Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VI SEMESTER B.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL/MAY 2017

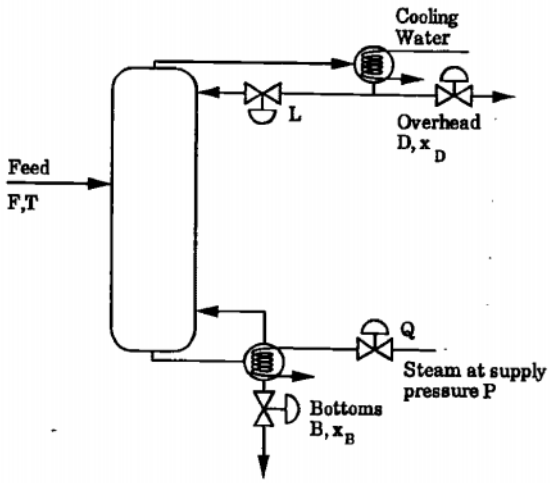
SUBJECT: PROCESS DYNAMICS AND CONTROL [CHE3203]

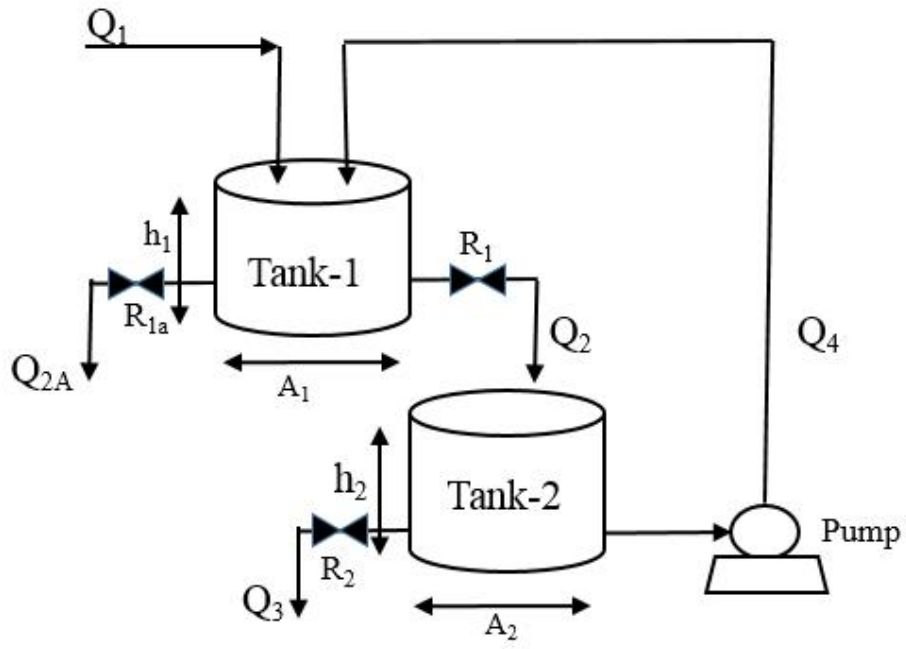
REVISED CREDIT SYSTEM

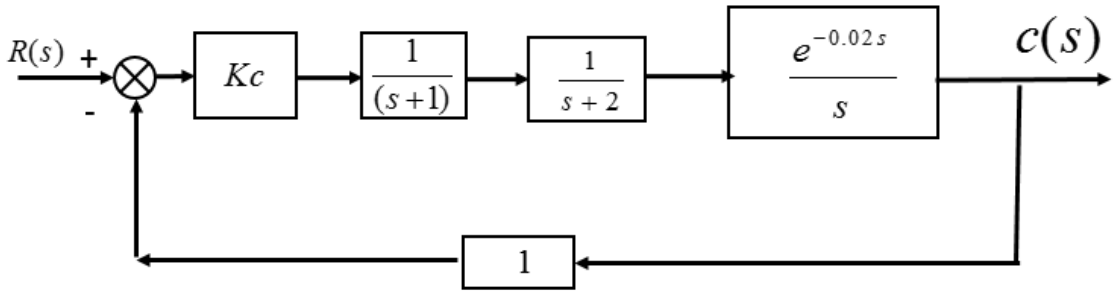
Time: 3 Hours MAX. MARKS: 100

Instructions to Candidates:

- Answer **ALL** questions.
- Use of log-log sheet is permitted.
- Missing data may be suitably assumed.

1A.	What differentiates a feedback control system configuration from the feedforward configuration?	**06**
1B.	The process shown in Figure 1B is a distillation column used to separate a binary mixture of methanol and water. It is desired to regulate the composition of methanol in both overhead and bottoms product streams: X_D and X_B respectively. Let us assume that the reflux flow rate L can be varied, but both overhead and bottoms product flow rates, respectively, D and B, are determined by the steady-state material balance model of the distillation column. The feed rate to the column F, as well as the feed temperature T, are known to vary. The steam supply pressure to the reboiler P is also known to vary; Q is the steam flow rate through the thermal siphon reboiler. a. Identify the output, manipulated, and disturbance variables of this process. b. Assume that feed temperature measurements are available, and that this information is used to adjust the steam flow into the reboiler in order to control the bottoms product composition. What type of control system configuration is this?  Figure 1B.	**08**
1C.	Prove a. Final value theorem of Laplace Transform b. Initial value theorem of Laplace Transform	**06**

2A.	Solve the differential equation using Laplace transform $\frac{d^2T}{dt^2}+5\frac{dT}{dt}+6T=z(t) \quad \text{given} \quad z(t)=1: T(0)=1; T^I(0)=0.$	**08**
2B.	Most control valves are designed to operate with signals between 3 to 15 psig. A signal-to-Open valve will fully closed at 3 psig and fully open at 15 psig. If the maximum flow rate through the valve is 120 M^3/hr, then what would be the average valve gain? Similarly, what would be the average valve gain for Signal-to-Close valve of the same size?	**06**
2C.	Define the time integral performance criteria to shape the closed loop response. What are the relative advantages and disadvantages of these criteria? How would you select the most appropriate for a particular application?	**06**
3A	Derive the transfer function model (which relates between output and input concentrations) for continuous stirred tank reactor in which second order reaction is taking place. ($-r_A = KC_A^2$). State all the assumptions.	**10**
3B.	Develop a transfer function model (i.e., relates between h_2 and Q_1) for the problem given in Figure 3B. It is Assumed that flow-head relationship are linear for both the tanks and constant displacement pump is used to pump the liquid from Tank-2 to Tank-1.  Figure 3B.	**10**
4A.	Describe the Ziegler-Nichols tuning methodology. This procedure is often called the "continuous cycling" tuning method. Why?	**06**
4B	Consider the liquid level control in a single storage tank. As the manipulated variable we can use either the effluent flow rate, F_O, or the inlet flow rate, F_i. Initially system is at steady state with $F_i=F_o=10$ m^3/hr. and liquid level at 2 m. The cross sectional area of the tank is 6 m^2. Assume a proportional	**08**

	controller with K_C=10 and the transfer function for the measuring element and final control valve are equal to unity. a. Compute the closed loop response to a unit step increase in the desired set point when F_i is used as the manipulated variable. b. Do the same as in part (a), but consider Fo as the manipulated variable. c. Sketch the two responses above and qualitatively explain whether you would use F_i or F_o as the manipulated variable, or it makes no difference which one you use.	
4C	Define the different terminology (with governing equation) used to describe the second order underdamped system response for step input.	**06**
5A	A proportional derivative controller with the gain K_C and the derivative time 0.5 is used to control the two first order system connected in series (non-interacting way) having time constant τ_1 = 1 and τ_2=0.5. If the gain of the process is 0.5. The transfer function of the measuring element is $G_m(s)=\frac{1}{s}$. Final control element having unity transfer function. Sketch the root locus diagram for the control system and find the rage of K_C for which the control system is stable.	**08**
5B.	Construct a Bode diagram and find the valve of Gain Margin and Phase Margin. 	**12**

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