Ex/CHE/PC/B/T/322/2025

BACHELOR OF CHEMICAL ENGINEERING EXAMINATION, 2025

(3rd Year, 2nd Semester)

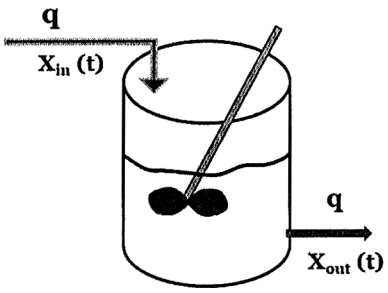
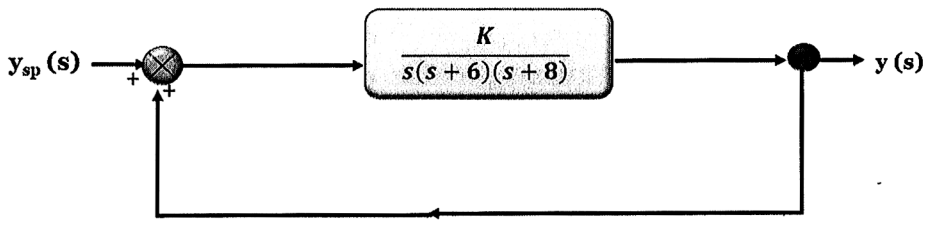
PROCESS DYNAMICS AND CONTROL

Time : Three hours | Full Marks : 100

(Attempt all questions)

		Marks
	CO1 , CO2, CO3, CO4	
Q1	Justify your answers as follows: I. Traffic light is the example of ..... II. The good control system has following features except a) Perfect accuracy b) Strong stability c) Slow response d) Sufficient power handling capacity III. Which of the following controller has the maximum stabilizing time? a) P b) PI b) PD c) PID IV. Phase lag of the frequency response of a second order system to a sinusoidal forcing function is..... a) 120° b) 90° at most b) 30° c) Approaches 180° asymptotically V. A second order system can be modeled as two first order systems in ..... a) Parallel b) Both b) Series c) None VI. Function of the reset mode is to..... VII. The steady state error can be reduced by a) Increasing the input c) Increasing system gain b) Decreeing the static error constant d) Decreasing the type of system VIII. The derivative controller should be applied for a) Fast process c) slow process b) Noisy process d) None of the above IX. Controller tuning is a) Servo response c) Process of finding optimum controller parameters b) Detecting controller schemes d) None of the above X. The manipulated variables in CSTR is a) Fluid inlet temperature c) Coolant flowrate b) Liquid volume d) Effluent temperature	10 × 1

[Turn over

	CO2	
Q2	Initially, at 40°C, the time constant of a thermometer is found in 20 seconds. Suddenly, the thermometer is immersed into water at 100°C. How long will it take for the thermometer reading to meet 95°C.	5
Q3	1. Determine the transfer function relating the outlet concentration X_{out} to the inlet concentration X_{in}, having a mixing process (shown in the below figure) in which a stream of solution containing dissolved salt flows at a constant volumetric flow rate (q) into a tank of constant holdup volume V. The concentration of the salt in the entering stream x (mass of salt/volume) varies with time. 2. Estimate the transient response of a mixing process for ramp change in input for a first order process  Figure: Mixing process	10
Q3	Consider a second order system with the following transfer function? $$G(s) = \frac{Y(s)}{X(s)} = \frac{12}{5s^2+2.1s+3}$$ Estimate the percentage overshoot with decay ratio, rise time and ultimate value of Y(t) when initiate a step change of magnitude four into the system and plot all the estimated value in time domain. Draw the locations of that transfer function through the pole-zero plot.	15
Q4	Suppose you have a transfer function $$G(s) = \frac{Y(s)}{X(s)} = \frac{k}{2s+1}$$ When system undergoes to impulse function, estimate the final expression of Y(t) having two process gain (k) value of 2 and 5 and plot them. Justify the better performance if you use two process gain.	10
Q5	Derive the transfer function of PI controller and estimate the dynamic response of PI controller's output to a step change in error and plot all through taking consequent 5 reset time increases.	10
	CO3	
Q6	Constitute the root locus for the control system shown in following pic, through the following steps (i) Locate the poles/zeros on the s-plane. (ii) Find the number of root locus branches (iii) Draw the segment of the root locus on the real axis. (iv) Find the centroid and the angle of asymptotes (v) Find the intersection points of root locus branches with an imaginary axis. (vi) Evaluate the break-away and break-in points (vii) Find the angle of departure and the angle of arrival (viii) Determine the limiting value of the gain K for stability using the Routh-Hurwitz criterion. 	20

Q7	Derive the closed loop servo and regulatory transfer functions of a system whose open loop dynamics are represented by the following process $[G_P(s)]$ and disturbance $[G_d(s)]$ transfer functions $$G_P(s) = \frac{0.3}{5s+1} \quad and \quad G_d(s) = \frac{0.5}{5s+1}$$ Assume the transfer functions of the control valve and the measuring element are $G_f(s) = 1$ and $G_m(s) = 1$. Use a P controller with the controller gain $K_C = 5, K_C = 10$ $and K_C = 20$. I. Determine the unit step servo response of the closed loop system II. Compute the offset for each controller gain K_C	20