

**B.Tech. III Semester – VI**  
**Program: Minors - Industrial Automation**

**Subject Name: Process Control**

**Subject Code: BTIC19651**

**Type of course: Minors**

**Prerequisite (if any):** Industrial Measurement Techniques, Instrumentation system components

**List of Courses where this course will be prerequisite:** Industrial Automation

**Rationale:**

Process control is commonly used for mass production. The knowledge of this subject enables the automation of industrial processes. This course includes various dynamics of processes and the most widely used PID control algorithms with its tuning methods used industrial process.

**Teaching and Examination Scheme:**

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
4	0	2	5	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:**

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**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 noncredit course**

Sr. No.	Content	Total Hrs	
1	<b>Introduction</b> Introduction to Process Control: Terms and Process Control objectives, servo and regulatory control, and classification of process variables.	3	4%
2	<b>Types Of Dynamic Processes</b> Dead time, self-regulation, inverse response, capacity of process, integrating systems, Interacting and non-interacting systems	8	13%
3	<b>Modelling Of Chemical Process Systems</b> 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	8	13%
4	<b>Process Identification</b> Dynamic behavior of first and second order processes, Obtaining First Order Plus Time Delay (FOPTD) model with Process Reaction curve.	3	6%
5	<b>Common Controller Modes</b> Controller Modes, ON OFF, Multi position, time proportional controller, Proportional, Integral and Derivative modes, PI, PD, PID Controller, Electronics Controller implementation of ON-OFF, PID controller using Opamp, Selection of control modes for processes like level, pressure, temperature and flow. Dynamic behaviour of P, I, D controller for three tank mixing system closed loop for disturbance change. Laplace transfer function for PID controller with different modes.	15	24%
6	<b>Discretisation And Implementation Issues</b> Discrete time control mode realization. Velocity and Position algorithm of PID control. Integral windup, anti-windup systems, controller bias, bumps less transfer.	7	9%

<b>7</b>	<b>Tuning Methods Of Controller</b> Open and Closed loop Tuning method, Integral based criteria.,Heuristics based controller tuning,frequency response based controller tuning	<b>7</b>	<b>9%</b>
<b>8</b>	<b>Some Advance Control Techniques</b> Cascade Control, Feed forward Control, ratio Control,Over-ride, split range and selective control.	<b>9</b>	<b>22%</b>

**Suggested Specification table with Marks (Theory): (For BTech only)**

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
<b>20%</b>	<b>25%</b>	<b>20%</b>	<b>15 %</b>	<b>10%</b>	<b>10%</b>

**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:**

Sr no	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Process Control : Principles and Applications	Surekha Bhanot	Oxford University Press ISBN-13:978-0-19-569334-8	2008	1 <sup>st</sup> Edition
2	Process Control Instrumentation Technology	C.D. Johnson	Prentice Hall India ISBN-10-0131194577		8 <sup>th</sup> Edition

			ISBN-13-978-0131194571		
3	Process Control Designing Processes and Control for Dynamic Performance	Thomas Marlin	Tata MC Graw Hill ISBN-13-978-0070393622	2012	2 <sup>nd</sup> Edition
4	Chemical Process Control :An Introduction to Theory and Practice	Stephanopolous	Prentice Hall India,	August 2000	
5	Process Control Systems	Shinsky	McGraw Hill,Singapore	1996	4 <sup>th</sup> Edition

**Course Outcomes:** After learning this course, students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Define common dynamics of processes found in many industries and model them mathematically using First Principle method as well as empirical methods.	25%
CO-2	Interpret each mode of PID Controller in closed loop and Develop skill to tune PID controller using trial and error and known theoretical methods for industrial process loops.	25%
CO-3	Implement discontinuous and continuous modes of controller using electronic devices using Opamp and microcontroller/matlab.	10%
CO-4	Implement position and velocity form of Discrete PID control algorithms.	10%
CO-5	Categorize the issues related to typical industrial processes and classify various advance control strategies like cascade, ratio, selective mode etc. with their theoretical and practical issues.	20%
CO-6	Analyse the industrial processes with different types of controllers in	10%

	closed loop and check the stability of overall system.	
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**Mapping CO-POs:**

	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO3
CO1	3													3	
CO2				1									3		
CO3					2									1	
CO4					2								2		
CO5			2				2								
CO6	1		2										2		

**List of Open learning website:**

- 1) NPTEL lectures on Chemical Process Control by Prof Sujit Jogwar, Chemical Department, IITBombay  
<https://nptel.ac.in/courses/103/101/103101142/#>
- 2) Process Control - Design, Analysis and Assessment by Prof. Raghunathan Rengaswamy , IIT Madras  
[https://onlinecourses.nptel.ac.in/noc22\\_ch21/preview](https://onlinecourses.nptel.ac.in/noc22_ch21/preview)
- 3) Process Control- by Thomas Marlin, McMaster university, Canada.  
<http://www.pc-education.mcmaster.ca/>

**List of Open Source Software: Scilab Software**

**FOR LAB SESSIONS: Closed loop Process Control Trainer, PC, Matlab/Scilab Software**

**List of Experiments:**

1. To find Unit step, ramp, impulse response of first and second order system using MATLAB/Scilab.
2. To implement the ON OFF control with op-amp or other equivalent circuits.

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3. Software implementation of ON OFF controller using 8051 or equivalent.
4. Closed loop stability analysis of three tank mixing system with P,PI,PID controller and effect of  $k_p, k_i$  and  $k_d$  on system's overall performance and stability.
5. Implementation of PID controller with op-amp or other equivalent circuit. \
6. To study ZN tuning for a given plant/system with MATLAB or SCILAB.
7. To implement Discrete PID controller with MATLAB.
8. Hardware implementation of closed loop systems with flow and level control system.
9. Implementation of Cascade Control System.
10. Modelling the system of first order plus delay time using PRC.
11. Study of industrial grade single loop controller (specifications, configuration, testing, calibration

**Major Equipment Needed:** Closed loop Process Control Trainer, PC, Matlab/Scilab Software