B.E. Electronics & Communication / Telecommunication Engineering (Model Curriculum) Sem-VI

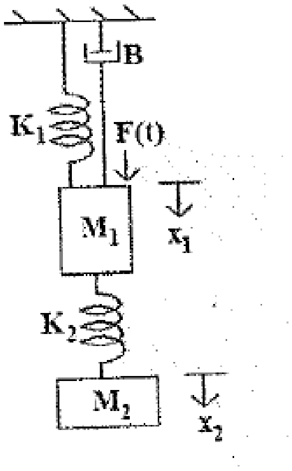
ET605M : Control Systems

P. Pages : 4 **GUG/W/22/13938**

Time : Three Hours Max. Marks : 80

Notes :
1. Solve Q. 1 or Q. 2, Q. 3 or Q. 4, Q. 5 or Q. 6, Q. 7 or Q. 8, Q. 9 or Q. 10
2. All questions carry equal marks.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.

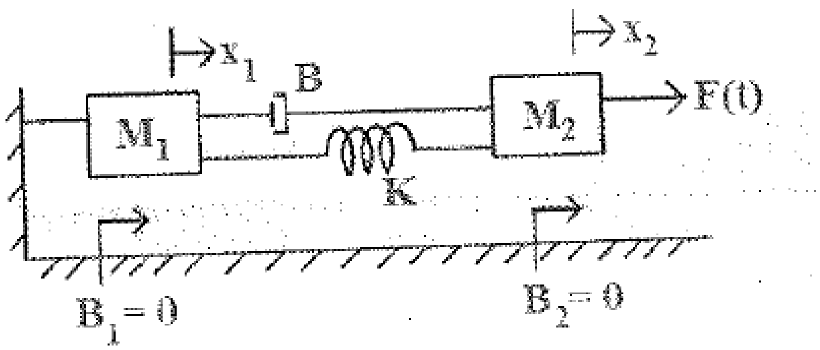
1. a) Write the differential equations governing the behaviour of the mechanical system shown. Also obtain an analogous electrical circuit based on force – current analogy. **8**



b) Derive the transfer function for armature controlled DC motor. **8**

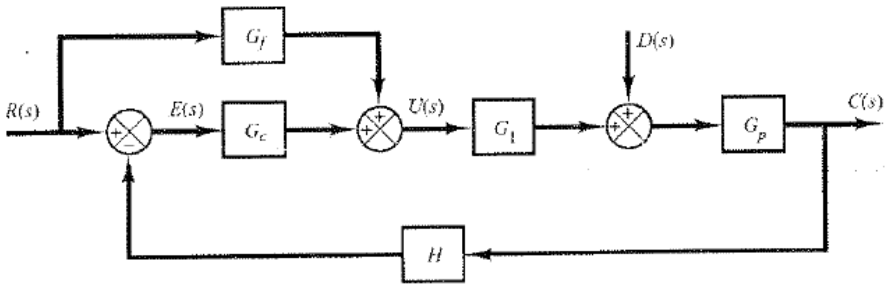
OR

2. a) Obtain mathematical model of the mechanical system shown in figure. Also obtain an analogous electrical circuit based on force – voltage analogy. **8**

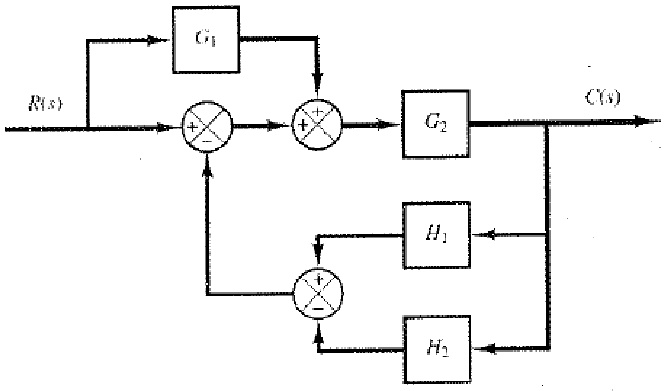


b) Explain position control system with the help of neat schematic diagram. **8**

3. a) Obtain transfer functions C(s)/R(s) and C(s)/D(s) of the system shown in figure. **8**

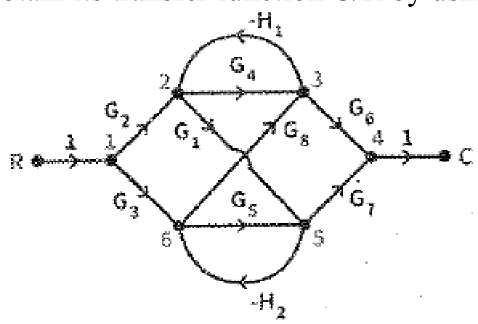


b) Using block diagram reduction technique simplify the block diagram and obtain transfer function C(s)/R(s) **8**



OR

4. a) A system is represented by signal flow graph as shown in figure. **8**
Obtain its transfer function C/R by using Mason's Gain equation.



b) Characteristic equation of a system is given by **8**
$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$
Determine the stability of system using Routh's stability criterion.

5. a) Plot the Bode diagram for the following transfer function and obtain the gain crossover frequency (ω_{gc}) and phase crossover frequency (ω_{pc}) **8**

$$G(s) = \frac{10}{s(1+0.4s)(1+0.1s)}$$

b) If the system transfer function is $\frac{C(s)}{R(s)} = \frac{1}{s^2 + s + 1}$ **8**

Find

i) Natural frequency (ω_n)

ii) Damping ratio (ξ)

iii) Damped frequency (ω_d)

iv) Delay Time (t_d)

v) Rise Time (t_r)

vi) Peak Time (t_p)

vii) % Peak Overshoot $\% M_p$

viii) Settling Time (t_s)

OR

6. a) Draw the root locus for the system having. **8**

$$G(s)H(s) = \frac{k}{s(s+3)(s+6)}$$

Determine value of k for marginal stability and critical damping.

b) A unity feedback system has **8**

$$G(s) = \frac{100(s+12)}{s(s+4)(s+5)}$$

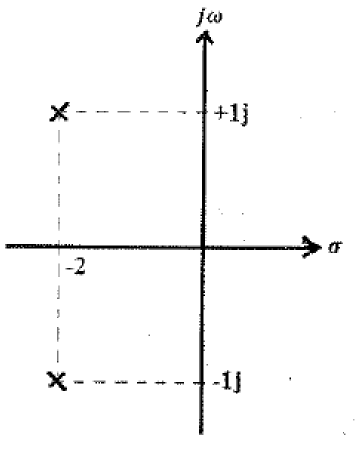
Determine i) Type of system

ii) All static error coefficients.

iii) Steady state error when given system is subjected to input (t) = 4t

7. a) A second order system has resonance peak of 2 at a resonance frequency of 3 rad / sec. Determine peak overshoot, peak time, settling time and rise time. **8**

b) The pole zero configuration of a closed loop transfer function is plotted. Determine bandwidth of system. **8**



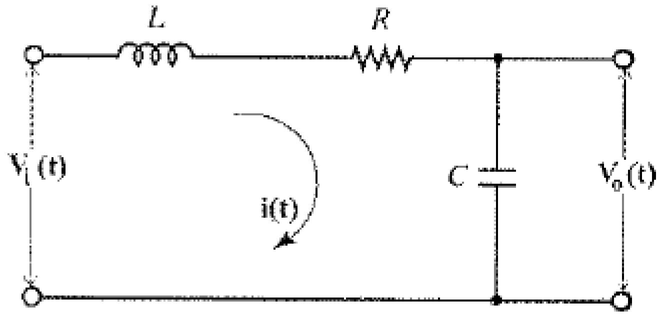
OR

8. a) Draw a Lead Compensator network and derive its transfer function. **8**

b) Draw the polar plot of the system having. **8**

$$G(s)H(s) = \frac{k(s+5)}{s(s+2)(s+4)}$$

9. a) Obtain the state model of the given RLC circuit. **8**



b) The transfer function of system is given as **8**

$$T(s) = \frac{s+3}{s^3 + 5s^2 + 8s + 4}$$

Obtain the state variable model of the system.

OR

10. a) Obtain state transition Matrix for the system. **8**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

b) Consider a system having state model. **8**

$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -2 & -3 \\ 4 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 5 \\ 3 \end{bmatrix} U$ and $Y = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ with D = 0. Obtain the transfer function.

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