U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Electronics and Instrumentation Engineering **Duration: 3 hrs.**

Course Code: 23EI5PCPCS / 22EI5PCPCS **Max Marks: 100**

Course: Process Control Systems

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			MODULE - I	CO	PO	Marks
1	a)		Construct a block diagram of a flow rate process control loop by identifying and organizing the various process elements under appropriate functional blocks.	*CO1*	*PO1*	**08**
	b)		Demonstrate the operation of a Direct Digital Control (DDC) system and a Supervisory Control system for controlling a heater in an oven using a block diagram.	*CO1*	*PO1*	**08**
	c)		A sensor resistance changes linearly from 100 Ω to 180 Ω as temperature changes from 20 ºC to 120 ºC. Find a linear equation relating to resistance and temperature.	*CO1*	*PO2*	**04**
			OR			
2	a)		Draw the physical and block diagram of a feedback control loop in a temperature control system. Analyze and assess the role of current and pressure transmission signals in the system.	*CO1*	*PO1*	**08**
	b)		Identify and analyze three key criteria used to evaluate the performance of a process control loop. Discuss the impact of each criterion on the loop's ability to maintain the desired system behavior.	*CO1*	*PO2*	**08**
	c)		A level sensor inputs a range from 4.50 to 10.6 ft and outputs a pressure range from 3 to 15 psi. Find an equation between level and pressure. What is the pressure for the level of 9.2 ft?	*CO1*	*PO2*	**04**
			MODULE - II			
3	a)		Classify the various types of actuators. Describe the principle operation of the spring-and-diaphragm pneumatic actuator with simple diagram.	*CO5*	*PO1*	**08**
	b)		Define the term "correction factor" in the context of control valve sizing. Find the Cv for a valve that must allow 150 gallons of ethyl alcohol per minute with a specific gravity of 0.8 at a maximum pressure of 50 psi.	*CO5*	*PO2*	**06**

		c)	Describe how you would select an appropriate control valve to regulate flow in a system. An equal percentage valve has a maximum flow of 50 cm^3/sec. and a minimum of 2 cm^3/sec. If the full travel is 3 cm, find the flow at a 1- cm opening.	*CO5*	*PO2*	**06**
			OR			
	4	a)	Describe the types of control valves and explain the flow characteristics of quick-opening, linear, and equal-percentage valves based on stem position. Create a graph to show these relationships.	*CO5*	*PO1*	**08**
		b)	Explain, with a diagram, the working of a signal conversion system that converts pressure into mechanical motion and vice versa. Analyze the factors that affect its efficiency.	*CO5*	*PO1*	**06**
		c)	Identify and describe the different types of instrumentation symbols and interconnection lines used in P&IDs.	*CO2*	*PO1*	**06**
			MODULE - III			
	5	a)	The thermocouple sensor outputs a range of 20 to 250 mV as the temperature varies over its range. Design a signal conditioning circuit, so that the output becomes 0 to 5V. The circuit must have very high input impatience.	*CO3*	*PO3*	**06**
		b)	Using labelled schematic, analyse and explain the following concepts related to process control system: i) Process equation ii) Process lag iii) Dead time iv) Self-regulated process	*CO3*	*PO1*	**08**
		c)	Differentiate between discontinuous and continuous controller modes. A proportional controller controls the level from 2.8 meters to 6.5 meters with a 3.7-meter set point. The proportional gain is 5%/%, and no error output is 54%. What is the controller output for levels of 3.5 meters and 4.0 meters?	*CO3*	*PO2*	**06**
			OR			
	6	a)	Classify the modes of control actions based on application. In a single-speed floating control, the process error is within the neutral zone, with the controller output (p) at 25%. At time t=0, the error falls below the neutral zone. Given the rate of change of error is k = 2%/sec, calculate the time when the output reaches saturation.	*CO3*	*PO2*	**06**
		b)	Explain and analyze the following concepts with graphical diagrams: i) The ‘Neutral zone’ in a 2-position controller ii) The ‘Offset error’ in a proportional controller iii) The 'Overshoot’ and ‘Cycling’ problem of PI controller modes.	*CO3*	*PO1*	**08**
		c)	What is the need of signal conditioning circuits & discuss signal level and bias changing circuits importance?	*CO3*	*PO1*	**06**

			MODULE - IV			
	7	a)	Draw the circuit of an error detector, using ground based current and a differential amplifier. Design a two-position controller that provides an output of 5V at 250°C and drops to 0V when the temperature falls to 240°C, with a 0°C reference.	*CO3*	*PO3*	**08**
		b)	A proportional-derivative controller has a 0.4- to 2.0-V input measurement range, a 0- to 5-V output, Kp 5%/%, and KD 0.08% per (%/min). The period of the fastest expected signal change is 1.5 s. Implement this controller with an op amp circuit	*CO3*	*PO3*	**06**
		c)	Illustrate with a clear schematic diagram and explain the details of Data loggers.			**06**
			OR			
	8	a)	A temperature-control system inputs the controlled variable as a range from 0 to 4 V. The output is a heater requiring 0 to 8 V. A PID is to be used with Kp = 2.4%/%, KI = 9%/(%/min), and K_D = 0.7%/(%/min). The period of the fastest expected change is estimated to be 8 s. Design and draw the PID circuit.	*CO3*	*PO2*	**08**
		b)	Discuss the working of digital two position controller.	*CO3*	*PO2*	**06**
		c)	Level measurement in a sump tank is provided by a transducer scaled as 0.2 V/m. A pump is to be turned on by application of +5 V when the sump level exceeds 2.0 m. The pump is to be turned back off when the sump level drops to 1.5 m. Develop a two-position controller.	*CO3*	*PO1*	**06**
			MODULE - V			
	9	a)	Define control system quality in the context of process loop performance.	*CO4*	*PO1*	**06**
		b)	What does the term 'tuning' mean? Describe the process of tuning a controller using the open-loop transient response method, including a process reaction curve. Provide the Ziegler–Nichols empirical relations for tuning a three-mode PID controller.	*CO4*	*PO2*	**08**
		c)	Using appropriate diagrams illustrate and explain the operation of cascade control system in a process control application.	*CO4*	*PO1*	**06**
			OR			
	10	a)	Define three standard measures of quality in a control system.	*CO4*	*PO1*	**06**
		b)	Discuss the steps of Ziegler-Nichols tunning method and also detail the prescribed parameter configurations for proportional, PI and PID controllers.	*CO4*	*PO1*	**08**
		c)	Implement split range controllers using a suitable example.	*CO4*	*PO1*	**06**

****