

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: INSTRUMENTATION & CONTROL ENGINEERING (17)

SUBJECT NAME: PROCESS DYNAMICS AND CONTROL

SUBJECT CODE: 2171710

B.E. 7th SEMESTER

Type of course: Core Engineering

Prerequisite: Process Instrumentation, Process Loop Components, Control System Design

Rationale: In the process industries like petrochemical, chemical, cement, textile, power plant, pulp & paper, certain sub-processes are part of the main process stream. For continuous production, it is very much important to know the dynamic behavior of such process units and their control. The content of this subject focuses on such sub-processes and its control.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning

Content:

Sr. No.	Content	Total Hrs	Weightage %
1.	Introduction to process control Dynamics and stability of controlled systems. Dynamic behavior of linear and non-linear first-and second-order systems. The development of mathematical models to describe process dynamic behavior	6	12
2.	The Dynamics and Control of Heat Exchangers Basic control strategies, dynamics of the heat exchangers, response to changes in steam temperature, measurement lag and control schemes	6	12
3.	The Dynamics and Control of Boilers Boiler basic controls (safety interlocks, single element, two and three element level control, shrink, swell effect, inverse response, feed forward control of feed water, dynamic compensation, fuel-air ratio, stoichiometric calculations, steam temperature and pressure control) Boiler dynamics, burner management system, boiler optimization	8	15

4. The Stability and Control of Chemical Reactors Types of reactions and reactors (overview), factors governing the conduct of reaction, stability of reactors, time constant, effects of lag, flow control, temperature control, pH control, end point detection of continuous and batch reactors. Sequential & logic control in batch process, batch production management	8	15
5. Dynamic Behavior and Control of Distillation Column Mass and Energy balance, column feed control, column pressure control, control of overhead and bottom composition, distillate reflux flow control. Frequency response, lag in liquid and vapor flow, concentration lag, predicting the behavior of control system	8	15
6. Dynamic behavior and controls required in pumps and compressors Design aspects and control scheme development for Waste-Water Treatment plant	6	12
7. Unit operations in different industries Identification and justification of unit operations used in different industries like food, pharma, paper, sugar, cement, fertilizer, Petrochemical industry with help of process flow diagram	10	19

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
Remembrance	Understanding	Application	Analyze	Evaluate	Create
R Level	U Level	A Level	N Level	E Level	C Level
14	14	14	14	14	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. Instrument Engineers Handbook: Process Control by Bela G Liptak , Chilton book co.
2. Process Dynamics and Control by Dale E. Seborg, John Wiley & Sons,
3. Process Instrumentation and control Handbook by Considine, Mc-Graw-Hill publication

Text Book:

1. Process Control by Peter Harroitt, Tata-McGraw Hill. Fifth ed.
2. Process Control Systems by F. G. Shinskey, Tata-McGraw Hill.

3. Chemical Process Control by George Stephanopolous, PHI
4. Computer based Industrial Control by Krishna Kant, PHI
5. Process Control: Modeling, Design and Simulation by B. Wayne Bequette, PHI

Course Outcome: After learning the course the students will be able to

- CO1. recognize unit operations and effect of other parameters on them.
- CO2. evaluate instrumentation and control related with the unit operations.
- CO3. identify unit operations used in different industries.

List of Experiments:

Students are expected to perform minimum 8 experiments based on the above topics

- Modeling and Designing control strategies of a typical process
- Process simulation: using MATLAB Simulink, Simulation of different process
- Problems based on stability, frequency response etc.

Suggested Experiment list

1. Study of Dynamic behaviour of 2nd order systems. (suggestion: use RLC circuit and for a given step input in voltage try to find out its second order equivalent model by observing capacitor voltage as output)
2. Study of flow control loop using PID controller
3. Study of Level Control loop using PID controller
4. Simulation study of cascade control preferably for chemical process.
5. Simulation study of feed-forward control preferably for chemical process.
6. Simulation study of ratio control preferably for chemical process.
7. Implement temperature control system with PID controller or ON OFF controller.
8. Perform system identification of first or second order system with input and output data. (Suggestion: use system identification toolbox in MATLAB/Simulink or use open source ware: SCILAB)
9. Use the in-built PID controller in PLC. Implement On/ OFF control for temperature process with PLC. (Suggestion: work on actual PLC like (SIEMENS, ABB, SCHNEIDER, DELTA etc.)

Open ended problem:

Try to obtain the mathematical model of Tubular heat exchanger with theoretical background and chemical/mechanical engineering. Propose a control strategy for the heat exchanger. Also discuss various issues in control of the heat exchanger.

Major Equipment:

Computers, simulation software, multi loop/ single loop control system, etc.

List of Open Source Software/learning website:

<http://nptel.ac.in/video.php?subjectId=108105064>

Freeware- consim

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.