COURSE TITLE	**INSTRUMENTATION & PROCESS CONTROL**
COURSE CODE	**01CH1504**
COURSE CREDITS	**4**

Objective:

1 This course introduces dynamic processes and its control. Subject deals with modelling, static, dynamic behaviour of processes and its control strategies; design of feedback, feed forward, and other control structures.

Course Outcomes: After completion of this course, student will be able to:

1 Understand the concept of open and closed loop control systems.

2 Construct mathematical models of chemical process with its transfer function.

3 Analyze the order of control system with its transfer function and control strategies along with instrumentation.

4 Design control loops with appropriate controllers and control valve.

5 Select appropriate instruments for various applications in chemical plant.

Pre-requisite of course: Basics of differential equations, material and energy balance.

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Process Instrumentation** Principles and classification of process control instruments Temperature,, Pressure, Fluid Flow Rate,, Pressure, Fluid Flow Rate,	6
2	**Introduction to Process Control** Laplace transformation: transform of standard functions, derivatives and integrals, inversion theorems., Open loop system: Transfer functions, Forcing functions: step, pulse, impulse and sinusoidal., First order and Higher order system dynamics: Linearization and its application in process control - Continuous and batch processes- Transportation lag,, Systems with inverse response, process reaction curve.	10

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Contents : Unit	Topics	Contact Hours
3	**Linear Closed-Loop Control Systems** Concept of Feedback control, Types of Feedback controllers,, Control valves, transducer dynamics,, Block Diagram and Closed loop response, Servo problem, v/s regulator problems,, Transfer function of controllers and control valve - Characteristics of ON-OFF,, Proportional, Integral and Derivative control modes : P, PI, PD, PID control modes	10
4	**Time and Frequency Domain Analysis** Stability criteria- Routh's stability criteria,, Root locus diagram, Frequency response analysis,, Gain margin, Phase margin and cross over frequency,, Bode plot, Polar plot and Nyquist plot	8
5	**Controller Tuning** Process reaction curve,, Cohen-Coon method, IMC tuning,, Ziegler Nichols method.	8
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment 1** To know the hardware element of closed loop control system.	2
2	**Experiment 2** To determine the dynamics of given thermometer and compare the theoretical value of the time constant with experimental value.	2
3	**Experiment 3** To determine the dynamics of liquid level in a tank and compare the experimental value of time constant with the experimental value for the step input.	2
4	**Experiment 4** To determine the dynamics of liquid level in a tank and compare the experimental value of time constant with the experimental value for Impulse	2
5	**Experiment 5** To determine the response of two first order system in series of the non – interacting system for Impulse	4
6	**Experiment 6** To determine the response of first order system in series of the interacting system for step input.	4
7	**Experiment 7** To determine the response of first order system in series of the two interacting system for Impulse disturbance.	2
8	**Experiment 8** To develop approximation for nonlinear model to be linear & study the dynamics of liquid tank.	2

DR. ABHISHEK GUPTA
Digitally signed by (Name of HOD)

DR. RAJENDRASINH BAHADURSINH JADEJA
Digitally signed by (Name of Dean/ Principal)

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
9	**Experiment 9** To determine the Control valve characteristic.	2
Total Hours		**22**

Textbook :

1 Instrumentation and process control, , Sikdar, D.C., Khanna Publication, 2019

2 , Industrial Instrumentation, , Eckman D., CBS Publishers., 2020

3 Instrumentation and Control for Chemical, Mineral and Metallurgical Processes, , Radhakrishnan, V.R.,, Allied Publishers., 1997

References:

1 Process systems analysis and control (Indian Edition),, Process systems analysis and control (Indian Edition),, Coughanowr, D. R.,, McGraw- Hill., 2017

2 Chemical process control - An Introduction to Theory and Practice,., Chemical process control - An Introduction to Theory and Practice,., Stephanopoulos, G., Prentice hall India, 2015

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	20.00	25.00	25.00	10.00	10.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

Supplementary Resources:

1 http://nptel.ac.in/courses/103107123/

2 https://ocw.mit.edu/courses/audio-video-courses/#chemical-engineering

DR. ABHISHEK GUPTA
Digitally signed by (Name of HOD)

DR. RAJENDRASINH BAHADURSINH JADEJA
Digitally signed by (Name of Dean/ Principal)

Supplementary Resources:

3 https://www.youtube.com/watch?v=GO8HkEZlb9k

DR. ABHISHEK GUPTA
Digitally signed by (Name of HOD)

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