Reg. No.																

Question Paper Code	13113

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Fifth Semester

Instrumentation and Control Engineering

(Common to Electronics and Instrumentation Engineering)

20ICPC501 - PROCESS CONTROL

Regulations - 2020

Duration: 3 Hours Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)

Answer ALL Questions

No.	Question	Marks	K – Level	CO
1.	What is a key step in deriving the transfer function for a two-tank interacting system? (a) Ignoring interaction effects (b) Considering interaction effects (c) Simplifying to one tank (d) Using only empirical data	1	K1	CO1
2.	What is the main difference between continuous and batch processes? (a) Continuous processes are always running (b) Batch processes use only manual control (c) Continuous processes have fixed durations (d) Batch processes are used for constant flow	1	K1	CO1
3.	A heat exchanger's thermal model typically requires which type of parameter model? (a) Lumped parameter (b) Linear parameter (c) Self-regulated parameter (d) Non-interacting parameter	1	K1	CO1
4.	What is the primary characteristic of a non-interacting system? (a) All components affect each other directly (b) Components act independently without affecting each other (c) Self-regulation is impossible (d) Manual control is necessary	1	K1	CO1
5.	When should a valve positioner typically be used? (a) When the valve is operating at full capacity only (b) When precise control of the valve position is required (c) When the valve is manually controlled (d) When the system is completely static required	1	K1	CO2
6.	What is the primary reason for the difference between inherent and installed characteristics of a control valve? (a) Valve material differences (b) Variations in installation conditions and piping (c) Differences in valve size (d) Changes in ambient temperature	1	K1	CO2
7.	Why is the equal percentage valve commonly used in process industries? (a) It provides a linear flow characteristic (b) It offers a quick opening characteristic (c) It maintains a consistent percentage change in flow rate with valve movement (d) It is suitable for applications with minimal flow rate variation	1	K1	CO2
8.	Which of the following best defines a control valve's inherent characteristic? (a) It describes the valve's flow rate when installed in a process system (b) It represents the flow characteristic under standard, ideal conditions (c) It accounts for system pressure variations (d) It describes how the valve responds to changes in temperature	1	K1	CO2

9. What is the primary role of the integral action in a PID controller when used with proportional control? *1 K1 CO3*
(a) To enhance the rate of response to changes
(b) To correct for any steady-state error that remains after proportional control
(c) To predict future errors and adjust the output accordingly
(d) To dampen high-frequency oscillations in the control output

10. How does derivative action in a PID controller help in improving system performance? *1 K1 CO3*
(a) By increasing the overall error correction speed
(b) By reducing the impact of past errors
(c) By predicting future trends based on the rate of change of the error
(d) By eliminating the need for proportional control

11. Which form of PID algorithm provides separate computation for each term before combining them? *1 K1 CO3*
(a) Series form (b) Parallel form (c) Cascade form (d) Integral form

12. What is the benefit of using a PID controller with an integral term in applications requiring precise control? *1 K1 CO3*
(a) It reduces the response time of the system
(b) It eliminates any steady-state error that occurs with proportional control alone
(c) It amplifies the noise in the process signal
(d) It simplifies the control strategy to only proportional and derivative actions

13. What is the impact of time response criteria on PID controller evaluation? *1 K1 CO4*
(a) It focuses on energy efficiency rather than response time.
(b) It allows engineers to assess how quickly and accurately the controller can achieve setpoint.
(c) It eliminates the need for mathematical modelling.
(d) It simplifies the PID tuning process.

14. Which of the following is a criterion based on frequency response for evaluating PID controller performance? *1 K1 CO4*
(a) IAE (b) ITAE (c) Phase margin (d) Settling time

15. How does the Integral of Time-weighted Absolute Error (ITAE) influence PID controller design? *1 K1 CO4*
(a) It provides a measure of steady-state error only
(b) It helps in achieving a quicker response time by emphasizing errors occurring later in time
(c) It eliminates the need for integral control
(d) It solely focuses on the amplitude of the response.

16. What is the significance of using the Ziegler-Nichols method for PID tuning? *1 K1 CO4*
(a) It is the only method that guarantees stability
(b) It provides a quick approximation for controller parameters based on system response
(c) It requires extensive calculations of system dynamics
(d) It focuses on minimizing the energy consumed by the actuator.

17. What is the primary purpose of a control scheme for a Continuous Stirred Tank Reactor (CSTR)? *1 K1 CO5*
(a) To monitor the temperature of the reactor
(b) To maintain the concentration and temperature of reactants
(c) To maximize energy efficiency
(d) To ensure uniform mixing of solid reactants

18. What type of process variable is most commonly controlled in a boiler drum level control system? *1 K1 CO5*
(a) Temperature (b) Pressure (c) Level (d) Flow rate

19. How does the Smith Predictor improve control performance in systems with time delays? *1 K1 CO5*
    (a) By ignoring delays altogether
    (b) By predicting the future process output based on the current control input
    (c) By directly measuring the output with no delays
    (d) By increasing the actuator speed
20. In a three-element boiler drum level control, how do the elements interact to maintain the desired level? *1 K1 CO5*
    (a) They independently control the feedwater flow
    (b) They provide feedback to correct any deviations in level, pressure, and steam flow
    (c) They regulate the temperature of the steam generated
    (d) They only control the flow rate of the steam.

PART - B (10 × 2 = 20 Marks)
Answer ALL Questions

21.	Define controlled variable, manipulated variable, and load variable in process control.	*2*	*K1*	*CO1*
22.	Illustrate the term degrees of freedom in the context of process control.	*2*	*K2*	*CO1*
23.	State the need for a valve positioner.	*2*	*K2*	*CO2*
24.	Why a valve is called an "equal percentage" valve? Explain its operational principle.	*2*	*K1*	*CO2*
25.	What is meant by a Neutral Zone in an ON-OFF controller?	*2*	*K1*	*CO3*
26.	Compare PI and P controllers based on their response.	*2*	*K2*	*CO3*
27.	Why controller tuning is necessary for maintaining optimal control performance?	*2*	*K2*	*CO4*
28.	List any two merits and demerits of feed forward controllers.	*2*	*K2*	*CO4*
29.	Point out the advantages of IMC.	*2*	*K1*	*CO5*
30.	What is the need for multi loop control?	*2*	*K1*	*CO5*

PART - C (6 × 10 = 60 Marks)
Answer ALL Questions

31. a) Derive the transfer function for a two-tank interacting system and explain the steps involved in the derivation process. *10 K2 CO1*

OR

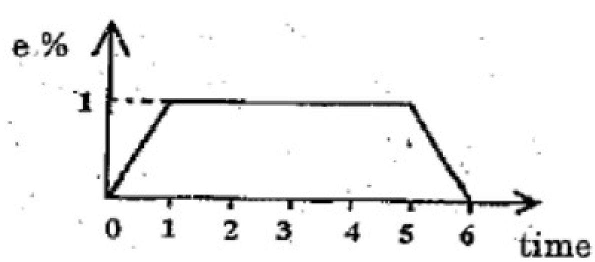
b) Differentiate between servo and regulatory operations with the help of suitable examples. *10 K2 CO1*

32. a) Describe a pneumatic actuator with a neat diagram. *10 K2 CO2*

OR

b) Describe the inherent and installed characteristics of valves and explain their significance. *10 K2 CO2*

33. a) Sketch the PID controller output for the given error signal shown in the following figure. Given that $K_P = 5$, $K_I = 0.7$s-1, $K_D = 0.5$ sec and $P_I(0) = 20\%$. *10 K2 CO3*



OR

b) Explain the characteristics of ON-OFF and single speed floating controller. *10 K2 CO3*

34. a) Write the design procedure for tuning of controller with Cohen coon parameters. *10 K2 CO4*

OR

	b)	Describe the functions of an evaluation criteria and list different types of criteria for control system applications.	*10*	*K2*	*CO4*
35.	a)	Discuss the Smith control algorithm's approach for handling dead time in process control, including its primary advantages.	*10*	*K2*	*CO5*
		OR			
	b)	Explain the block diagram of multiloop control performance using decoupling.	*10*	*K2*	*CO5*
36.	a)	Outline the key aspects of a two-element drum level control system, illustrating with diagrams.	*10*	*K2*	*CO5*
		OR			
	b) i)	Examine ¼ decay ratio criteria with example.	*5*	*K2*	*CO4*
	ii)	Describe how feed-forward and cascade control strategies are used in a distillation column.	*5*	*K1*	*CO5*