QP Code : 814101

(3 Hours) [Total Marks : 80

N. B. : (1) Question no. **1** is **compulsory**.
   (2) Answer any **three** questions from the remaining.
   (3) Assume the data if necessary and specify the assumptions clearly.
   (4) Answer to the sub questions of the individual questions should be grouped and written together.

I. (a) A liquid surge tank has the following transfer function of   5

$$\left(\frac{H(s)}{Q_{i(s)}}\right) = \frac{10}{50\,s + 1}$$

The system is operating at the steady state with q_{is} = 0.4 m3/s and hs = 4m when the inlet flow tare fluctuates as a sin wave with an amplitude of 0.1 m3/s and a period of 500sec. What is the maximum and minimum value of the level after 10 min.

(b) Explain phase margin and gain margin.   5

(c) Consider the following Open loop unstable process.   6

$$Gp(S) = \frac{1}{(s - 2)\,(s + 1)}$$

Can a PI controller stabilize the process? Justify your answer.

(d) A particular system has been disturbed with a unit impulse function. The response of the system in the time domain, has been found to be well described by the function $y(t) = t\,e^{-t}$, Determine the unit step response of the system.   4

II. (a) Derive the transfer function between liquid level and the inlet stream for the figure mentioned below and outlet flowrate is given by $F_2 = h/3$?   10
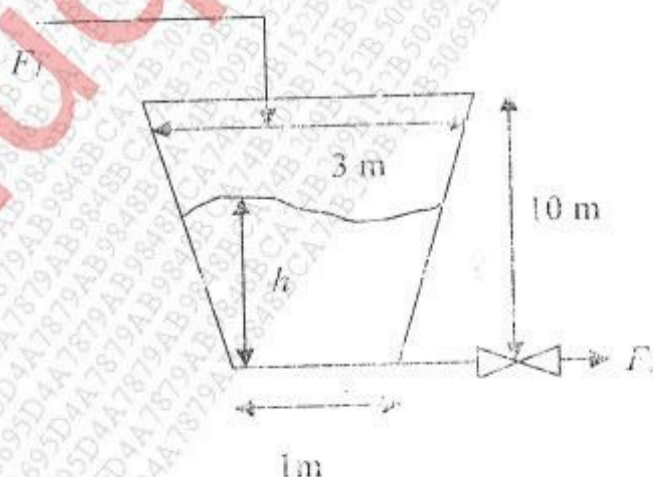
[TURN OVER

(b)   What conditions must be satisfied by a two tank non interacting system   **5**
      to exhibit a critically damped response.

(c)   Develop dynamic model for blending process.   **5**

III. (a)   A continuous stirred tank heating system shown in figure below. The   **10**
           liquid inlet stream consists of a single component with a mass flow
           rate W_i and inlet temperature T_i. The tank contents are agitated and
           heated using a electrical heater that provides a heating rate Q, density
           and specific heat capacity of the mixture is constant. Carryout the
           degrees of freedom analysis, also state the disturbance and manipulated
           variables, for following two cases (i) hold up is constant. (ii) hold up
           is varying.
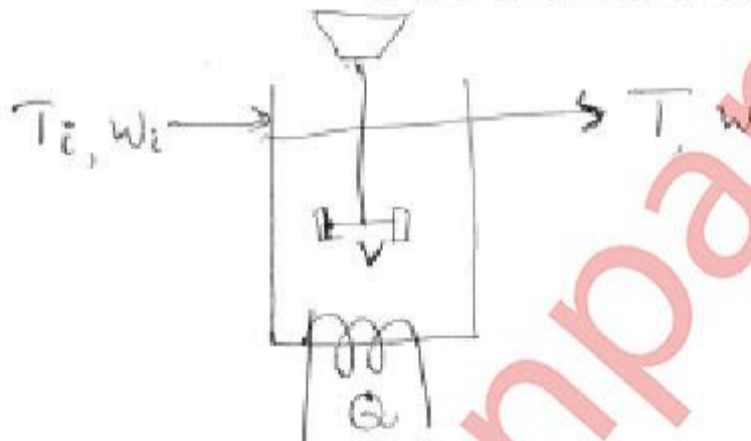
(b)   Discuss the guideline for the selection of controlled, manipulated and   **10**
      measured variables.

IV.   (a)   For a unity feedback system   **10**

$$G(s) = \frac{k}{S(s+4)(s+2)}$$

      Sketch the root locus showing all details on it. Comment on the
      stability of the system.

(b)   Using Routh Criteria determine the limits of Kc for the stability of   **10**
      the system with the following open loop transfer function:

$$G(s) = \frac{kc}{(s+1)(0.5s+1)\left(\frac{s}{3}+1\right)}$$

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V. (a) A unity feedback system has   15

$$G(s) = \frac{100}{S(s + 0.5)(s + 10)}$$

Draw the asymptotic Bode plot. Determine Gm, Pm, wgc, wpc and comment on stability.

(b) Derive the transfer function of P, PI, PID controllers.   5

VI. Write a short notes on: 20
   a) Discuss in brief discrete time dynamic model
   b) Explain Nyquist-Stability criteria
   c) Explain Ziegler-Nichols controller settings
   d) Explain Servo and Regulatory control.

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