Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VI SEMESTER B.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL 2019

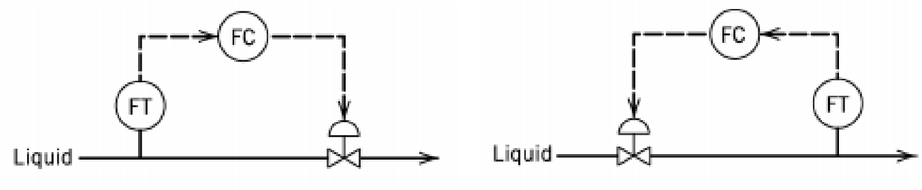
SUBJECT: PROCESS DYNAMICS AND CONTROL [CHE3203]

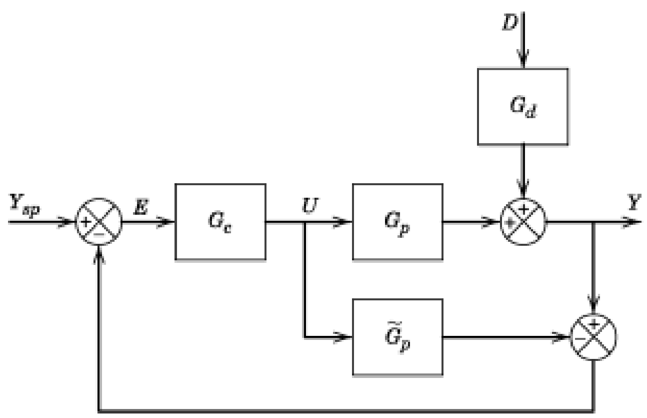
REVISED CREDIT SYSTEM (23/04/2019)

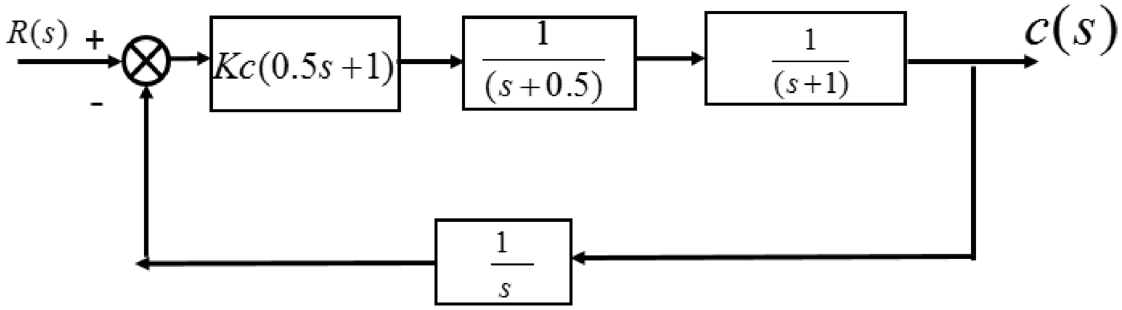
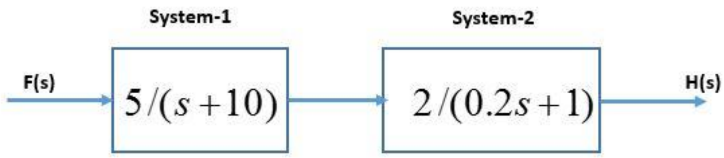
Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A	Two flow control loops are shown in the drawing. Indicate whether each system is either a feedback or a feedforward control system. Justify your answer. It can be assumed that the distance between the flow transmitter (FT) and the control valve is quite small in each system.  System I System II	**02**
1B	Consider the following transfer function: $\frac{y(s)}{u(s)} = \frac{5}{10s+1}$ a) What is the steady-state gain? b) What is the time constant? c) If u(s) = 2/s, what is the value of the output *y(t)* when $t --> \infty$? d) For the same u(s), what is the value of the output when t = 10 time unit?	**04**
1C	Solve the differential equation using Laplace transform $\frac{d^2C}{dt^2} + 5\frac{dC}{dt} + 6C = f(t) \quad \text{given} \quad C(0) = 1; C^I(0) = 0.$ Find the process transfer function, $\frac{C(s)}{f(s)} = ?$ If *f(t)* is ramp input with magnitude 'M' , find the *C(t)* using Laplace Transform method.	**04**
2A	The liquid flow rate from a vertical cylindrical tank, 10 feet in diameter, is flow controlled. The liquid flow into the tank is manipulated to control liquid level in the tank. The control valve on the inflow stream has linear installed characteristics and the can pass 1000 gpm when wide open. The level tramsmitter has a span of 6 feet of liquid. A proportional controller is used with a gain of 2. It is assumed that liquid density remain constnt. i) Should the control valve be Signal-to-open or Signal-to-close? ii) Should the controller be reverse or direct acting?	**02**

2B	The dynamic behavior of a pressure sensor/transmitter can be expressed as a first-order transfer function (in deviation variables) that relates the measured value P_m to the actual pressure, P: $\frac{\tilde{p}_m(s)}{\tilde{p}(s)} = \frac{1}{30s+1}$ Both P_m and P have units of psi and the time constant has units of seconds. Suppose that an alarm will sound if P_m exceeds 45 psi. If the process is initially at steady state, and then P suddenly changes from 35 to 50 psi at 1:10PM, at what time will the alarm sound?	**02**
2C	An exothermic reaction, A ---->B, takes place isothermally in a stirred-tank reactor. This liquid reaction occurs at constant volume in a 1,000-gal reactor. The reaction can be considered to be second order and irreversible. a) Derive a transfer function relating the exit concentration C_A to the inlet concentration C_{Ai}. State all assumptions that you make. b) How sensitive is the transfer function gain K and time constant to the operating conditions? Find an expression for the gain and time constant in terms of k $\bar{C}_A$ and $\bar{V}$.	**06**
3A	Design a controller for the following plant, $G_p(s) = \frac{1}{(2s+1)(5s+1)}$ Using the direct synthesis approach, given desired closed loop behavior is $q(s) = \frac{1}{(\tau_r s+1)}$ with (a) τ_r=5 and (b) τ_r=1. Compare the results of (a) with (b) with respect to controller response.	**04**
3B	A heater for a semiconductor wafer has first-order dynamics, that is, the transfer function relating changes in temperature T to changes in the heater input power level P is $\frac{T(s)}{P(s)} = \frac{K}{\tau s+1}$, where K has units [°C/Kw] and T has units [min]. The process is at steady state when an engineer changes the power input stepwise from 1 to 1.5 Kw. Engineer notes the following: (i) The process temperature initially is 80 °C. (ii) Four minutes after changing the power input, the temperature is 230 °C. (iii) Thirty minutes later the temperature is 280 °C. Note: This scenario can be considered as very large time with ~~rest~~ to the system time constant. Find the K and τ in the process transfer function?	**03**
3C	A block diagram for internal model control shown below. Derive closed-loop transfer functions for the servo problem. 	**03**

4A	Construct a root locus diagram for the control system shown below and find the range of K_C for which the control system is stable. 	**06**
4B	Draw an approximate Bode plot for system connected in series as show below. (*Note: You have been asked to specify and mark all the parameters which is required for plotting bode plot (no need of using graph sheet)*. 	**04**
5A	a) Describe the Ziegler-Nichols tuning methodology. This procedure is often called the “continuous cycling” tuning method. Why? b) Define a Bode stability criteria.	**04**
5B	Discuss the working principle of inferential and auctioneering control schemes.	**04**
5C	Distinguish between effective and inherent valve characteristics.	**02**

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