

Enrollment No.....



Faculty of Engineering  
End Sem (Even) Examination May-2019  
EI3CO16 Process Control

Programme: B.Tech.

Branch/Specialisation: EI

**Duration: 3 Hrs.****Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

- Q.1 i. The output of the controller in a process control is always being fed to **1**  
 (a) Process (b) Final control element  
 (c) Sensor (d) Error detector
- ii. The controlled variable is maintained at its desired value irrespective **1**  
 of changes in the load variable while the set point is constant. This  
 type of control is called as  
 (a) Servo control (b) Digital control  
 (c) Regulatory control (d) Override control
- iii. The term hysteresis is associated with **1**  
 (a) On-Off control (b) Feed forward control  
 (c) Ratio control (d) Proportional control
- iv. Which of the following controller/s can reduce the steady state error **1**  
 to zero  
 (a) PI (b) PD (c) PID (d) Both (a) and (c)
- v. In damped oscillation method of tuning the ratio of overshoot second **1**  
 peak to the first peak must be  
 (a) 2:1 (b) 4:1 (c) 1:4 (d) 1:2
- vi. For a PID controller using Zeigler Nichols method the value of **1**  
 proportional gain  $K_p$  in terms of ultimate gain  $K_c$  is  
 (a)  $K_p = 0.6 K_c$  (b)  $K_p = K_c$   
 (c)  $K_p = 0.5 K_c$  (d)  $K_p = 2 K_c$
- vii. A P/I converter works in the range of 4-20 mA and 3-15 psi for **1**  
 current and pressure respectively. current corresponding to 10 psi of  
 pressure is  
 (a) 12.33 mA (b) 13.33 mA (c) 10 mA (d) 15 mA

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- viii. Voltage signal in process industry is less preferred for information transmission because **1**  
 (a) It may be corrupted by noise very easily  
 (b) It requires reference point in the space  
 (c) Losses are more as compared to current signal  
 (d) All of these
- ix. A control scheme consists of two or more controllers in series but have a single independently adjustable set point of primary controller. This scheme is referred as: **1**  
 (a) Cascade control (b) Selective Control  
 (c) Ratio Control (d) None of these
- x. The control scheme suitable to control the flow of hot and cold water for a in a bath room is **1**  
 (a) Cascade control (b) Feed Forward control  
 (c) Ratio Control (d) Selective Control
- Q.2 i. What is the need for process control? Explain with at least one suitable example. **2**  
 ii. Draw the basic block diagram of industrial process control and explain each and every block. **3**  
 iii. Develop a mathematical model for a thermal system by taking suitable assumptions and neat diagram. Also relate the transfer function with that of a first order RC network **5**
- OR iv. For a liquid level process derive the transfer function relating the inflow rate  $Q_i$  and the steady head  $H$ . Assume that the outflow  $Q_0$  is controlled by a valve having restriction  $R$  and the flow is laminar. Also draw the process diagram. **5**
- Q.3 i. The temperature in a process has a range of 400 to 650 K and a set point of 500 K. Find the percent of span error when the temperature is 510 K. **2**  
 ii. Describe the characteristics of on-off and single speed floating control with the help of neat sketch. **3**  
 iii. Explain the functioning of PID controller with suitable waveforms. Also compare P, PI and PID controllers. **5**
- OR iv. Draw the circuit diagram and derive the transfer function of **5**  
 (a) Pneumatic PI controller (b) Electronic PI controller

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- Q.4 i. Define quarter decay ratio. **2**  
 ii. What do you mean by tuning of controller? How tuning of controller can be achieved using Bode plot? **3**  
 iii. Explain process reaction curve method for tuning of controller in detail. **5**
- OR iv. Write the steps of Zeigler Nichols method of tuning. A process has a transfer function  $Gp(s)$  as given below; for a unity feedback system a PID controller is inserted in the process loop. **5**
- $$Gp(s) = \frac{1}{S(S+1)(S+5)}$$
- Determine the three mode controller setting based on Z-N method
- Q.5 i. Discuss following in brief **4**  
 (a) Control valve sizing  
 (b) Valve selection criteria  
 (c) Role of actuator in process control
- ii. Explain the functioning of **6**  
 (a) I to P converter (b) P to I converter with neat sketch
- OR iii. What are the different types of valves used in process control industry? Explain with the help of characteristics. A Valve with certain  $C_v$  rating is used to throttle the flow of a liquid for which specific gravity  $S_g = 1.26$ . Determine the value of  $C_v$  such that flow rate through the valve for a pressure drop of 100 psi is recorded 120 gallons per minute **6**
- Q.6 Attempt any two: **5**  
 i. What is split range control explain with the help of an example. **5**  
 ii. What are the advantages and limitations of feed forward control? Explain the concept of feed forward control with the example of distillation column. **5**  
 iii. Discuss in brief: **5**  
 (a) Ratio control (b) Override control

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**Marking Scheme**  
**EI3CO16 Process Control**

Q.1	i.	The output of the controller in a process control is always being fed to	1
		(b) Final control element	
	ii.	The controlled variable is maintained at its desired value irrespective of changes in the load variable while the set point is constant. This type of control is called as	1
		(c) Regulatory control	
	iii.	The term hysteresis is associated with	1
		(a) On-Off control	
	iv.	Which of the following controller/s can reduce the steady state error to zero	1
		(d) Both (a) and (c)	
	v.	In damped oscillation method of tuning the ratio of overshoot second peak to the first peak must be	1
		(c) 1:4	
Q.2	vi.	For a PID controller using Zeigler Nichols method the value of proportional gain $K_p$ in terms of ultimate gain $K_c$ is	1
		(a) $K_p = 0.6 K_c$	
	vii.	A P/I converter works in the range of 4-20 mA and 3-15 psi for current and pressure respectively. current corresponding to 10 psi of pressure is	1
		(b) 13.33 mA	
	viii.	Voltage signal in process industry is less preferred for information transmission because	1
		(d) All of these	
	ix.	A control scheme consists of two or more controllers in series but have a single independently adjustable set point of primary controller. This scheme is referred as:	1
		(a) Cascade control	
	x.	The control scheme suitable to control the flow of hot and cold water for a in a bath room is	1
		(c) Ratio Control	
Q.2	i.	Need for process control with example.	2
	ii.	Block diagram of industrial process control	3
		Description of each block.	2 marks
	iii.	Process diagram	5

OR	iv.	Correct transfer function deduction	3 marks	5
		Relation with RC network	1 mark	
		Process diagram	1 mark	
		Correct transfer function	4 marks	
Q.3	i.	Correct formula	1 mark	2
		Correct answer (-4%)	1 mark	
	ii.	Explanation of on-off control	1.5 marks	3
		Explanation of floating control	1.5 marks	
	iii.	Functioning of PID controller circuit diagram with waveforms	3 marks	5
			2 marks	
OR	iv.	Comparison of P, PI and PID controllers.	2 marks	5
		Draw the circuit diagram and derive the transfer function of		
		(a) Pneumatic PI controller		
		Circuit diagram	1 mark	
		Transfer function	1.5 marks	
		(b) Electronic PI controller		
Q.4	i.	Definition of quarter decay ratio.		2
		Definition of tuning of controller	1 mark	
	ii.	Tuning of controller using Bode plot	2 marks	3
	iii.	Process reaction curve method for tuning of controller		5
		Block diagram	1 mark	
		Characteristic	1 mark	
OR	iv.	Steps for tuning	3 marks	5
		Zeigler Nichols method of tuning steps	2 marks	
		Correct solution of problem		
		Ultimate gain = 30 and frequency = 2.236 rad/s	1.5 marks	
		Setting of parameters of PID		
		$K_p = 18$ , $T_i = 1.404$ sec and $T_d = 0.35$ sec	1.5 marks	
Q.5	i.	Discuss following in brief		4
		(a) Control valve sizing	1.5 marks	
		(b) Valve selection criteria	1.5 marks	
	ii.	(c) Role of actuator in process control	1 mark	6
		Explain the functioning of		
		(a) I to P converter	3 marks	

		(b) P to I converter with neat sketch	3 marks	
OR	iii.	Types of valves	1 mark	<b>6</b>
		Description of characteristic with diagram	3 marks	
		Correct calculation for $C_v = 13.469$	2 marks	
Q.6		Attempt any two:		
	i.	Split range control		<b>5</b>
		Description with diagram	4 marks	
		Example.	1 mark	
	ii.	Advantages and limitations of feed forward control	2 marks	<b>5</b>
		Description of feed forward control	3 marks	
	iii.	Discuss in brief:		<b>5</b>
		(a) Ratio control	2.5 marks	
		(b) Override control	2.5 marks	

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