BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

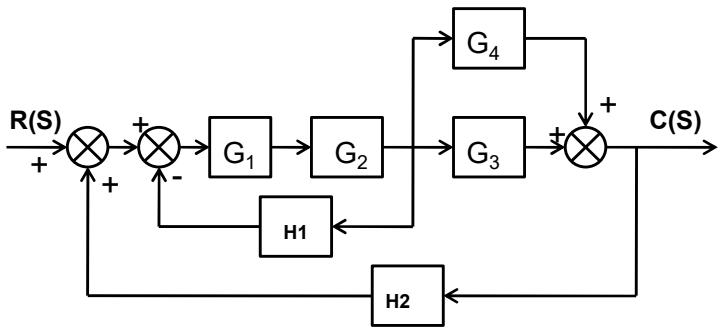
CLASS: B.TECH. **SEMESTER: VI**
BRANCH: CHEMICAL ENGINEERING **SESSION: SP/2025**

SUBJECT: CL333 PROCESS CONTROL & INSTRUMENTATION

TIME: 02 Hours **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates:

			CO	BL
Q.1(a)	In a CSTR, an exothermic reaction is taking place, where temperature needs to be controlled with the help of cooling water flowing in a jacket around the CSTR. What will be the types of control valve and controller action recommended for this system and why?	[2.5]	CO1	3
Q.1(b)	Draw and explain the (a) feedforward, and (b) feedback control system separately for a stirred tank heater.	[2.5]	CO2	3
Q.2(a)	State the degree of freedom and how to reduce it?	[2]	CO2	3
Q.2(b)	A 1st order element is subjected to a step change of magnitude 50 units. Its response shows the ultimate output as 25 units and an output of 15.8 units at a time t =15 secs after the step change is given. Calculate the steady state gain, and the time constant.	[3]	CO2	3
Q.3.	A thermocouple has the following characteristics when it is immersed in a stirred bath: Mass of thermocouple =1.5 gm, heat capacity of the thermocouple = 0.65 cal/gm^{o}C, heat transfer coefficient = 40 cal/cm^{2}hr^{o}C (for thermocouple and bath), surface area of thermocouple = 5 cm^2. i) Derive a transfer function model for the thermocouple relating the change in its indicated output T to the change in the temperature of its surroundings T_s assuming uniform temperature (no gradients in the thermocouple bead), no conduction in the leads, constant physical properties and conversion of the millivolt-level output directly to an ^{o}C reading by a very fast meter. ii) If the thermocouple is initially out of the bath and at room temperature (25 ^{o}C), what is the maximum temperature that it will register if it is suddenly plunged into the bath (100 ^{o}C) and held there for 20 sec?	[2.5 +2.5]	CO2	4
Q.4(a)	A step input of magnitude 4 is introduced into a system having the transfer function. $\frac{Y(s)}{X(s)} = \frac{10}{s^2 + 1.6s + 4}$ Determine: a) Percent overshoot, b) Rise time, c) Ultimate value of Y(t), d) Maximum value of Y(t), e) Period of oscillation.	[3]	CO2	4
Q.4(b)	Reduce the block diagram to a single block and find C/R.	[2]	CO2	4



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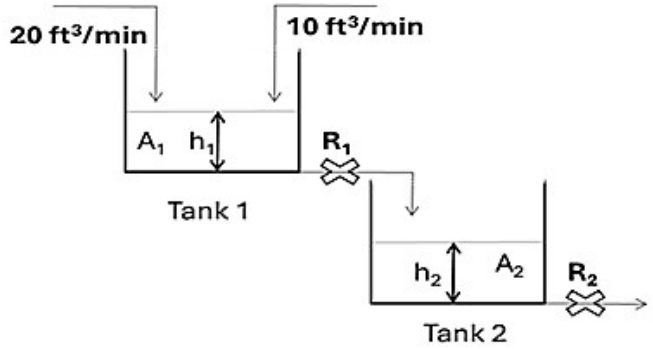
Q.5(a) The two tank system shown in fig is operating at steady state. At time t = 0, 10 ft^3 of water is quickly added to the first tank. Using appropriate figures and equations in the text, determine the maximum deviation in level (feet) in both tanks from the ultimate steady state values and the time at which each maximum occurs. Data: $A_1 = A_2 = 10\ ft^2$; $R_1 = 0.1$ ft/cfm; $R_2 = 0.35$ ft/cfm [3] CO2 4



Q.5(b) Develop a transfer function for two non-interacting tanks in series with input step response. [2] CO2 4

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