B. Tech. - IV Semester – VII

Subject Name: Process Dynamics and Control **Subject Code: BTIC14704**

Type of course: Professional Elective Course

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 it's control.

Teaching and Examination Scheme:

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TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests CA2: Sincerity in attending classes/class tests/ timely submissions of assignments/ self-learning attitude/solving advanced problems TEE: Term End Examination TEP: Term End Practical Exam (Performance and viva on practical skills learned in course) CA3: Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

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, stochiometric 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					
R Level	U Level	A Level	N Level	E Level	C Level
7	**21**	**14**	**21**	**7**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

BSC: basic science course /ESC: Engineering Science Course /HSM: Humanities and management /PCC: Professional Core course /PEC: professional Elective course /OEC: Open Elective course/ MD: mandatory non-credit course

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

Course Outcomes:

Sr. No.	CO statement At the end of the course the student will be able to:	Marks % weightage
CO-1	recognize unit operations and effect of other parameters on them.	30%
CO-2	evaluate instrumentation and control related with the unit operations.	35%
CO-3	identify unit operations used in different industries.	35%

Mapping with POs:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	3												3	3	
CO2	3												3	3	
CO3	3	2											3	3	

Rationale* : Explaining why it is matching this particular program outcome

List of Open Source Software/learning website:

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

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List of Experiments:

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.)

Major Equipment:

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