5. Attempt any **two** parts of the following : **(10×2=20)**

(a) Construct the state model for a system characterised by the differential equation :

$$\frac{d^3y}{dt^3}+6\frac{d^2y}{dt^2}+11\frac{dy}{dt}+6y=u.$$

Give the block diagram and signal flow graph representation of the state model.

(b) The open loop transfer function of a unity feedback control system is given by :

$$G(S)=\frac{K}{S(1+0.2\,S)}$$

Design a suitable compensator such that the system will have $K_v = 10$ and P.M. = 50°.

(c) A system is described by the equations :

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

$$y=[1 \quad 1 \quad 0]$$

Find if the system is completely observable. If not, find the mode which is not observable.

Printed Pages—6 **TEE502**

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2056 **Roll No.**

B.Tech.

(SEM. V) THEORY EXAMINATION 2010-11

CONTROL SYSTEM

Time : 3 Hours *Total Marks : 100*

Note : Attempt **all** questions. Each question carries equal marks.

1. Attempt any **two** parts of the following : **(10×2=20)**

(a) Evaluate $\frac{C}{R_1}$ and $\frac{C}{R_2}$ for a system whose block diagram representation is shown in following Figure 1 (A) using block diagram reduction method.

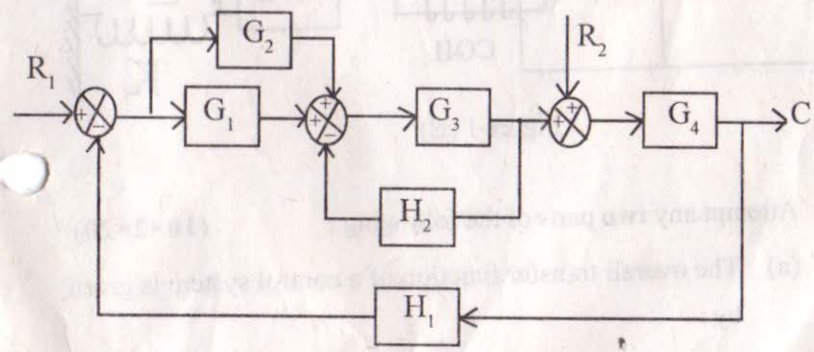

Figure 1 (A)

(b) Obtain signal flow graph representation for a control system whose block diagram is given in the following Figure 1 (B). Find overall transfer function using Mason's gain formula.

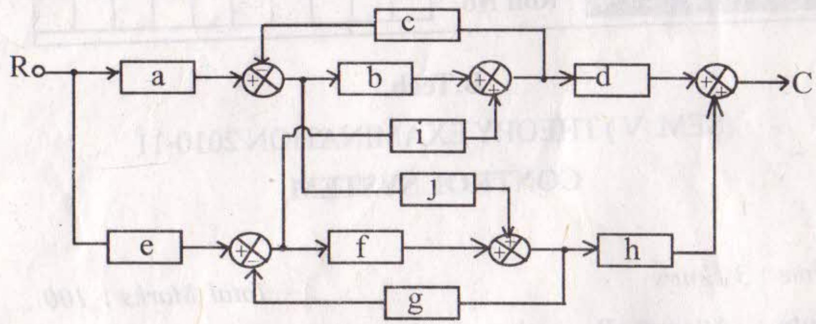

Figure 1 (B)

(c) Find the transfer function X(s)/E(s) for the electromechanical system shown in following Figure 1 (C).

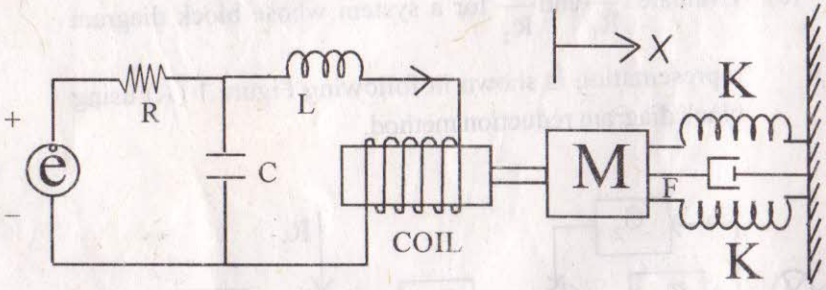

Figure 1 (C)

2. Attempt any **two** parts of the following : **(10×2=20)**

(a) The overall transfer function of a control system is given by :

$$\frac{C(S)}{R(S)} = \frac{16}{S^2 + 1.6S + 16}$$

It is desired that the damping ratio is 0.8. Determine the derivative rate feedback constant K_t and compare rise time, peak time, maximum overshoot and steady state error for unit ramp input without and with derivative feedback control.

(b) The maximum overshoot of a unity feedback control system having its forward path transfer function as G(S)=K/S(1+ST) is to be reduced from 60% to 20%. The system input is an unit step function. Determine the factor by which K should be reduced to achieve aforesaid reduction.

(c) A control system is shown in following Fig. 2 (C)

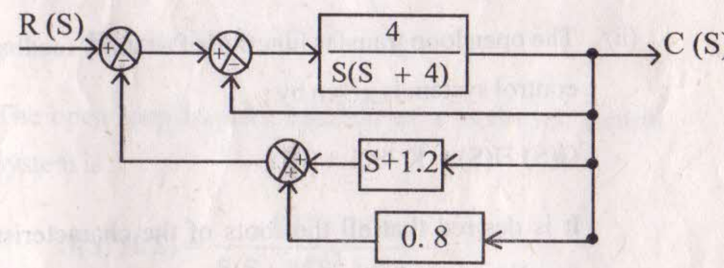

Figure 2 (C)

Determine the transfer function and derive an expression relating the output and time if the input is a step having a magnitude of 2 units.

3. Attempt any **two** parts of the following : **(10×2=20)**

(a) The open loop transfer function of a control system is given by :

$$G(S)H(S)=\frac{K}{S(S+6)(S^2+4S+13)}$$

Sketch the root locus and explain the stability conditions of the control system.

(b) (i) Using Routh-Hurwitz stability criterion, investigate the stability of a unity feedback control system whose open loop transfer function is given by :

$G(S) = e^{-ST}/S(S+2)$.

(ii) The open loop transfer function of an unity feedback control system is given by :

$G(S)\,H(S) = K/S(1+TS)$.

It is desired that all the roots of the characteristic equation must lie in the region to the left of the line S = — a. Determine the values of K and T required so that there are no roots to right of the line S = — a.

(c) Prove that the simplified block diagram of an A.C. two phase servo motor relating $\omega_m(S)$ and $V_C(S)$ is given by :

$$V_C(S) \longrightarrow \boxed{\frac{Km}{(1+S\,Tm)}} \longrightarrow \omega_m(S).$$

4. Attempt any **two** parts of the following : **(10×2=20)**

(a) Derive the transfer function of the control system from the data given on the Bode diagram as shown in the Fig. 4(A).

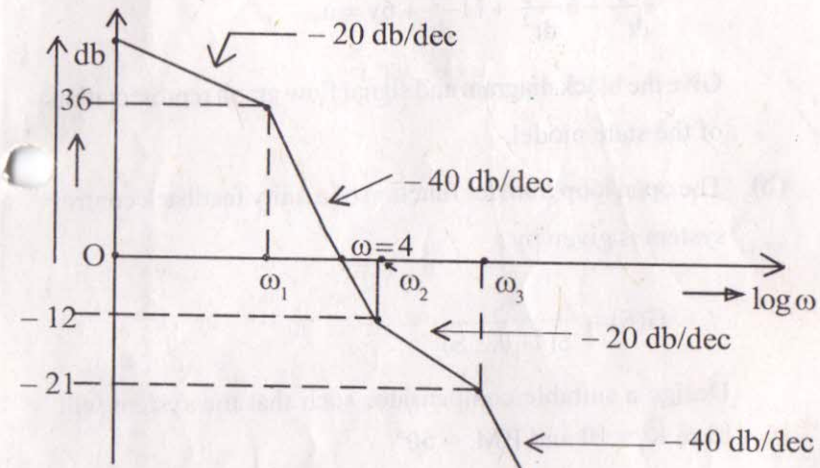

Figure 4 (A)

(b) The open loop transfer function of a feed back control system is :

$$G(S)\,H(S)=\frac{K(1+2S)}{S(S+1)(S^2+S+1)}.$$

Find the restriction on K for stability using Nyquist stability criterian. Find the value of K for the system to have a gain margin of 3db. With this value of K. Find the phase cross over frequency and phase margin of the system.

(c) The open loop transfer function $G(j\omega)$ of a unity feed back control system is given by $G(j\omega) = (x + jy)$.

Draw constant Magnitude loci-M circles of the system.