(Time: 3 hour) **[Total marks: 80]**

N.B.:

1) **Question-1 is compulsory. Answer any three questions from remaining**
2) **Assume data if necessary and specify the assumptions clearly**
3) **Draw neat sketches wherever required**
4) **Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other**

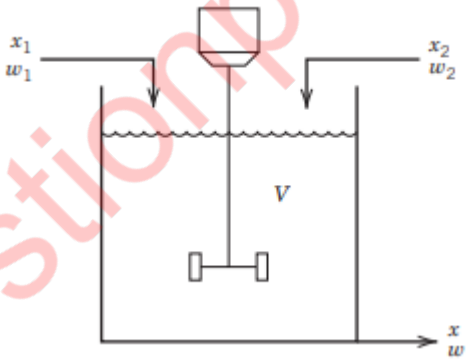
Q.1) a) A process of unknown transfer function is subjected to a unit impulse input. The output of the process is measured accurately and is found to be represented by the function . Determine the unit step response of this process **(5)**

b) Define gain margin and phase margin **(5)**

c) Describe in detail Zeigler Nichols controller tuning method **(5)**

d) Discuss degrees of freedom analysis for process and its significance **(5)**

Q.2) a) Consider the continuous blending process, liquid density ρ and volume V are constant. Mass flow rates w_1, w_2, and w, are constant. Derive transfer function models for two cases: (a) Inlet concentration x_1 varies while x_2 is constant. (b) Inlet concentrations x_1 and x_2 vary **(10)**



b) consider the following transfer function **(10)**

$$G(s) = \frac{Y(s)}{U(s)} = \frac{3}{10s+1}$$

i) Find the steady state gain and time constant?

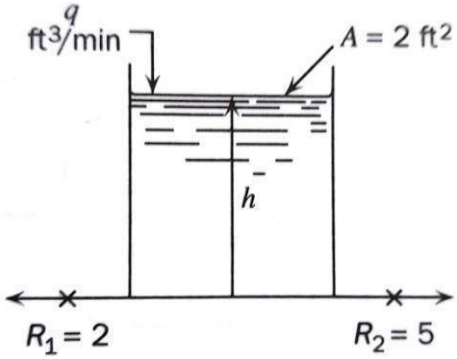
ii) If $U(s)$ = 2/s, what is the value of the output $y(t)$when t → ∞?

iii) For the same $U(s)$, what is the value of the output when t=10?

iv) If u(t) = δ(t), that is the unit impulse at t=0, what is the output when t → ∞?

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Q.3) a) Derive the transfer function H/Q for the liquid level system shown in figure. The resistances are linear. H and Q are deviation variables. Show clearly how you derive the transfer function. You are expected to give numerical values in the transfer function **(10)**



b) Derive transfer function for mercury in glass thermometer system with appropriate assumptions **(10)**

Q.4) **(10)**

a) Calculate the offset for the control loop with transfer function **(10)**

$$\frac{C(s)}{R(s)} = \frac{8}{2s^2 + 3s + 9}$$ for a step change of 0.1 unit.

Q.5) a) Construct Assymptotic Bode plot for the following open loop transfer function and determine Gain Margin and Phase margin **(12)**

$$G_{OL}(s) = \frac{80}{(s)(s+2)(s+20)}$$

b) Using Routh Criteria determine the limits of K_c for the stability of the system with following open loop transfer function. **(08)**

$$G(s) = \frac{K_c}{(s+1)(0.5s+1)(s/3+1)}$$

Q.6) a) Explain the two methods of calibration of thermometers. **(10)**

b) Explain Bourdon Pressure Gauge with neat labelled diagram. **(10)**

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