Total number of printed pages: **04** **B.Tech(UG)/6th /UIE604**

2023

Process Control and Instrumentation

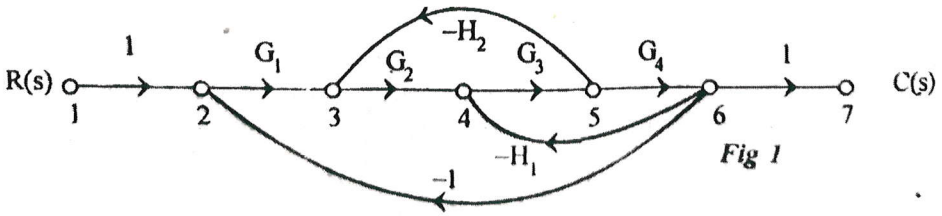
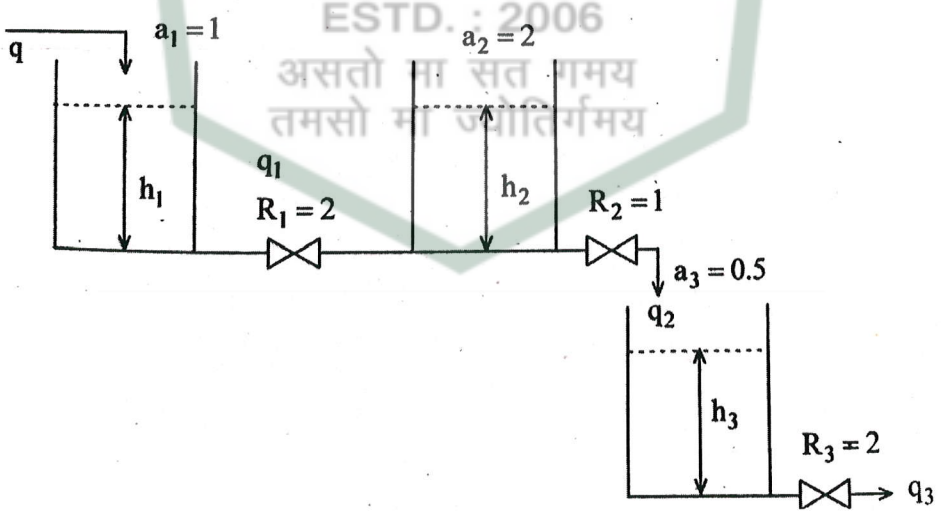
Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

Answer any five questions.

1.	a)	Briefly discuss with sketch wherever necessary, the following head Pressure measuring elements for FLOW measurement: i)Two main types of Orifice element. ii)What type of bore opening you shall use for slurry measurement. iii) In a milk powder process, milk is flowing in a pipe line. If the differential pressure across an orifice plate is 16 kg/cm², specific gravity (ϒ) for milk is 1.032 and coefficient of discharge (Cd) = 0.89, Calculate volumetric flow. iv) Describe the working of Pitot tube. v) Explain with a neat diagram the vena-contracta in venturimeter flow meter. What is its importance?	2 x 5=10
	b)	Explain the working of Flapper Nozzle valve and draw the characteristics of flapper displacement and pneumatic pressure. **OR** Explain the principle, application and working of Rotameter. Draw a neat diagram.	10
2.	a)	Compare the features of ON-OFF, P, PI, PD and PID control modes. Also draw their output response characteristics for a Unit STEP input and the Controller output equations.	10
	b)	i) Explain with a neat diagram the working of Turbidity analyser. ii) Explain with a neat diagram the working of pH instrument.	5 5
3.	a)	Find the over all gain C(s)/R(s) for the signal graph shown in fig 1.	10

		 *Fig 1*	
	b)	Explain the working of Gas Chromotograph used for the detection of the compound/ preservatives used in food industry.	10
4.	a)	Define the order and type number of the system?	4
	b)	Consider the unity feedback closed loop system when the forward transfer function is G(s) = 20/s(s+4). Obtain the rise time, peak time, maximum overshoot and the settling time when the system is subjected to a unit-step input.	8
	c)	For unity feedback system having open loop transfer function as, $G(s) = K(s+4)/s^2(s^2+9s+20)$ Determine (i) All error constants and (ii) steady state error for parabolic input.	8
5.	a)	Why process control is needed in industries and what are the advantages of automatic process control?	5
	b)	What are the process variables, explain it with suitable example?	5
	c)	Find the transfer function $H_3(s)/Q(s)$ for the three-tank system shown in fig. 2.  *Fig.2*	10
6.	a)	The characteristics polynomial of a system is, $s^7+9s^6+24s^5+24s^4+24s^3+24s^2+23s+15=0$	10

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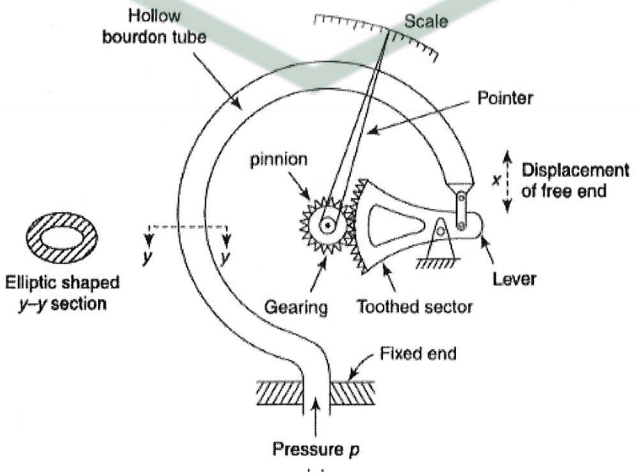
<table>
<tr><td></td><td></td><td>Determine the location of roots on s-plane and hence the stability of the system.</td><td></td></tr>
<tr><td></td><td>b)</td><td>The PI controller indicates an output of 16mA when the error is zero. The set point is suddenly increased to 20 mA and the controller output is recorded and is given below.
<table>
<tr><td>Time t, sec</td><td>0</td><td>10</td><td>20</td><td>30</td><td>40</td></tr>
<tr><td>Output mA</td><td>20</td><td>24</td><td>28</td><td>32</td><td>36</td></tr>
</table>
Find Kp and T_i (check integral time for three different conditions in the table)</td><td>10</td></tr>
<tr><td>7</td><td>a)</td><td>i)Explain the different types of resistance type of temperature measuring elements.
ii)Draw their Resistance vs temperature characteristics, equation, temperature range.
iii) Comment on their linearity, sensitivity.</td><td>12</td></tr>
<tr><td></td><td>b)</td><td>Discuss the advantages of using a Positioner in Control valve.
OR
Explain the inherent characteristics of a control valve used in process control.</td><td>4</td></tr>
<tr><td></td><td>c)</td><td>An equal percentage control valve has 10 GPM flowing through it. When the air to valve signal increases 0.5 psi, flow through the valve increases 3 GPM. Much later, the base flow through the valve is operating at 20 GPM when the air to valve signal increases 0.5 psi; how much flow will increase through the valve?</td><td>4</td></tr>
<tr><td>8</td><td>a)</td><td> 

Fig. 3</td><td>8</td></tr>
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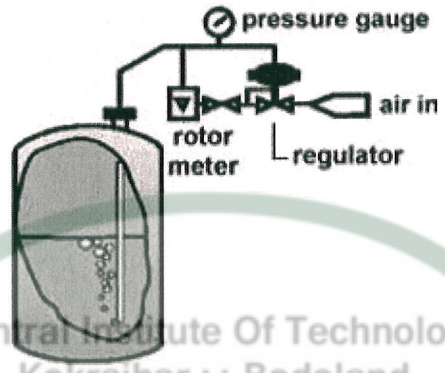
		For the Bourdon tube shown above, draw the block diagram showing the functional elements of the measurement system.	
	b)	Explain the term Linearity and Repeatability used frequently in measurement system.	6
	c)	 *Fig. 4* i)What is the head pressure measurement of a bubbler tube submerged 30" in a fluid with a specific gravity of 0.85? ii) What is the mA output and percent output of the transmitter is calibrated for a tube 100" long?	6

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