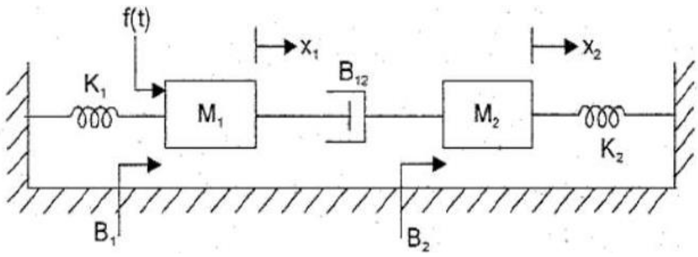
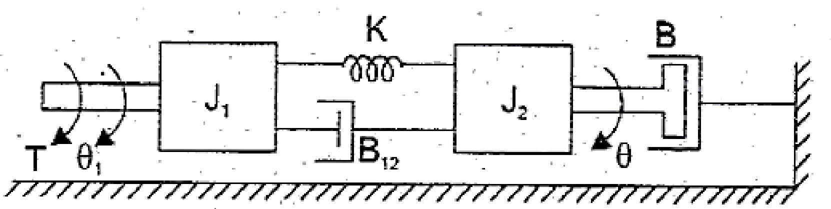
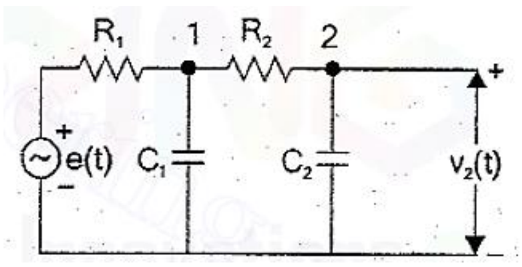
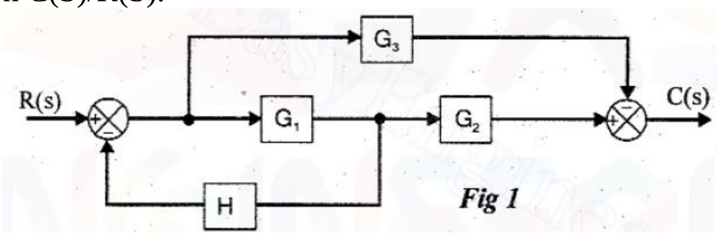
SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR (AUTONOMOUS)
Siddharth Nagar, Narayanavanam Road – 517583

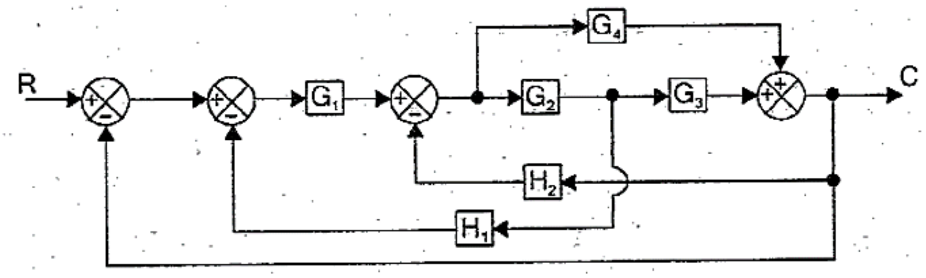
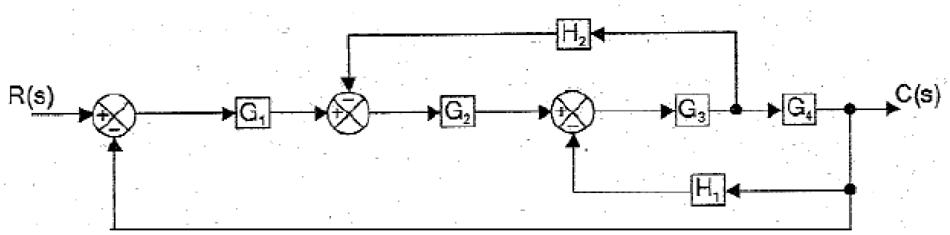
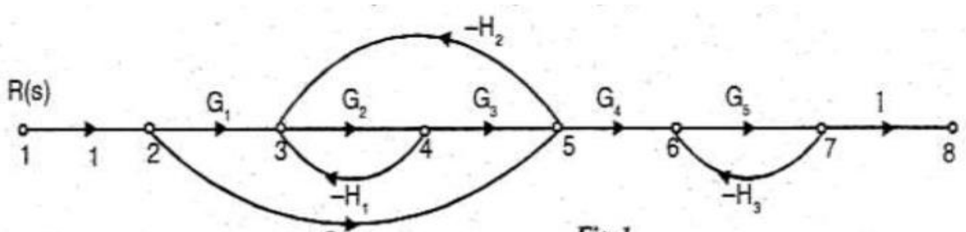
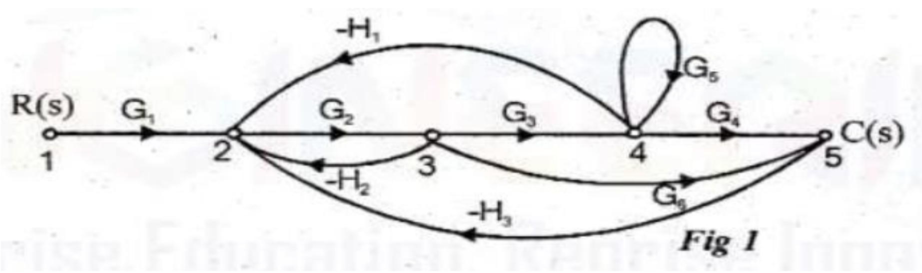
QUESTION BANK (DESCRIPTIVE)

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

Year & Sem: II-B.Tech & II-Sem **Regulation: R20**

UNIT –I
SYSTEMS AND REPRESENTATION

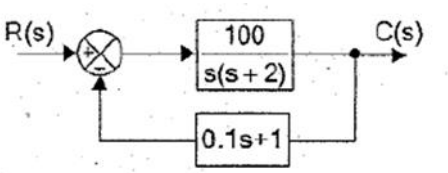
1.	a)	Compare open loop and closed loop control systems based on different aspects?	[L2][CO1][6M]
	b)	Distinguish between Block diagram Reduction Technique and Signal Flow Graph?	[L4][CO1][6M]
2.		Determine the transfer function, $\frac{X1(s)}{F(s)}$ *and* $\frac{X2(s)}{F(s)}$ for the system shown in fig. 	[L4][CO2][12M]
3.		Write the differential equations governing the mechanical rotational system shown in the figure and find transfer function. 	[L4][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).  *Fig 1*	[L3][CO2] [6M]
5.		Find the transfer function of Armature controlled DC Motor.	[L3][CO2][12M]

6.		Using Block diagram reduction technique find the Transfer Function of the system.  	[L4][CO2][12M]
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.  *Fig 1*	[L4][CO2][12M]
10.		Obtain the overall gain C(S)/R(S) from signal flow graph shown in fig.1  *Fig 1*	[L4][CO2][12M]

Course Code: 20EE0214 **R20**

UNIT-II

TIME DOMAIN ANALYSIS

1.		List out the time domain specifications and derive the expressions for Rise time, Peak time and Peak overshoot.	[L2][CO3][12M]
2.		Find all the time domain specifications for a unity feedback control system whose open loop transfer function is given by **G(S)** = $\frac{25}{S(S+5)}$.	[L2][CO3][12M]
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)	Measurements conducted on a servo mechanism, show the system response to be **c(t) =** $\mathbf{1+0.2e^{-60t}-1.2e^{-10t}}$ 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)=**$\frac{10}{S^2(S+1)(S+2)}$.	[L2][CO3][4M]
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.	[L4][CO3[12M]
6.		Define steady state error? Derive the static error components for Type 0, Type 1 &Type 2 systems?	[L2][CO3][12M]
7.		A positional control system with velocity feedback shown in fig. What is the response c(t) of the system for unit step input?  *Fig 1 : Positional control system.*	[L4][CO3][12M]
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][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]
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.	

		(ii) The steady state error when the input is R(S) = $\frac{3}{s}-\frac{2}{s^2}+\frac{1}{3s^3}$.	[L2][CO3][6M] [L4][CO3][6M]
10.	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 overshot from **75%** to **25%?**	[L3][CO3][8M]

UNIT –III

STABILITY ANALYSIS

1.	 a) b)	With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations: $s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$. $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$.	[L2][CO5][6M] [L3][CO5][6M]
2.	 a) b)	With the help of Routh's stability criterion determine the stability of the following systems represented by the characteristic equations: $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$ $9s^5 - 20s^4 + 10s^3 - s^2 - 9s - 10 = 0$	[L2][CO5][6M] [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 sustained oscillationsin the closed loop system and what is the corresponding oscillation Frequency.	[L4][CO5][12M]
4.		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]
5.		Explain the procedure for constructing root locus.	[L2][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 **G(s)** = $\frac{K}{s(s^2+4s+13)}$	[L4][CO5][12M]
8.		Develop the root locus of the system whose open loop transfer function is **G(s)** = $\frac{K(s+9)}{s(s^2+4s+11)}$	[L4][CO5][12M]
9.		Develop the root locus of the system whose open loop transfer function is **G(s)** = $\frac{K(s+1.5)}{s(s+1)(s+5)}$	[L4][CO5][12M]
10.		Develop the root locus of the system whose open loop transfer function is **G(s)** = $\frac{K}{s(s^2+6s+10)}$	[L3][CO5][12M]

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.	[L3][CO4][6M]
3.		Develop the Bode plot for the following transfer function and determine the system phase and gain cross over frequencies $$G(s) = \frac{10}{s(1+0.4S)(1+0.1S)}$$	[L4][CO4][12M]
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. $$G(s) = \frac{KS^2}{(1+0.2S)(1+0.02S)}$$	[L4][CO4][12M]
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. $$G(s) = \frac{75(1+0.2S)}{S(S^2+16S+100)}$$	[L3][CO4][12M]
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.	[L4][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.	[L4][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.	[L4][CO4][12M]
10.	a) b)	Determine the transfer function of Lag Compensator and draw pole-zero plot. Determine the transfer function of Lead Compensator and draw pole-zero plot.	[L3][CO4][6M] [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. $\dot{X}$ = Ax + Bu and y = Cx + Du	[L3][CO2][6M]
2.		Determine the Solution for Homogeneous and Non homogeneous State equations.	[L3][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: $\dot{X} = \begin{pmatrix} 0 & 1 \\ -2 & -3 \end{pmatrix}\mathbf{X} + \begin{pmatrix} 0 \\ 1 \end{pmatrix}\mathbf{U}$ with the unit step input and the initial conditions are $\mathbf{X(0)} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$. 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	[L3] [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: $\dot{X} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{pmatrix}X + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$ U and $Y = \begin{pmatrix} 1 & 0 & 0 \end{pmatrix}X$ Determine: (i) The Eigen Values. (ii) The State Transition Matrix.	[L3][CO6][6M]
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]
	b)	Diagonalize the following system matrix A = $\begin{pmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{pmatrix}$	[L3][CO6][6M]
8.	a)	Explain the properties of STM.	[L2][CO6][6M]
	b)	For the state equation: $\dot{X} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}\mathbf{X} + \begin{pmatrix} 0 \\ 1 \end{pmatrix}\mathbf{U}$ when, $\mathbf{X(0)} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$. Find the solution of the state equation for the unit step input.	[L1][CO6][6M]
9.		Find a state model for the system whose Transfer function is given by **G(s) H(s) =** $\frac{(7s^2+12s+8)}{(s^3+6s^2+11s+9)}$	[L3][CO2][12M]
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)	Diagonalize the following system matrix A = $\begin{pmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{pmatrix}$	[L3][CO6][6M]

PREPARED BY: Dr. Rahul Bhattacharjee, Sai Praveen Kumar