme in which this course is offered	**Semester in which offered**
Instrumentation and Control Engineering	3rd semester

1. RATIONALE

For a diploma Instrumentation engineer, before knowing the control action fundamentals, it is important to maintain and calibrate different process instrumentation components used for controlling the process parameters. Hence the students will have to understand the construction, working and applications of various control instruments. Therefore, this course has been designed to maintain control components of the instrumentation loop.

2. COMPETENCY ('Programme Outcome' according to NBA Terminology)

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 control components of instrumentation loop.**

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**	
3	0	4	7	70	30	40	60	**200**

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

4. COURSE DETAILS

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Control Valve	1a. Define the valve parameters 1b. Name at least 7 types of control valve used in the industry. 1c. Describe the construction of at least 4 types of control valve 1d. Describe the functions of parts of control valves. 1e. State the procedure to test and calibrate	1.1. Control valve parameters: Rangeability, Hysteresis, Capacity, Linearity, etc. 1.2. Control valves in industries - Globe, Ball, Butterfly, Needle, Pinch, Diaphragm, Solenoid, Piston type valve (single acting/double acting). 1.3. Basic Parts of Control Valve: valve body, Trim, Stem, Plug, Cage, Seat, Bonnet, Actuator. 1.4. Flow characteristics of control valve 1.5. Calibration procedure
	1i. Classify control valves based on plug shapes and actuators 1j. Describe the working of a least 2 actuators and positioners with sketches and application 1k. Describe the characteristics of the actuators and positioners 1l. State the procedure to test and calibrate the actuators and positioners.	1.6. Classification of control valve as ATO/ATC, Linear/Rotary, Manually operated/Remote operated, Based on plug shapes, based on actuators 1.7. Valve actuators: Mechanical, Pneumatic (Diaphragm, piston), Hydraulic Electropneumatic, electrical 1.8. Valve Positioners: Mechanical, electrical 1.9. Calibration procedure
Unit – II Pneumatic Components	2a. State the need of pneumatic components 2b. Explain the working of pneumatic components with sketches	Pneumatic Components: Flapper-Nozzle, Air Filter Regulator lubricator, Volume Booster, Pneumatic Relay-Bleed/ Non-bleed, Direct/Reverse
Unit – III Piping Components	3a. Describe applications of each piping components with sketches	Piping component: Hydraulic Metallic, plastic) and Pneumatic (copper, steel, plastic) piping components- Mufflers, Reducers, Silencer, Bends, tees (equal, unequal), flanges, couplings (spring loaded\threaded),etc.
Unit – IV Control System Components	4a. Classify control system components 4b. Describe the construction of control system components with sketches 4c. Explain working principle	4.1. Control System Components: Synchros and Resolvers Servomotor-AC/DC 4.2. Stepper Motor-Variable reluctance, Permanent Magnet, Hybrid (CAV/CLV)

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	control system components 4d. State the procedure to test the control system components 4e. Explain the working of a typical Gyroscope	4.3. Potentiometer and gyroscope: • Potentiometer- Linear and log (Linear, Rotary) • Potentiometer as an error detector 4.4. Gyroscope working principle
Unit V Safety and Auxiliary Components	5a. Identify the various types of relays, switches and auxiliary components from the list of given symbols. 5b. Classify the various types of safety and auxiliary components 5c. Explain the working of the various types of safety and auxiliary components 5d. State the testing procedure of the various types of safety and auxiliary components	**5** Safety and auxiliary components: a. Relays: Electromechanical, Reed, Solid state and Field Failure relay b. Switches i. Toggle switch: SPST, SPDT, DPST, DPDT ii. Push Button iii. DIP switch iv. Self illuminated resettable switch v. Rotary switch(Single pole/Multi pole) vi. Thumbwheel switch vii. Limit switch (mechanical lever type) viii. Proximity Switch: inductive, capacitive, optica ix. Flow switch: HHL, HL, LL, LLL x. Level switch: HHL, HL, LL, LLL xi. Pressure switch: HHL, HL, LL, LLL xii. Thermostat: HHL, HL, LL, LLL) xiii. Humidistat: HHL, HL, LL, LLL c. Auxillary Components: Alarm Annunciator, Square Root Extractor, Damper, Safety Valve, Relief Valve, Rupture Disc, Safety Relief Valve

5. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Control Valves	12	04	09	12	25
II	Pneumatic Components	04	01	02	02	05
III	Piping Components	04	01	02	02	05
IV	Control System Components	12	02	03	10	15
V	Safety and auxiliary components	10	02	04	14	20
Total		**42**	**10**	**20**	**40**	**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.

6. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course 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 course outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of Programme Outcomes/Course Outcomes in ***affective domain*** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

S. No.	Unit No.	Practical/Exercise ('Course Outcomes' in Psychomotor Domain according to NBA terminology)	Approx. Hrs. Required
1	I	Identify and Label basic parts of control valve.	2
2	I	Identify the type of valve from its construction.	2
3	I	Calibrate control valve.	2
4	I	Obtain the Globe valve characteristics .	2
5	I	Plot the graph of valve characteristics for given Ball valve.	2
6	I	Plot the graph of valve characteristics for given Butterfly valve.	2
7	I	Plot the graph of valve characteristics for given Needle valve.	2
8	I	Plot the graph of valve characteristics for given Pinch valve.	2
9	I	Plot the graph of valve characteristics for given Solenoid valve.	2
10	I	Plot the graph of valve characteristics for given Piston type valve.	2
11	I	Plot the graph of valve opening vs input air signal for given air to open type of valve.	2
12	I	Plot the graph of valve opening vs input air signal for given air to close type of valve.	2
13	I	Differentiate between the performance of rotary valve and linear valve.	2
14	I	Devise a plan to check working of electro pneumatic valve	2

		actuator.	
15	I	Observe the valve opening status at different pressure levels in pneumatic valve actuators.	2
16	I	Maintain pneumatic piston-cylinder actuator.	2
17	II	Plot the graph of voltage v/s pressure for given flapper nozzle system +	2
18	II	Analyze the effect of volume booster in line .	2
19	II	Test the air lock relay.	2
20	II	Check and observe the output reading of air filter regulator.	2
21	III	Check the effect of silencers,mufflers and reducers in hydraulic lines.	
22	IV	Examine the design of a 3-phase synchronous motor and learn how to connect it.	2
23	IV	Obtain Synchronous motor starting characteristic and determine the full-load and pull-off characteristic of a synchronous motor.	2
24	IV	Connect potentiometer as an error detector.	2
25	IV	Wire a servo motor and control it using labview program.	2
26	IV	Control the steps of stepper motor by varying the input pulse.	2
27	V	Test the given electro mechanical relay by energizing its coil.	2
28	V	Test the given reed relay by energizing its coil.	2
29	V	Test the given solid state relay(SSR) by energizing its coil.	2
30	V	Test the given Field failure relay by energizing its coil.	2
31	V	Test the operation of flow switch.	2
32	V	Test the operation of thermostat.	2
33	V	Test the operation of Pressure switch.	2
34	V	Test the operation of Humidistat.	2
35	V	Test the operation of Level switch.	2
36	V	Test the operation of given limit switch.	2
37	V	Test the operation of given proximity switch.	2
38	V	Test the operation of Toggle switch.	2
39	V	Test the operation of DIP switch.	2
40	V	Test the operation of Rotary switch.	2
41	V	Test the operation of Thumbwheel switch.	2
		Total	**84**

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

i. Dismantle the control valve in order to recognize its internal parts.
ii. Calibrate the control Valve.
iii. Use proper piping elements for proposed hydraulic line.
iv. Control Temperature of given loop using thermostat.
v. Control Pressure of given loop using pressure switch.

8. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Visits to Industries
ii. Take small instrumentation components to the class when teaching
iii. Video films/animation films on working of different type of power stations from YouTube and other resources
iv. Mini project

9. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Books	Author	Publication
1	Control system components	B. Chatterjee	Khanna Publishers, latest edition
2	Control system components	M D Desai	PHI Learning,
3	Applied instrumentation in process industries	W. G Andrews	Gulf Publishing co., Houston
4	Instrumentation engineer's handbook	B.G Liptak	Chilton Book Co., Philadelphia
5	ISA handbook of control valves	James W Hutchison	ISA
6	Instrumentation and Control systems	D S Kumar	
7	Valve selection handbook	R W Zappe	Gulf Publishing Co., Houston

B) List of Major Equipment/Materials with Broad Specifications

i. Pliers,Screwdriver and other hand tools
ii. Multimeter
iii. Voltage Source
iv. pressure source
v. Air compressor

C) List of Software/Learning Websites

i. www.control.com
ii. En.wikipedia.org
iii. www.youtube.com
iv. www.valveinternational.co.za
v. books.google.com

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. A. M. Patel,** HOD IC Engineering, Govt. Polytechnic, Palanpur
- **Prof. N. B. Mehta**, Lecturer IC Engineering, Govt. Polytechnic, Ahmedabad
- **Prof. M. J. Dehlvi**, Lecturer IC Engineering, Govt. Polytechnic, Gandhinagar

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering
- **Dr. Shashikant Gupta**, Professor and Coordinator for State of Gujarat