SIDDARTHA INSTITUTE OF ENGINEERING AND TECHNOLOGY:: PUTTUR
(AUTONOMOUS)
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QUESTION BANK (DESCRIPTIVE)

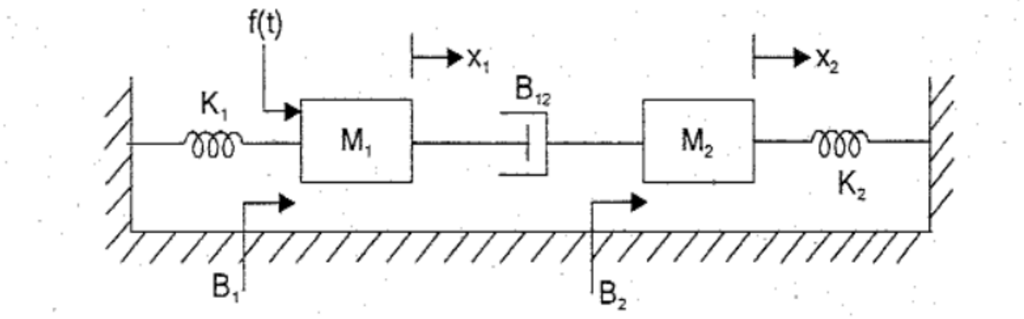
Subject with Code : Control Systems (19EE0212) **Course & Branch**: B.Tech– EEE&ECE

Year & Sem: III-B.Tech & I-Sem **Regulation:** R19

UNIT –I

SYSTEMS AND REPRESENTATION

Q.1 Determine the transfer function, $\frac{X_1(s)}{F(s)}$ and $\frac{X_2(s)}{F(s)}$ for the system shown in fig [L1][CO1][12M



Q.2 Write the differential equation governing the mechanical system shown in figure and determine the transfer function [L1][CO1][12M

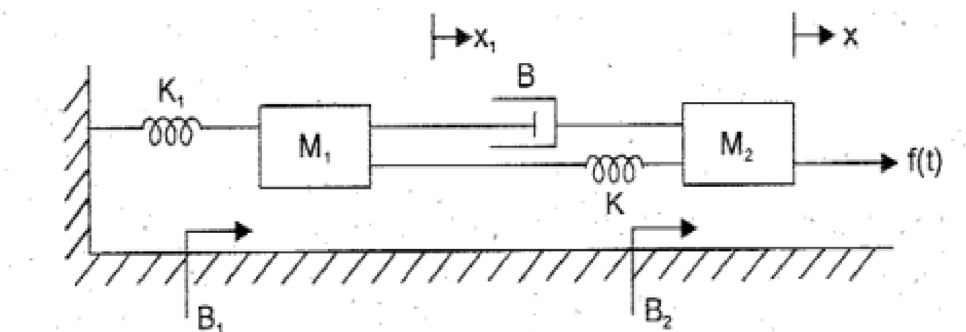
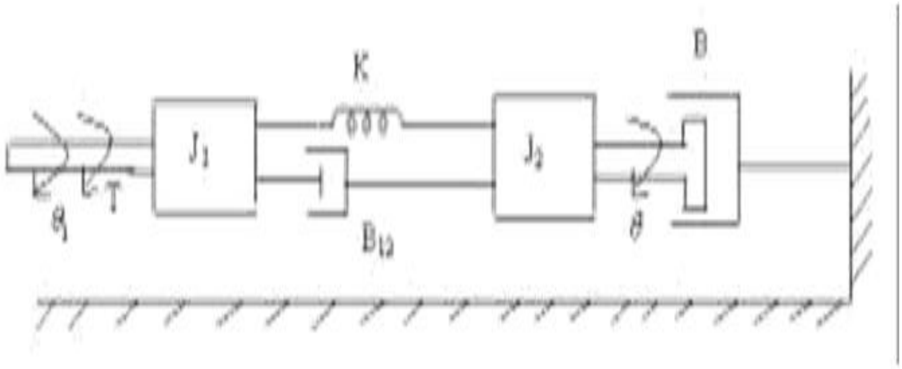


Fig 1.

Q.3 [L1][CO1][12M

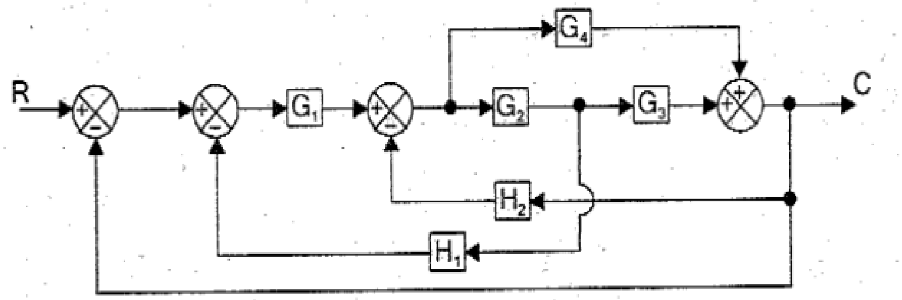
Write the differential equations governing the mechanical rotational system shown in the figure and find transfer function.



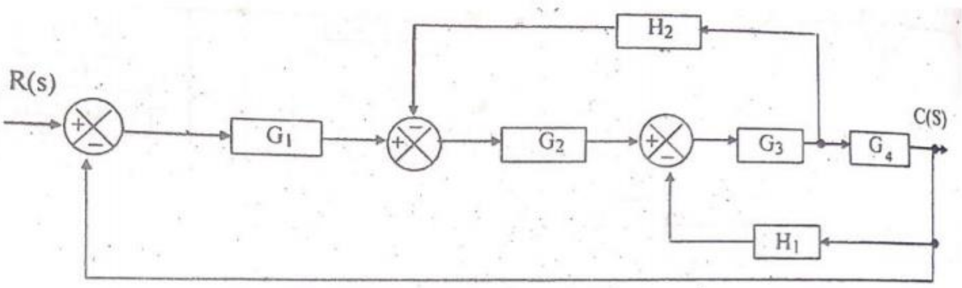
Q.4 a. Compare open loop and closed loop control systems based on different aspects? [L4][CO1] [8M

b. Distinguish between Block diagram Reduction Technique and Signal Flow Graph? [L4][CO1][4M]

Q.5 Using Block diagram reduction technique find the Transfer Function of the system. [L1][CO1] 12M



Q.6 For the system represented in the given figure, obtain transfer function C(S)/R(S). [L1][CO1] 12M



Q.7 a. Give the block diagram reduction rules to find the transfer function of the system [L4][CO1] 8M

b. List the properties of signal flow graph. [L4][CO1] 4M

Q.8 Find the overall transfer function of the system whose signal flow graph is shown below [L1][CO1] 12M

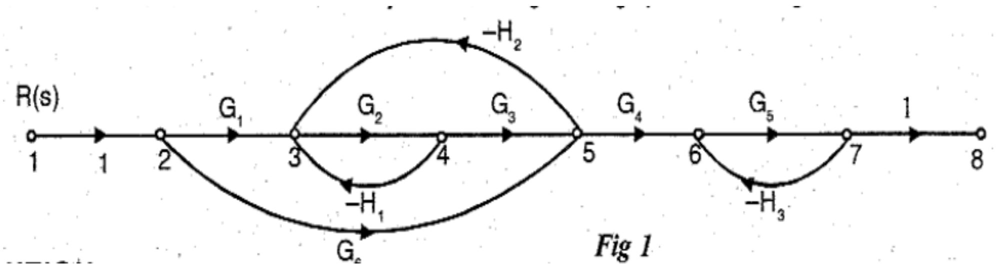


Fig 1

Q.9 Obtain the overall gain C(S)/R(S) from signal flow graph shown in [L1][CO1] 12M

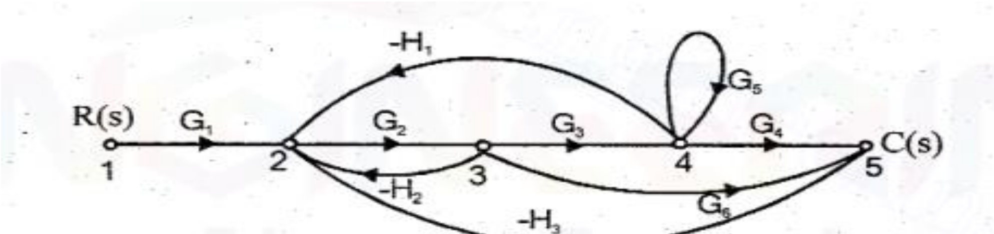


Fig 1

Q.10 [L1][CO1] 12M

Convert the block diagram to signal flow graph and determine the transfer function C(S)/R(S).

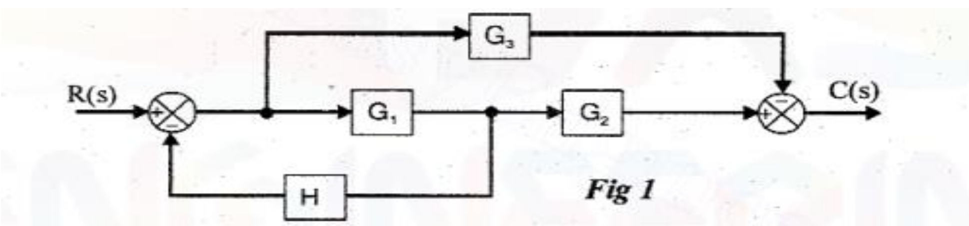
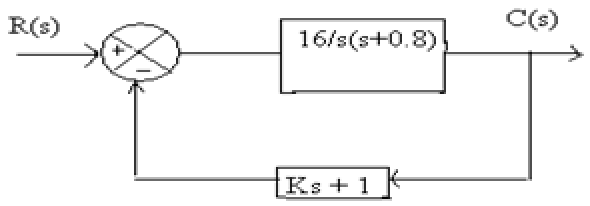


Fig 1

<u>UNIT-II</u>

<u>TIME DOMAIN ANALYSIS</u>

Q.1 List out the time domain specifications and derive the expressions for Rise time, Peak time and Peak overshoot. [L1,CO2] 12M

Q.2		Find all the time domain specifications for a unity feedback control system whose open loop transfer function is given by **G(S)** = $\frac{25}{S(S+5)}$.	[L1,CO2]	12M
Q.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.	[L5,CO2]	12M
Q.4	a.	Measurements conducted on a servo mechanism, show the system response to be $c(t) = 1+0.2e^{-60t} - 1.2e^{-10t}$ When subject to a unit step input. Obtain an expression for closed loop transfer function, determine the undamped natural frequency, damping ratio?	[L5,CO2]	6M
	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. $$G(s)H(s)=\frac{10}{S^2(S+1)(S+2)}.$$	[L1,CO2]	6M
Q.5		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.	[L1,CO2]	12M
Q.6		Define steady state error? Derive the static error components for Type 0, Type 1 &Type 2 systems?	[L1,CO2]	12M
Q.7		A positional control system with velocity feedback shown in figure. What is the response c(t) to the unit step input. Given that damping ratio=0.5.Also determine rise time, peak time, maximum overshoot and settling time. 	[L5,CO2]	12M
Q.8	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,CO2]	6M

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 $\frac{(a-K)}{b}$ [L1,CO2] 6M

Q.9 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. [L5,CO2] 6M

(ii) The steady state error when the input is **R(S)** = $\frac{3}{S} - \frac{2}{S^2} + \frac{1}{3S^3}$. [L1,CO2] 6M

Q.10 a. What is the characteristic equation? List the significance of characteristic equation. [L1,CO2] 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 overshot from **75%** to **25%?** [L5,CO2] 8M

UNIT –III

STABILITY ANALYSIS

Q.1 With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations: [L1,CO3] 12M

(a) $\mathbf{s^4 + 8\,s^3 + 18\,s^2 + 16s + 5 = 0.}$

(b) $\mathbf{s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0}$.

Q.2 With the help of Routh's stability criterion determine the stability of the following systems represented by the characteristic equations: [L5,CO3] 12M

(a) $\mathbf{s^5 + s^4 + 2\,s^3 + 2\,s^2 + 3s + 5 = 0}$

(b) $9s^5 - 20s^4 + 10\,s^3 - s^2 - 9s - 10 = 0$

Q.3	The open loop Transfer function of a unity feedback control system is given by **G(s)H(s)** = $\frac{K}{(S+2)(S+4)\,(S^2+6S+25)}$ Determine the value of K which will cause sustained oscillationsin the closed loop system and what is the corresponding oscillation Frequency.	[L5,CO3]	12M
Q.4	Find the range of K for stability of unity feedback system whose open loop transfer function is **G(s) H(s)** = $\frac{K}{S(S+1)\,(S+2)}$ using Routh's stability criterion.	[L1,CO3]	12M
Q.5	Explain the procedure for constructing root locus.	[L2,CO3]	12M
Q.6	Develop the root locus of the system whose open loop transfer function is **G(s) H(s)** = $\frac{K}{S(S+2)\,(S+4)}$.	[L3,CO3]	12M
Q.7	Develop the root locus of the system whose open loop transfer function is **G(s) H(s)** = $\frac{K}{S\,(S^2+4S+13)}$	[L3,CO3]	12M
Q.8	Develop the root locus of the system whose open loop transfer function is **G(s) H(s)** = $\frac{K\,(S+9)}{S(S^2+4S+11)}$	[L3,CO3]	12M
Q.9	Develop the root locus of the system whose open loop transfer function is **G(s) H(s)** = $\frac{K(S^2+6S+25)}{S(S+1)\,(S+2)}$	[L3,CO3]	12M
Q.10	Develop the root locus of the system whose open loop transfer function is **G(s)H(s)** = $\frac{K}{S\,(S^2+6S+10)}$	[L3,CO3]	12M

UNIT-IV

FREQUENCY DOMAIN ANALYSIS

Q.1 Develop the Bode plot for the following transfer function [L3,CO4] 12M

$$G(s)H(s) = \frac{K\,e^{-0.1s}}{S(S+1)\,(1+0.1S)}$$

Q.2 Develop the Bode plot for the system having the following transfer function [L3,CO4] 12M

$$G(s) = \frac{15\,(S+5)}{S(S^2+16S+100)}$$

Q.3 a. Define and derive the expression for resonant frequency. [L1,CO4] 6M

b. Develop the magnitude bode plot for the system having the following transfer function: $G(s)\,H(s) = \frac{2000\,(S+1)}{S(S+10)\,(S+40)}$ [L3,CO4] 6M

Q.4 Derive the expressions for resonant peak and resonant frequency and hence establish the correlation between time response and frequency response. [L3,CO4] 12M

Q.5 Develop the Bode plot for the following Transfer Function **G(s) H(s) =** $\frac{20(0.1S+1)}{S^2(0.2S+1)\,(0.02S+1)}$ [L3,CO4] 12M

From the bode plot determine (a) Gain Margin (b) Phase Margin (c) Comment on the stability

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

b. Given $\xi = 0.7$ and $\omega_n = 10$ **rad/sec.** Find resonant peak, resonant frequency and bandwidth. [L5,CO4] 6M

Q.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

Q.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

Q.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

Q.10	Obtain the transfer function of Lead Compensator, draw pole-zero plot and write the procedure for design of Lead Compensator using Bode plot.	[L5,CO4]	12M

UNIT-V

STATE SPACE ANALYSIS

Q.1 Determine the Solution for Homogeneous and Non homogeneous State equations [L5,CO5] 12M

Q.2 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,CO5] 12M

(b) Solution of the state equation.

Q.3 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.

(b) Compute the STM [L5,CO5] 12M

Q.4 a. What are the properties of State Transition Matrix. [L1,CO5] 4M

b. Diagonalize the following system matrix A = $\begin{pmatrix} 0 & 6 & -5 \\ 1 & 0 & 2 \\ 3 & 2 & 4 \end{pmatrix}$ [L3,CO5] 8M

Q.5 A state model of a system is given as: [L2,CO5] 12M

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

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

Q.6 a. Find a state model for the system whose Transfer function is given by [L3,CO5] 6M

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

b. Find the state model of the differential equation is [L3,CO5] 6M

$$\dddot{y} + 2\ddot{y} + 3\dot{y} + 4y = u$$

Q.7 Diagonalize the following system matrix A $=\begin{pmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{pmatrix}$ [L1,CO5] 12M

Q.8 a. Explain the properties of STM. [L2,CO5] 4M

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, $\mathbf{X(0)} = \begin{pmatrix} \mathbf{1} \\ \mathbf{0} \end{pmatrix}$. [L1,CO5] 8M

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

Q.9 Diagonalize the following system matrix A $= \begin{pmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{pmatrix}$ [L1,CO5] 12M

Q.10 a. Define state, state variable, state equation. [L1,CO5] 6M

b. Derive the expression for the transfer function from the state model. [L3,CO5] 6M

$\dot{X}$ = Ax + Bu and y = Cx + Du

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