Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS - MAY 2016

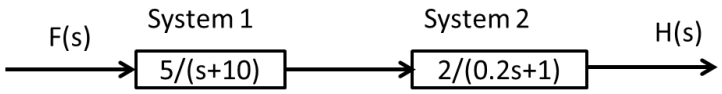
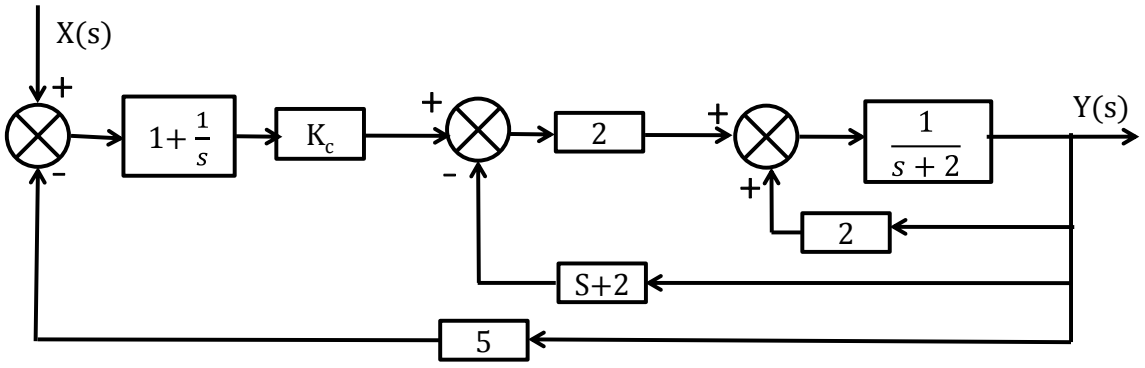
SUBJECT: BIOPROCESS CONTROL [BIO 304]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer any **five** questions.
- Missing data may be suitable assumed.

1A.	What is a process variable? How are they classified? Mention any five variables in each classification.	**3**
1B.	Differentiate between open and close loops. Discuss your answer by citing examples from your experience of the two types of loops.	**4**
1C.	How does the number of degrees of freedom affect the number and the selection of the control objectives in a process?	**3**
2A.	Using Laplace transform, solve the differential equation $\frac{\mathrm{d}^2\mathrm{y}}{\mathrm{dt}^2} + 4\frac{dy}{dt} + 3\mathrm{y} = e^{-t}$ given that $\mathrm{y}(0) = 1;\ \mathrm{y}'(0) = 0$	**3**
2B.	What is a block diagram of a process control system? What type of information does it convey?	**2**
2C.	Consider a second-order system with the following transfer function $\mathrm{G}(\mathrm{s}) = \frac{1}{(5\mathrm{s}^2+18\mathrm{s}+24)}$ Introduce a step change of 10 into the system and find the overshoot %, rise time, response time, period of oscillation and maximum value of response.	**5**
3A.	Is it possible to have an oscillatory behavior by the indicated temperature (T_m) of a thermocouple if the measured temperature (T) changes by step? Elaborate on your answer.	**3**
3B.	Define the valve coefficient (C_v). What is the function of valve actuator and valve positioner?	**3**
3C.	What is the order of the closed loop dynamic response for a second order process with PI controller? Can the PI control destabilize such a process? Justify.	**4**

4A.	Two non-interacting tanks with following characteristics are controlled by a Proportional Controller and a control valve. The resistance of the two tanks were found to be 2 m^2 /min. The resistance were found to be linear. The cross sectional area of the tank-1 is 2 m^2 and that of tank-2 is 1 m^2. The control valve was tested separately and it was found that a change in 1 psi in pressure to the valve produced a change inflow of 0.1 m^3/min. There is no dynamic lag in the valve. Also, It was observed that measuring element obeys the first order dynamics with time constant of 1 min. and gain of 10. i) Sketch the block diagram for the above control system with appropriate transfer function. ii) Determine the range of controller gain for which the closed loop system is stable.	**7**
4B.	If a closed loop response is stable with respect to changes in the set point, is it stable to changes in the load? Yes or No. Why?	**3**
5A.	Draw an approximate Bode plots for systems connected in series as shown in below figure. 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). 	**6**
5B.	Consider a process with one manipulated input and two measured outputs. Can you keep both outputs at the desired values using only the single manipulated variable? Yes or No. Explain the answer.	**4**
6A.	Obtain the value of K_c for which the system is stable for the following control loop system 	**6**
6B.	Develop a feedback control and feed forward control systems for controlling the temperature of liquid inside the stirred tank, which is heated by steam passing through the steam coil immersed inside the tank. Identify different variables involved in the process.	**4**