

GUJARAT TECHNOLOGICAL UNIVERSITY

PLASTIC TECHNOLOGY (23)

PLASTIC PROCESS INSTRUMENTATION AND PROCESS CONTROL

SUBJECT CODE: 2162303

B.E. 6th SEMESTER

Type of course: Core

Prerequisite: Plastic Processing

Rationale: NA

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		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.	Content	Total Hrs	% Weightage
1	Introduction: Process control and its importance; need for instrumentation; need for controllers; terminology. ACTUATORS, VALVES, AC DRIVES, applications of each	2	6%
2	Measurements: role of instruments, range, error, accuracy, precision, sensitivity, resolution, block diagram of instrumentation system.	5	10
A)	Pressure measurement. :Function of Transducers , types, selection and comparison of transducers with applications, Pneumatic pressure transducers; Mechanical Consideration, Specifications, etc	4	10
B)	Temperature Measurement: Methods of Temperature measurement: Resistive Temperature Sensors, Thermocouple Temperature Sensors, Radiation Pyrometers. Types of Resistive temperature sensors: Conductive type and semiconductor type	4	10
	THERMOCOUPLES : Principle and Function of a Thermocouple, various types of Thermocouples like Nickel Alloy type , Platinum / Rhodium Alloy type, Tungsten alloy type, Iron – Constantin ,etc. Features of each type, with applications, temperature ranges,etc. THERMISTOR: Applications., comparison with other Temperature Sensors. Barrel temperature measurement, Stock Temperature Measurement, Power Measurement, Rotational Speed Measurement, Measurement of Extrudate Thickness by LVDT. <u>Level, Flow, Viscosity and Density Measurements :</u> Direct and Indirect measurement of Liquid Level, Different Head flow meters, area flow meters, Total Flow measuring instruments, Viscosity Measurements of polymer solutions and polymer melt, and density measurements systems.	3	6

3	CONTROLLERS : Function of a Controller , Types of Controllers :ON-OFF ; PI ; PID controllers ; Time- Temperature Diagrams, Principle of ON-OFF, PI and PID controllers, etc.	4	10
4	INTRODUCTION TO PROCESS CONTROL : Introduction to Process control, Designing aspects of Process control system, control system performance, mathematical modeling principles used for process control, Dynamic response of linear open loop systems such as First order system, second order system, first order system in series with physical examples.	7	18
5	FEEDBACK CONTROL LOOP Introduction to control loop, open loop and closed loop, basic elements of closed loop control system, feedback control system, closed loop transfer function, open loop transfer function, multiple closed loop transfer function, effect of disturbances, modes of control action and control valve, Transient response of simple control system, controller tuning. APPLICATIONS	8	10
6	ADVANCE PROCESS CONTROL Introduction to Advanced process control system, Feed forward, cascade, ratio control with different application, Introduction to Digital control, introduction to discrete-time system, Introduction to Programmable Logic Control, Communication Protocols like Ethernet, RS-485/RS-232 MODBUS, CAN, etc. Supervisory control and data acquisition systems. Distributed control systems, Different examples of Microprocessor based control system used for chemical and polymer manufacturing such as control of continuous and batch polymerization processes.	7	16
7	Control systems in extrusion, injection moulding and blow moulding machines in detail	7	18

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	20	15	10	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create 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. Industrial instrumentation, Eckman D.P. Wiley Eastern, [16th edition],1991.
2. Process systems analysis and control, Coughanowr Donald R., McGraw Hill, [2nd edition], 1991
3. Chemical process control : An introduction to theory and practice, Stephnopoulos George, Prentice – Hall India, 2002.

4. Process control: Designing processes and control systems for dynamic performance, Marlin T., McGraw – Hill, [2nd edition] 2004.
5. Principles of industrial instrumentation, Patranabis D., Tata McGraw Hill, New Delhi, [2nd edition], 2004.
6. Instrumentation measurement and analysis, Nakra, B.C., Choudhary K.K., Tata McGraw Hill, New Delhi, [2nd edition], 2004.
7. Process control instrumentation technology, Johnson C.D., Pearson Prentice–Hall International, [4th edition], 1996.
8. Process / industrial instruments and control handbook, Considine D.M., McGraw – Hill, [1st edition] ,2006
9. process analyzer technology, Clevert J.G., Wiley, New York 1986.
10. Process instrumentation and control, A.P. Kulkarni, Nirali Publication, [1st edition], 2008.
11. Industrial Control and instrumentation, Bolton W., University Press, [1st edition],1991.
12. Handbook of Plastics Test Method, Handbook of Plastic Testing Technology, R.P. Brown, A. Wiley - Inter science Publication, 1981.

Course Outcome:

After learning the course the students should be able to:

1. Understand Instrumentation in various processing operations
2. Solve on the field problems
3. Give proper suggestions for modification of Instrumentation

List of Experiments:

1. Characteristics and calibration of temperature measuring instrument.
2. Characteristics and calibration of pressure measuring instrument.
3. Characteristics and calibration of level measuring instrument.
4. Characteristics and calibration of flow measuring instrument.
5. Control valve characteristics
6. Estimation of response of first order system.
7. Estimation of damping coefficient for U tube manometer.
8. Experiments on Proportional integral and derivative control actions.
9. Controller tuning using Ziegler Nichols rules.
10. Feedback temperature, pressure, level and flow control loop.
11. Computer based control of polymer processing equipment such as injection molding machine.

Design based Problems (DP)/Open Ended Problem:

1. Experiment on screw speed measurements.
2. Experiment on cascade control.
3. Study of Programmable logic control.
4. Study of control stability analysis.
5. Study of Data Logger

Major Equipment: Processing Machines Like Injection Moulding, Extruder, Blow Moulding, Controllers, Control Circuits,Etc

List of Open Source Software/learning website:

1. www.wikipedia.org
2. www.sciencedirect.com
3. www.mit.edu

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.