Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/CT(NEW)/SEM-6/CT-605B/2013

2013
PROCESS CONTROL

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 × 1 = 10

   i) Which one is a closed loop system ?

      a) microwave oven

      b) refrigerator

      c) washing machine

   ii) Transfer function of a system

      a) depends on input only

      b) depends on input and output

      c) does not depend on input.

iii) The number of poles of the closed loop system in figure 1 is

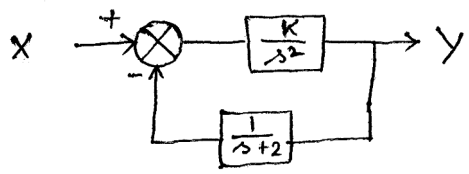

Figure 1

a) 1

b) 2

c) 3.

iv) Unit impulse response of a system is $5e^{-2t}$, its step response will be

a) $\frac{5}{2}(1-e^{-2t})$

b) $5\ (1-e^{-2t})$

c) $\frac{5}{2}\ (1+e^{-2t})$.

v) The second order system with transfer function $10/(2s^2+4s+9)$ is

a) underdamped

b) overdamped

c) critically damped.

vi) The system with characteristic equation $5s^3+3s+9=0$ is

a) stable

b) unstable

c) marginally stable.

vii) If the gain cross-over frequency is less than the phase cross-over frequency, then the system is

a) stable

b) unstable

c) marginally stable.

viii) If the type of a system increase the steady state error

a) increases

b) decreases

c) remains unchanged.

ix) With PI controller the system becomes

a) faster

b) more accurate

c) both (a) and (b).

x) The transfer function of the system in figure 2 is

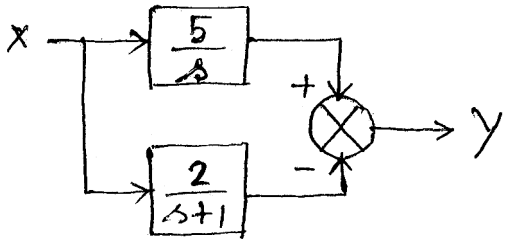

Figure 2

a) $\frac{5s+7}{s(s+1)}$

b) $\frac{5s+3}{s\ (s+1)}$

c) $\frac{3s+5}{s\ (s+1)}$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Find y/x for the block diagram in figure 3.

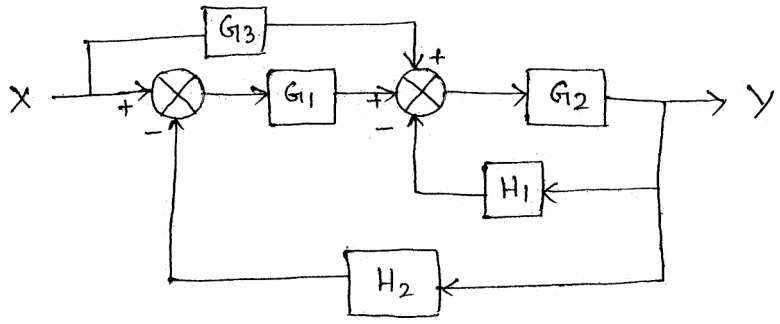

Figure 3

3. Find the relation between K and T for stability of the unity feedback system with open loop gain

$$\frac{K}{s\,[s\,(s+10)+T\,]}$$

4. Define closed loop and open loop systems and compare the two.

5. Find the steady state error of the system in figure 4, for unit step input.

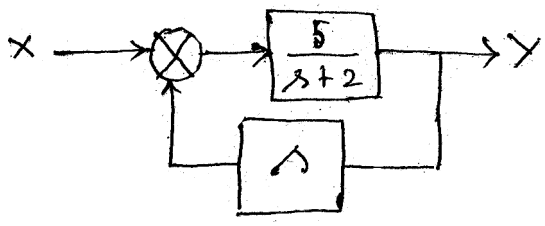

Figure 4

6. Show how the transfer function of a second order system is changed with PI control and hence indicate its advantage.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Derive the transfer function of a first order mercury thermometer.

   b) Given a system with transfer function $Y(s)/X(s) = (T_1 s + 1)/(T_2 s + 1)$. Find $Y(t)$ if $X(t)$ is a unit step function. If $T_1/T_2 = 5$, sketch $Y(t)$ *vs.* t/T_2. Show the numerical values of minimum, maximum and the ultimate values that may occur during the transient. Check these using initial value theorem and final value theorem. 6 + 9

8. a) Derive the transfer function of a liquid level system with constant outflow rate.

   b) A tank having a cross-sectional area of $2ft^2$ is operating at steady state with an inlet flow rate of 2·0 cfm. The flow-head characteristics are shown in figure.5.

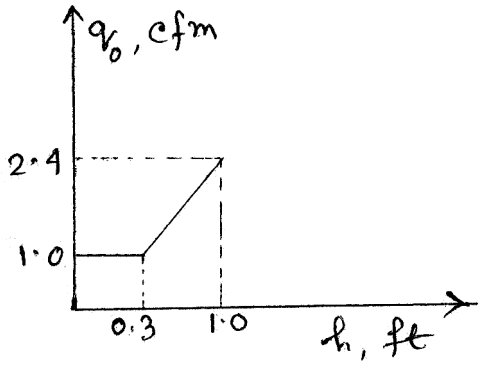

Figure 5

(i) Find the transfer function $H(s)/Q(s)$

(ii) If the flow to the tank increase from 2·0 to 2·2 cfm according to a step change, calculate the level h two minutes after the change occurs. 6 + 9

9. a) Derive the transfer function of the mixing process shown in figure 6.

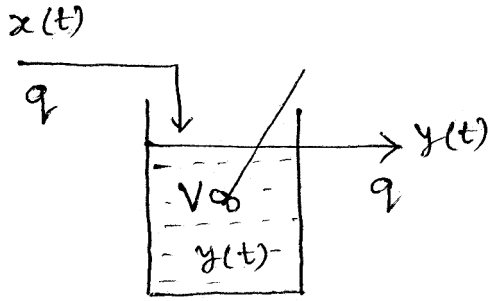

Figure 6

b) Three identical tanks are operated in a non-interacting fashion as shown in figure 7. For each tank, R = 1, $\tau = 1$. If the deviation in flow rate to the first tank is an impulse function of magnitude 2, determine :

(i) an expression for $H(s)$ where H is the deviation in level in the third tank

(ii) sketch the response $H(t)$

(iii) obtain expression for $H(t)$ 5 + 10

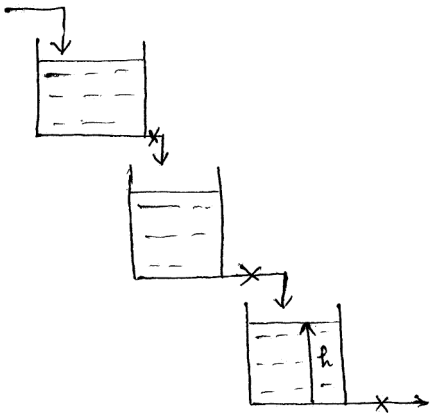

Figure 7

10. Obtain the unit step response of a second order underdamped system and hence find the expressions for :

    (i) rise time

    (ii) peak time

    (iii) peak overshoot

    (iv) settling time. 5 + 10

11. Draw Bode diagram of the system with :

$$GH = \frac{4}{s\,(1+0\cdot 5s)\,(1+0\cdot 08s)}$$

    And hence find :

    (i) gain cross-over frequency

    (ii) phase cross-over frequency

    (iii) gain margin and

    (iv) phase margin

    State whether the system is stable or not. 6 + 8 + 1