Registration No : | 1 | 7 | 2 | 1 | 3 | 3 | 1 | 2 | 2 | 0 |

Total Number of Pages : 04

B.Tech
PEE4I102

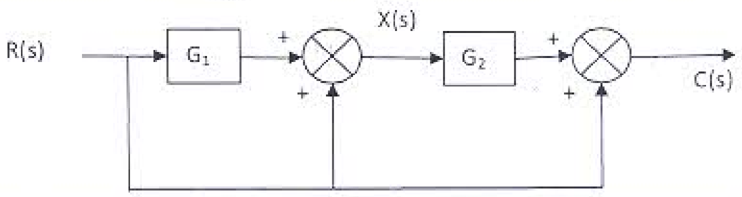
4[th] Semester Regular / Back Examination 2017-18
CONTROL SYSTEM ENGINEERING - I
BRANCH : ELECTRICAL
Time : 3 Hours
Max Marks : 100
Q.CODE : C677

Answer Part-A which is compulsory and any four from Part-B.
The figures in the right hand margin indicate marks.
Answer all parts of a question at a place.

Part – A (Answer all the questions)

Q1 Answer the following questions : (2 x 10)

a) The transfer function $\frac{C(s)}{R(s)}$ of the block diagram shown in figure is ____________.



b) Time domain information is not considered in block diagram representation of dynamic systems because(Choose the right option)
   a) Output cannot be directly obtained by multiplying the time-domain input with the impulse response function
   b) It is difficult to get physical insight using time-domain response
   c) It is difficult to give time-domain input
   d) None of the above

c) If open-loop poles and zeros are on the right-hand plane, then (Choose the right option)
   a) The system is unstable for all values of the gain
   b) The system is stable for all values of the gain
   c) Nothing can be said about the stability based on this information
   d) The system is stable for some values of gain depending on the input excitation

d) Controllability of a system means (Choose the right option)
   a) The input is related to all the state-variables
   b) The input is related to most dominant state-variables
   c) The input is related to the least dominant state-variables
   d) None of the above

e) The open loop transfer function of a unity feedback system is given by
$$G(s) = \frac{20(0.1s+1)}{s(0.2s+1)(0.02s+1)}$$
The corner frequencies for the system are ___________.

f) Bode magnitude and phase plots are plotted on a semi-log paper because(Choose the right option)
   a) Magnitude and phase are plotted on a frequency scale that contains very small to very large frequencies, thus, requiring a log scale
   b) Magnitude is expressed in decibels, and thus, a linear scale is sufficient along the y-axis
   c) Both a) and b)
   d) The characteristics features of magnitude and phase are better displayed on a semi-log paper

g) If there are n number of poles and m number of zeroes of a transfer function, ________ number of branches of the root locus will move to ∞ and along which ____________ angles.

h) A network comprises of 2 inductors, 1 capacitors and 1 resistors. The current across different inductors are linearly independent and voltage across different capacitors is linearly independent as well. ____________no. of states are necessary to describe the network in state variable form.

i) The biggest disadvantage of state-space methods is (Choose the right option)
   a) They consume too much of computer time
   b) Physical insight is lost after modeling a system in state space
   c) The analysis is done in time domain
   d) They cannot be used to solve a general class of problems in control

j) The damped natural frequency for a closed loop system represented by differential equation is ____________.

$$\frac{d^2c(t)}{dt^2} + 8\frac{dc(t)}{dt} = 64[r(t) - c(t)]$$

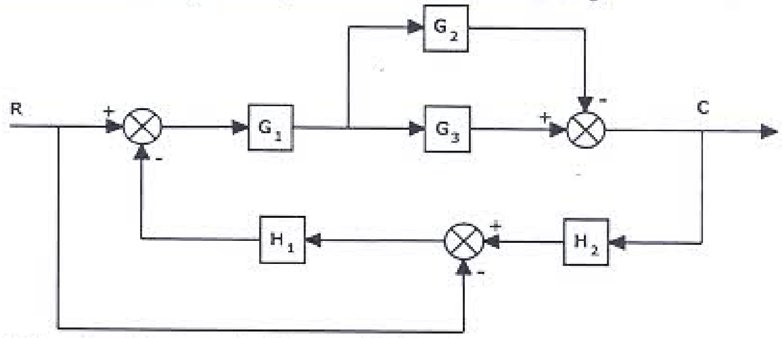
Where c(t) is the displacement of the output shaft and r(t) is the displacement of input shaft.

Q2 **Answer the following questions: *Short answer type:*** **(2 x 10)**

a) Define transfer function. What are the assumptions made for the initial conditions?
b) Write down Mason's gain formula for determining the transfer function of a signal flow graph, explaining the meaning of each term.
c) What do you understand by 'Sensitivity to parameter variations'? Is it more or less in closed loop systems in comparison to open loop systems?
d) Why is a system with poles on the RHS of the s-plane an unstable system?
e) How can you ascertain the status/ type of stability of a system from its root locus?
f) What is principle of argument?
g) What effect does the increase in gain have on the transient and steady state behavior of a system?
h) If you add a pole at the origin to a system, how its polar plot be modified with respect to the one before addition of the pole?
i) Name the standard test signals and draw the input – output relationships for each.
j) Write the transfer function for a PI and PID controller.

Part – B (Answer any four questions)

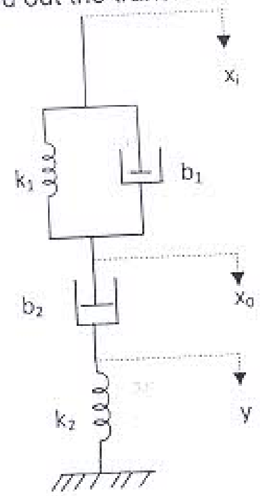
Q3 a) Evaluate the transfer function(C/R) by using block reduction techniques for a system whose block diagram representation as shown in Fig. **(10)**



Determine the transfer function(C/R) of the system shown in Fig,using Mason's Gain Formula.

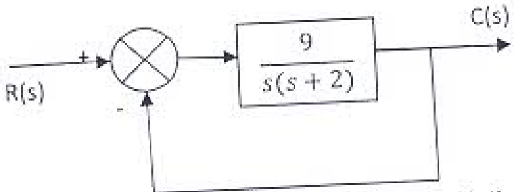
(5)

b) Find out the transfer function $X_o(s)/X_i(s)$.



(10)

Q4 a)



Determine the natural frequency of oscillation, damping factor, peak overshoot, rise time settling time and steady state error to unit step input for the above system.

(5)

b) A control system having a transfer function is $C(S)/R(s) = 10/(S^2+2s+10)$. Determine the expression for time response, if the system is subject to a unit step input.

(10)

Q5 a) Consider a control system with state model

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -6 & -5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}[u]; \quad \begin{bmatrix}x_1(0)\\ x_2(0)\end{bmatrix} = \begin{bmatrix}0\\ 1\end{bmatrix}, \mathrm{u = unit\ step}$$

Compute the state transition matrix and therefrom find the state response, i.e., $x(t)$ for $t>0$.

(5)

b) Check the observability of the following system

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}[u]$$

$$y = [4 \quad 5 \quad 1]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

(10)

Q6 a) For a unity feedback control system the open loop transfer function is

$$G(s) = \frac{100(s+5)}{s(s^2+2s)(s+7)}$$

(i) Find K_p, K_v, K_a

(ii) Find steady state error (e_{ss}) due to an input described by

$$r(t) = 1 + 7t + \frac{t^2}{2}$$

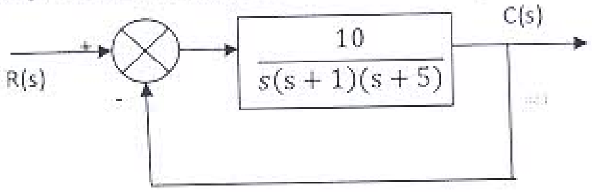
(5)

b) A unity feedback system is characterized by the open loop transfer function

$$G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$$

Using Routh's criteria, calculate the range of values of K for the system to be stable?

Q7 a) Draw the Bode magnitude and phase plot of the following system and determine gain margin, phase margin, and absolute stability **(10)**



b) Define the terms Gain Margin, Phase Margin, Gain crossover frequency and Phase crossover frequency. Why is Gain Margin determined at Phase crossover frequency and Phase Margin at Gain crossover frequency? **(5)**

Q8 a) Plot the root loci for the unity feedback system with **(10)**

$$G(s) = \frac{K}{(s+2)(s^2+2s+4)}$$

(i) Determine the centroid and the breakaway points.
(ii) Find the frequency at which the root locus branches cross the imaginary axis.

b) What do you mean by State Transition Matrix? Discuss one method of determining it. **(5)**

Q9 a) An open-loop transfer function of a unity feedback system is given by **(10)**

$$G(s)H(s) = \frac{K}{s(s+2)(s+4)}$$

(i) For K = 1, apply the Nyquist stability criterion to determine its stability
(ii) Determine the gain margin and the phase margin.

b) Write short notes on PID Controller. **(5)**