SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY: PUTTUR
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QUESTION BANK (DESCRIPTIVE)

Subject with Code: Control Systems (20EE0214) **Course & Branch**: B. Tech– EEE

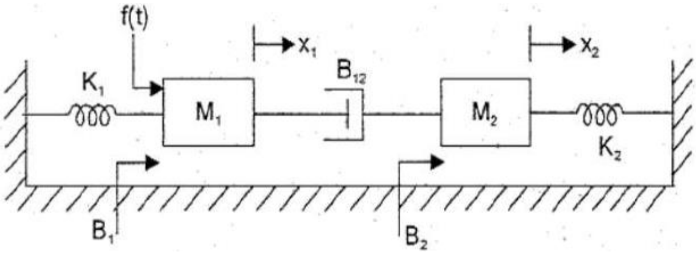
Year & Sem: III-B. Tech & I-Sem **Regulation:** R20

UNIT –I

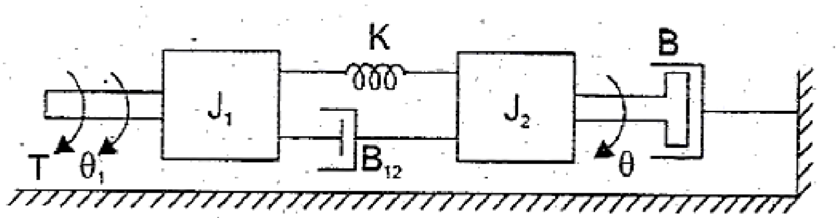
SYSTEMS AND REPRESENTATION

1. a) Define Open loop and Closed loop control systems with examples. [L1][CO1][6M]
b) Compare open loop and closed loop control systems based on different aspects? [L2][CO1][6M]

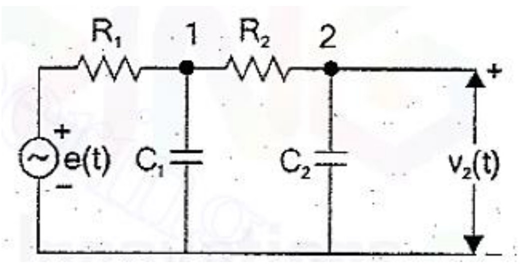
2. Define the Transfer function. Determine the transfer function, $\frac{X1(s)}{F(s)}$ *and* $\frac{X2(s)}{F(s)}$ for the system shown in fig. with the help of force balance equations of mechanical translational systems. [L1][CO2][12M]



3. Write the differential equations governing the mechanical rotational system shown in the figure and find transfer function. [L5][CO2][12M]



4. a. For the electrical system shown in Fig, find the transfer function. [L3][CO2][6M]



b. Convert the block diagram shown in fig 1, to signal flow graph and determine the transfer function C(S)/R(S). [L3][CO2] [6M]

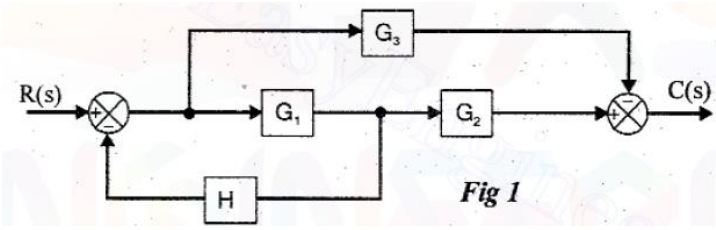
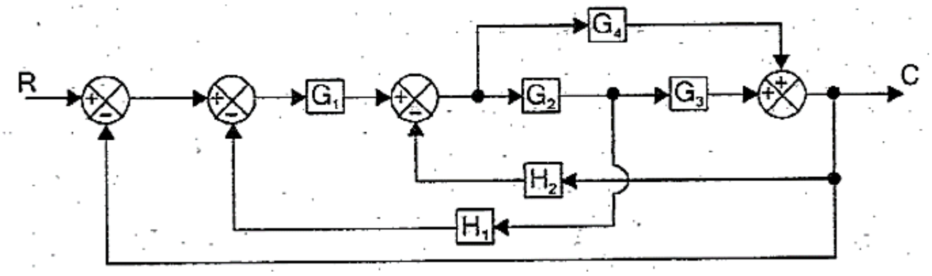


Fig 1

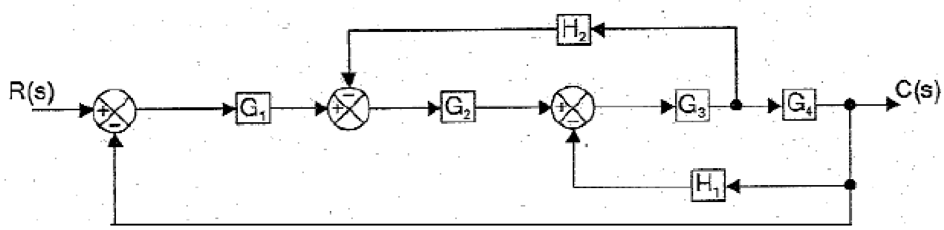
5. Find the transfer function of Armature controlled DC Motor. [L3][CO2][12M]

6. a) Distinguish between Block diagram Reduction Technique and Signal Flow Graph? [L4][CO1][6M]

   b) Using Block diagram reduction technique find the Transfer Function of the system. [L4][CO2][6M]



7. For the system represented in the given figure, obtain transfer function C(S)/R(S). [L4][CO2][12M]



8. a. Give the block diagram reduction rules to find the transfer function of the system [L2][CO1][8M]

   b. List the properties of signal flow graph. [L2][CO1][4M]

9. Find the overall transfer function of the system whose signal flow graph is shown in fig 1. [L4][CO2][12M]

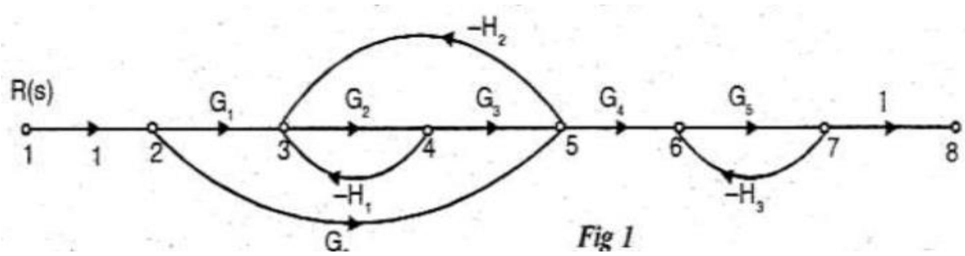


Fig 1

10. Obtain the overall gain C(S)/R(S) from signal flow graph shown in fig.1 [L4][CO2][12M]

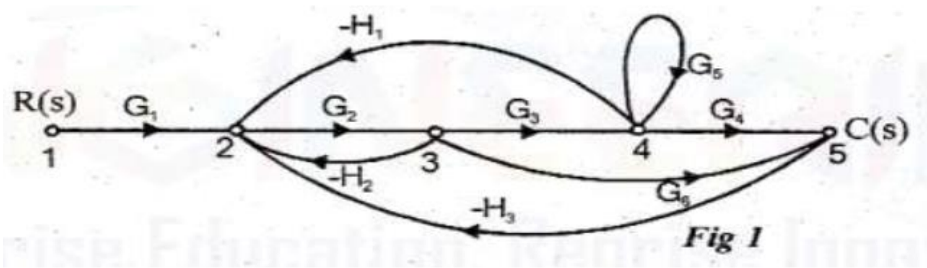


Fig 1

UNIT-II

TIME DOMAIN ANALYSIS

1. a) What is the Time response? Explain the standard test input signals with neat sketch. [L1][CO3][6M]

   b) List out the time domain specifications and derive the expressions for Risetime, Peak time and Peak overshoot. [L2][CO3][6M]

2. a) Find all the time domain specifications for a unity feedback control system whose open loop transfer function is given by **G(S) =** $\frac{\mathbf{25}}{\boldsymbol{S(S+5)}}$. [L2][CO3][6M]

   b) What is the Transient and steady state response of first and second order systems. [L1][CO3][6M]

3. A closed loop servo is represented by the differential equation: $\frac{d^2c}{dt^2} + 8\frac{dc}{dt} = 64e$. Where 'c' is the displacement of the output shaft, 'r' is the displacement of the input shaft and e =r – c. Determine undamped natural frequency, damping ratio and percentage maximum overshoot for unit step input. [L4][CO3][12M]

4. a) Define steady state error? Derive the static error components for Type 0, Type 1 &Type 2 systems? [L2][CO3][6M]

   b) A positional control system with velocity feedback shown in fig. What is the response c(t) of the system for unit step input? [L5][CO3][6M]

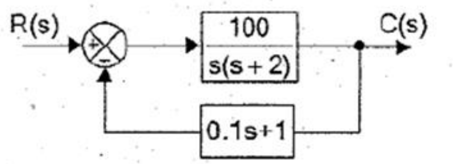


Fig 1 : Positional control system.

5. a. Measurements conducted on a servo mechanism, show the system response to be $\mathbf{c(t) = 1+0.2e^{-60t} - 1.2e^{-10t}}$ When subject to a unit step input. Obtain an expression for closed loop transfer function, determine the undamped natural frequency, damping ratio? [L4][CO3] [8M]

   b. For servo mechanisms with open loop transfer function given below what type of input signal give rise to a constant steady state error and calculate their values. **G(s)H(s)=**$\frac{\mathbf{10}}{S^2(S+1)(S+2)}$. [L2][CO3][4M]

6. A unity feedback control system has an open loop transfer function, **G(s) =** $\frac{10}{S(S+2)}$. Find the rise time, percentage overshoot, peak time and settling time for a step input of 12 units. [L4][CO3[12M]

7. a. A For servo mechanisms with open loop transfer function given below what type of input signal give rise to a constant steady state error and calculate their values. **G(s)H(s)=**$\frac{20(S+2)}{S(S+1)(S+3)}$ [L3][CO3][4M]

   b. Consider a unity feedback system with a closed loop transfer function $\frac{C(S)}{R(S)}=\frac{KS+b}{(S^2+aS+b)}$. Calculate open loop transfer function G(s). Show that steady state error with unit ramp input is given by $\frac{(a-K)}{b}$. [L4][CO3][8M]

8. For a unity feedback control system, the open loop transfer function **G(S) =** $\frac{10(S+2)}{S^2(S+1)}$.

   (i) Determine the position, velocity and acceleration error constants. [L2][CO3][6M]

   (ii) The steady state error when the input is R(S) = $\frac{3}{S}-\frac{2}{S^2}+\frac{1}{3S^3}$. [L5][CO3][6M]

9. a. What is the characteristic equation? List the significance of characteristic equation. [L1][CO3][4M]

   b. The system has **G(s)** = $\frac{K}{S(1+ST)}$ with unity feedback where K & T are constant. Determine the factor by which gain **'K'** should be multiplied to reduce the overshoot from **75%** to **25%?** [L5][CO3][8M]

10. What is the significance of controller? Explain the effect of P, I, and D controllers with block diagrams. [L1][CO4][12M]

UNIT –III

STABILITY ANALYSIS

1. a) What is the stability the of the system. Explain the procedure for Routh Hurwitz stability criterion. [L1][CO3][4M]

   b) With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations:

   a) $s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$. [L2][CO5][4M]

   b) $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. [L3][CO5][4M]

2. With the help of Routh's stability criterion determine the stability of the following systems represented by the characteristic equations:

   a) $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$ [L2][CO5][6M]

   b) $9s^5 - 20s^4 + 10s^3 - s^2 - 9s - 10 = 0$ [L3][CO5][6M]

3. The open loop Transfer function of a unity feedback control system is given by **G(s) =** $\frac{K}{(S+2)(S+4)(S^2+6S+25)}$ Determine the value of K which will cause [L5][CO5][12M]

sustained oscillationsin the closed loop system and what is the corresponding oscillation Frequency.

4. Explain the procedure for constructing root locus. [L2][CO5][12M]

5. Find the range of K for stability of unity feedback system whose open loop transfer function is **G(s) =** $\frac{K}{S(S+1)(S+2)}$ using Routh's stability criterion. [L3][CO5][12M]

6. Develop the root locus of the system whose open loop transfer function is **G(s) =** $\frac{K}{S(S+2)(S+4)}$. [L3][CO5][12M]

7. Develop the root locus of the system whose open loop transfer function is [L4][CO5][12M]

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

8. Develop the root locus of the system whose open loop transfer function is [L4][CO5][12M]

$$G(s) = \frac{K(S+9)}{S(S^2+4S+11)}$$

9. Develop the root locus of the system whose open loop transfer function is [L5][CO5][12M]

$$G(s) = \frac{K(S+1.5)}{S(S+1)(S+5)}$$

10. Develop the root locus of the system whose open loop transfer function is [L5][CO5][12M]

$$G(s) = \frac{K}{S(S^2+6S+10)}$$

UNIT-IV

FREQUENCY DOMAIN ANALYSIS

1. List out the frequency domain specifications and derive the expressions for resonant peak. [L2][CO4][12M]

2. a. Define and derive the expression for resonant frequency [L1][CO4][6M]

   b. Given ξ **= 0.7** and ω_n **= 10 rad/sec.** Find resonant peak, resonant frequency and bandwidth. [L5][CO4][6M]

3. Develop the Bode plot for the following transfer function and determine the system phase and gain cross over frequencies [L4][CO4][12M]

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

4. Develop the Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency to be 5 rad/sec. [L4][CO4][12M]

$$G(s) = \frac{KS^2}{(1+0.2S)(1+0.02S)}$$

5. Develop the Bode plot for the transfer function **G(s)** = $\frac{K e^{-0.2s}}{S(S+2)\,(s+8)}$ Find K so that the system is stable with a) gain margin equal to 2db b) phase margin equal to 45^0. [L3][CO4][12M]

6. Develop the Bode plot for the system having the following transfer function and determine phase margin and gain margin. [L3][CO4][12M]

$$G(s) = \frac{75\,(1+0.2S)}{S(S^2 + 16S + 100)}$$

7. Sketch the polar plot for the open loop transfer function of a unity feedback system is given by **G(s)** = $\frac{1}{S(1+S)\,(1+2S)}$ Determine Gain Margin & Phase Margin. [L5][CO4][12M]

8. Sketch the polar plot for the open loop transfer function of a unity feedback system is given by **G(s)** = $\frac{1}{S^2(1+S)\,(1+2S)}$ Determine Gain Margin & Phase Margin. [L5][CO4][12M]

9. Draw the Nyquist plot for the system whose open loop transfer function is, **G(s)H(s)** = $\frac{K}{S(S+2)\,(S+10)}$ Determine the range of K for which closed loop system is stable. [L5][CO4][12M]

10. a. What is the Lead and Lag Compensators? Determine the transfer function of Lag Compensator and draw pole-zero plot. [L3][CO4][6M]
    b. Determine the transfer function of Lead Compensator and draw pole-zero plot. [L3][CO4][6M]

UNIT-V

STATE SPACE ANALYSIS

1. a. Define state, state variable, state equation. [L1][CO2][6M]
   b. Derive the expression for the transfer function from the state model. [L3][CO2][6M]
   $\dot{X}$ = Ax + Bu and y = Cx + Du
2. Determine the Solution for Homogeneous and Non homogeneous State equations. [L5][CO6][12M]
3. a. What are the properties of State Transition Matrix. [L1][CO6][6M]
   b. Diagonalize the following system matrix A = $\begin{pmatrix} 0 & 6 & -5 \\ 1 & 0 & 2 \\ 3 & 2 & 4 \end{pmatrix}$ [L3][CO6][6M]
4. For the state equation: $\dot{X} = \begin{pmatrix} \mathbf{0} & \mathbf{1} \\ \mathbf{-2} & \mathbf{-3} \end{pmatrix}\mathbf{X} + \begin{pmatrix} \mathbf{0} \\ \mathbf{1} \end{pmatrix}\mathbf{U}$ with the unit step input and the initial conditions are $\mathbf{X(0)} = \begin{pmatrix} \mathbf{1} \\ \mathbf{1} \end{pmatrix}$.Solve the following
   (a) State transition matrix [L3][CO6][6M]
   (b) Solution of the state equation.

[L2][CO6][6M]

5. A system is characterized by the following state space equations:

$\dot{X}_1 = -3x_1 + x_2$; $\dot{X}_2 = -2x_1 + u$; $Y = x_1$

a) Find the transfer function of the system and Stability of the system. [L1][CO6][6M]

b) Compute the State transition matrix [L5] [CO6][6M]

6. a. Find state variable representation of an armature controlled D.C. motor. [L2][CO6][6M]

b. A state model of a system is given as: [L3][CO6][6M]

$$\dot{X} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{pmatrix} X + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} U \text{ and } Y = (1 \quad 0 \quad 0)X$$

Determine: (i) The Eigen Values. (ii) The State Transition Matrix.

7. a. Derive the expression for the transfer function and poles of the system from the state model. $\dot{X} = Ax + Bu$ and $y = Cx + Du$ [L3][CO6][6M]

[L3][CO6][6M]

b. Diagonalize the following system matrix $A = \begin{pmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{pmatrix}$

8. a. Explain the properties of STM. [L2][CO5][6M]

[L1][CO5][6M]

b. For the state equation: $\dot{X} = \begin{pmatrix} \mathbf{1} & \mathbf{0} \\ \mathbf{1} & \mathbf{1} \end{pmatrix} \mathbf{X} + \begin{pmatrix} \mathbf{0} \\ \mathbf{1} \end{pmatrix} \mathbf{U}$ when, $\mathbf{X(0)} = \begin{pmatrix} \mathbf{1} \\ \mathbf{0} \end{pmatrix}$.

Find the solution of the state equation for the unit step input.

9. Find a state model for the system whose Transfer function is given by [L1][CO2][12M]

G(s) H(s) = $\dfrac{(7S^2+12S+8)}{(S^3+6S^2+11S+9)}$

10. a. Find the state model of the differential equation is $\dddot{y} + 2\ddot{y} + 3\dot{y} + 4y = u$ [L1][CO6][6M]

b. Define the Controllability and Observability. Explain the testing methods for Controllability and Observability. [L1][CO5][6M]

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