[Total No. of Questions - 9] [Total No. of Printed Pages - 4] (2064)

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B. Tech 6th Semester Examination

Linear Control System (ECE/EEE)

EC-6004

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt five questions in all, by selecting one question from each section A, B, C, D and Section E. Question no. 9 is compulsory. All questions carry equal marks

SECTION - A

1. (a) What do you mean by sensitivity of the control system? Find S_G^T and S_H^T for the system shown in Fig. 1. (10)

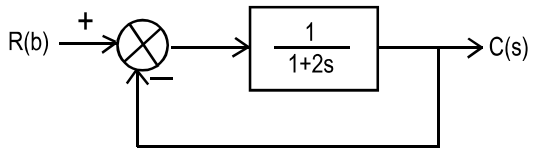

Fig. 1

(b) Find the transfer function for the system shown in Fig. 2 [$Y_1(s)/F(s)$]. (10)

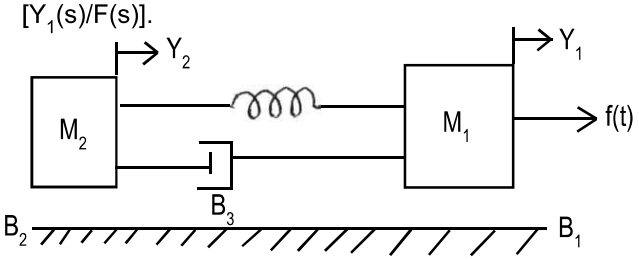

Fig. 2

2. (a) Find the transfer function C(s)/R(s) for the system shown in Fig. 3 by using block diagram reduction technique. (10)

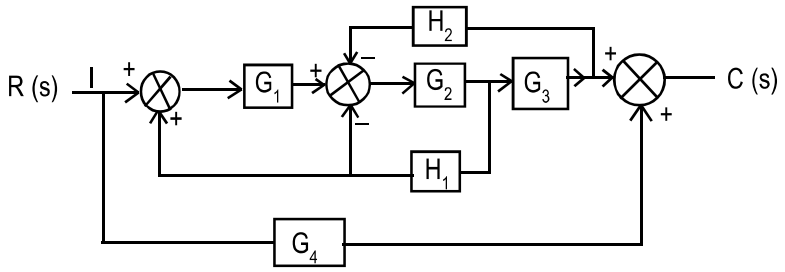

Fig. 3

(b) The signal flow graph is shown in Fig 4. Find the transfer function. (10)

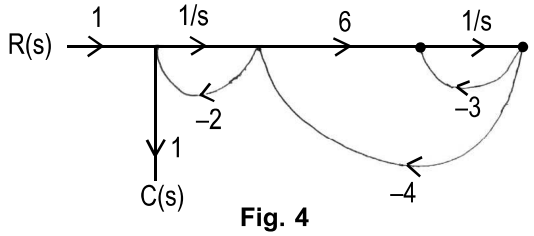

Fig. 4

SECTION - B

3. (a) Explain settling time, rise time and maximum overshoot. For the system as shown in Fig. 5, find the rise time and settling time for this system. (10)

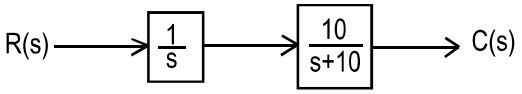

Fig. 5

(b) The transfer function of a unity feedback system is given below:
$G(s) = (10^5(s+3)(s+10)(s+20))/(s(s+25)(s+a)(s+30))$
(i) Find type and order of the system.
(ii) Find the value of 'a' to yield velocity error constant $k_V=10^4$. (10)

4. (a) The characteristics polynomial of a system is given as $P(s) = 2s^5+s^4+4s^3+2s^2+2s+1$. Determine the stability of the system. (10)

(b) The unity feedback configuration with transfer function is given by $G(s) = k(s^2-2s+2)/(s^2+2s+2)$. Find the breakaway/ break in points and angle of departure when forward path gain k varies from $-\infty$ to $0 (-\infty < k < 0)$. (10)

SECTION - C

5. (a) Find the steady state error for the plot shown in Fig. 6. (8)

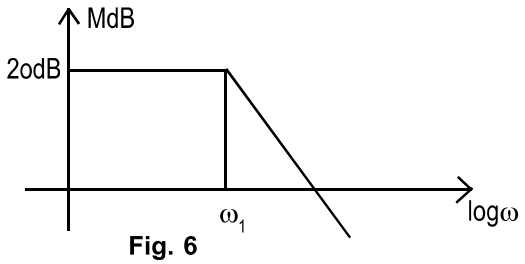

Fig. 6

(b) Determine the gain margin (GM) and phase margin (PM) of the system with unity feedback, given as under:

G(s)= 1/(s(s+1)(l+.1s)) (12)

6. (a) Draw the nyquist plot and determine the stability of the closed loop system.

G(s) H(s)= $1/(s^2(s+1))$ (12)

(b) Explain M and N circle. (8)

SECTION - D

7. (a) Write down the properties of state transition matrix. A linear system is described by the state equation shown in Fig. 7. Find the state transition matrix of the system. (10)

$$x(t) = Ax(t) + Bu(t),\ A\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

Fig. 7

(b) The block diagram of a system with one input and two output y_1 and y_2 is given in Fig. 8. Determine the state space model of the system in terms of the state vector x and the output vector $y= [y_1,y_2]^T$. (10)

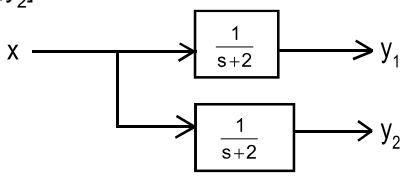

Fig. 8

8. (a) A transfer function of phase lead compensator is given by

$G(s) = (1 + 5T_s) / (1 + 2T_s)$.

Find the maximum phase shift provided by such compensator. Also draw the electrical network of the phase lead compensator. (10)

(b) Explain controllability and observability of the system. Determine the controllability and observability for the system by equations as shown in Fig. 9. (10)

$$\dot{x}(t) = Ax(t) + B\,u(t) \text{ and } y(t) = c\,x(t)$$

$$\text{where, } A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix},$$

$$C = \begin{bmatrix} 4 & 5 & 1 \end{bmatrix}$$

Fig. 9

SECTION - E (Compulsory)

9. (a) Define the transfer function.

(b) Derive the Laplace transform of $\sin \omega t\, u(t)$.

(c) Define state variables, state vector and state space.

(d) Briefly explain phase- variable form of the state-equation?

(e) Find the state equations and output equation for the phase - variable representation of the transfer function $G(s) = (2s+1) / (s^2 + 7s + 9)$.

(f) Give the pole-zero plot and response for $G(s) = 9/ (s^2+9)$; when $R(s) = 1/s$.

(g) Considering the root locus diagram for a system with $G(s) = K(s + 5)/ (s (s+ 2) (s+ 4) (s^2+ 2s +2))$, the meeting point of the asymptotes on the real axis occurs at _____?

(h) Find the steady state value for a control system if the Laplace transform of error e(t) is given as $8(s+3)/s(s+10)$. (8×2.5=20)