GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
PROCESS CONTROL SYSTEMS
SUBJECT CODE: 2151705
B.E. 5th SEMESTER

Type of course: Core

Prerequisite:
1**.** Calculus
2. Ordinary differential equations
3. Complex variables
4. Linear system concepts
5.Laplace transform
6. Fundamentals of control theory

Rationale: To prepare students for process control systems knowhow ad prevailing practices in the field of chemical process control.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

SR NO.	TOPIC	HRS	% WEITAGE
1.	INTRODUCTION Introduction to Process Control. Control objectives, servo regulatory control, classification of process variables.	3	5
2.	MODELING OF SOME CHEMICAL PROCESS SYSTEMS Modeling basics, Degree Of Freedom, Mass Balance, Energy Balance equations, linearization of nonlinear systems, Modeling of Level Tank System, Continuous Stirred Tank Heater, Continuous Stirred Tank Reactor, Transfer function.	6	12
3.	ELEMENTS OF PROCESS CONTROL Dead time, Interacting and non interacting systems, self regulation, inverse response, capacity of process, integrating systems, multicapacity process.	5	10
4.	PROCESS IDENTIFICATION Dynamic behavior of first and second order processes, Obtaining First Order Plus Time Delay (FOPTD) model with Process Reaction curve. Obtaining second order model of processes.	5	10
5.	COMMON CONTROLLER MODES	12	22

	Controller Modes, ON OFF, Multi position, time proportional controller, Theory Proportional, Integral and Derivative modes, PI, PD, PID Controller, Dynamic Behavior of closed loop systems with P, I, D , PI , PID modes.		
6.	DISCRETISATION AND IPLEMENTATION ISSUES Discrete time control mode realization. Velocity and Position algorithm of PID control. Integral windup, anti windup systems, controller bias, bumpless transfer.	4	8
7.	TUNING OF CONTROLLERS application and tuning, ZN Tuning (Openloop and Closed loop), Performance criteria, Integral criteria,	5	10
8.	SOME ADVANCE CONTROL Techniques Cascade Control, Feedforward Control, ratio Control, Selective Control, Inferential Control, Introduction to adaptive control. Examples of Drum Boiler, Heat Exchanger and CSTR, Feedforward+Feedback Control of Heat Exchanger, Air Fuel Ratio Control for Drum Boilers. Level Control in Drum Boiler, Shrinking and Swelling, Inverse response of Drum Boiler.	12	23

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
21	**14**	**14**	**14**	**7**	**-**

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.

Text Books:

1. G. Stephanopolous, "Chemical Process Control An Introduction to Theory and Practice", Prentice Hall India, August 2000.
2. Surekha Bhanot, "Process Control Principles and Applications", Oxford, 2008
3. C.D. Johnson, "Process Control Instrumentation Technology", Prentice Hall India.
4. Thomas Marlin, "Process Control Designing Processes and Control for Dynamic Performance", Tata MC Graw Hill, 2012.
5. F.G. Shinskey, "Process Control Systems Application Design and Adjustment" 3rd editionn, McGraw Hill International,
6. D. E. Seborg, T.F. Edgar, D. A. Mellichamp, "Process Dynamics and Control", Wiley, 2004

List of Experiments: (Outlines)

1. Introduction to Matlab/Scilab
2. To find Unit step, ramp, impulse response of first and second order system using matla / scilab.
3. To implement the ON OFF control with op-amp or other equivalent circuits.
4. Software implementation of On OFF controller using 8051 or equivalent.
5. Understanding FOPTD and SOPTD modeling of systems with MATLAB or SCILAB.

6. Implementation of PI controller with op-amp or other equivalent circuit.
7. Implementation of PID controller with op-amp or other equivalent circuit.
8. To study ZN tuning for a given plant/system with MATLAB or SCILAB.
9. Hardware implementation of closed loop systems with any control system trainer.
10. Implementation of P, PI, PID algorithm with microcontrollers like 8051.
11. Implementation of PI algorithm with microcontrollers like 8051.
12. Implementation of PID algorithm with microcontrollers like 8051.
13. Study of industrial grade single loop controller (specifications, configuration, testing, calibration)

Design based Problems (DP)/ Open Ended Problem:
To develop a simple control loop for a system using microcontroller or hardware circuit e.g. on off control of heaters/temperature control systems, displaying of the variables on computer screens or LCD screens etc.

Major Equipment:

MATLAB/SCILAB software/control loop trainer, PROTEUS, KEIL or equivalent.

List of Open Source Software/learning website:

www.control.com
http://en.wikipedia.org/wiki/Process_control
http://w3.siemens.com/mcms/automation/en/Pages/automation-technology.aspx
http://nptel.ac.in/video.php?subjectId=108105064

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.