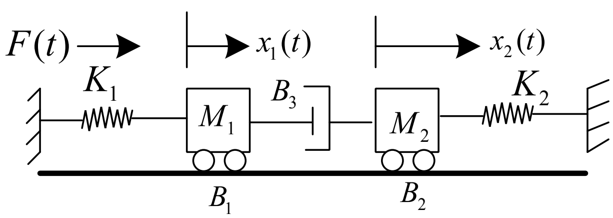
Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

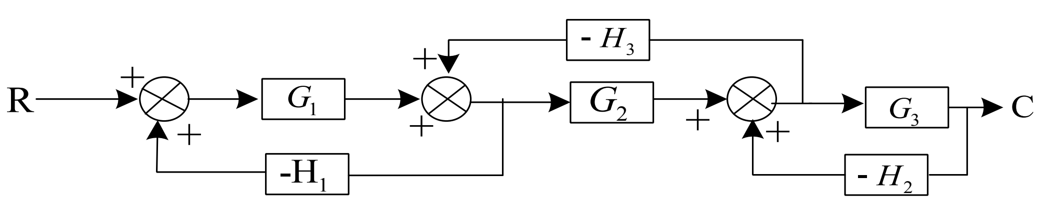
End Semester Examination, May 2019

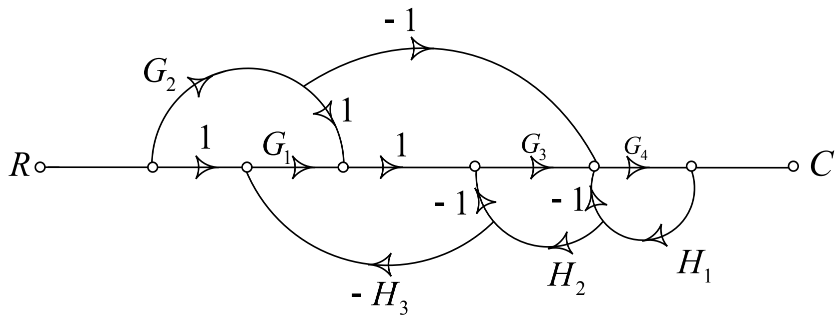
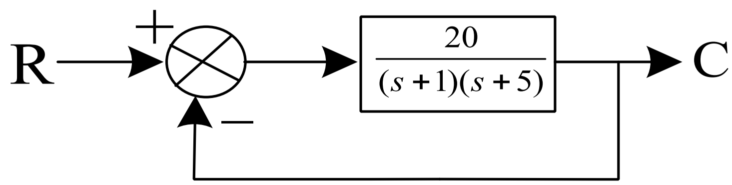
Programme Name: B. Tech-Electrical Engineering +Power system Engineering   **Semester : IV**
Course Name : Control System Engineering   **Time : 03 Hrs.**
Course Code : ECEG-2009   **Max. Marks : 100**
Nos. of page(s) : 3
Instructions: Attempt all the sections.

SECTION A

S. No.	Attempt all the questions.	**Marks**	**CO**
Q 1	How do we decide the initial slop of Bode plot? Analyze it for Type 0 and 1 order systems.	**5**	**CO3**
Q 2	Draw the mechanical circuit diagram for the system shown in figure and write the system equations.  	**5**	**CO1**
Q 3	Analyze the (i) overdamping (ii) critical damping (iii) Underdamping conditions for the second order system and also sketch the time responses.	**5**	**CO2**
Q 4	Determine the state space model for generalized second order polynomial differential equation, $$a\frac{d^2x(t)}{dt^2}+b\frac{dx(t)}{dt}+cx(t)=u(t)$$	**5**	**CO4**

SECTION B

	Attempt all the questions.		
Q 5	Determine the transfer function C/R for the block diagram given below in figure as,  	**10**	**CO1**
Q 6	Find the transfer function between C and R of the given signal flow graph shown in figure using Mason's gain formula.	**10**	**CO2**

			
Q 7	The block diagram of unity feedback of a unity feedback control system is shown in figure,  Determine the characteristics equation of the system ω_n, ξ, ω_d, t_p and M_P. The time at which the first undershoot occurs, the time period of oscillations and the number of cycles completed before reaching the steady state.	**10**	**CO2**
Q 8	The state equations are written below- $\dot{X}_1 = x_2$ $\dot{X}_2 = x_3$ $\dot{X}_3 = -24x_1 - 26x_2 - 9x_3 + u$ Output equation as, $y = 2x_1 + x_2$ Check the controllability and observability of the system.	**10**	**CO4**
	SECTION-C		
Q 9	Design state model of the given transfer function $\frac{Y(s)}{U(s)} = \frac{1}{s^3 + 9s^2 + 26s + 24}$ Using **(a)** state block diagram approach **(b)** state signal flow graph approach	**10**	**CO4**
Q 10	**NOTE: Attempt both the parts** **(A).** Determine the transfer matrix from the matrices given below	**15+15**	**CO4+ CO3**

$$A = \begin{bmatrix} -3 & 1 \\ 0 & -1 \end{bmatrix}, \quad B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \quad C = \begin{bmatrix} 1 & 1 \end{bmatrix} \text{ and } D = 0$$

(B). Sketch the asymptotic bode plot for the transfer function given below

$$G(s)H(s) = \frac{2(s+0.5)}{s^2(s+1)(s+0.5)}$$

From the bode plot determine,

a) the phase cross over frequency
b) the gain cross over frequency
c) the gain margin
d) the phase margin

Is the system is stable?

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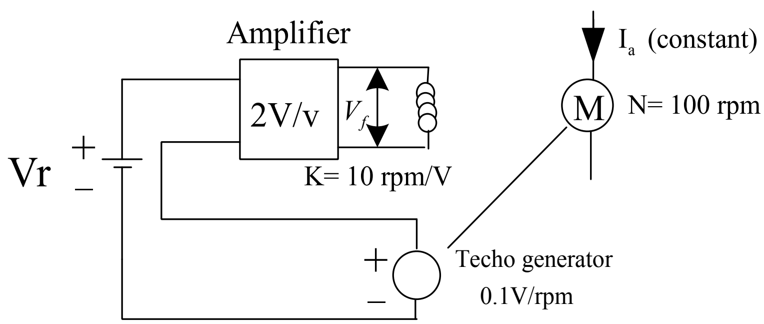
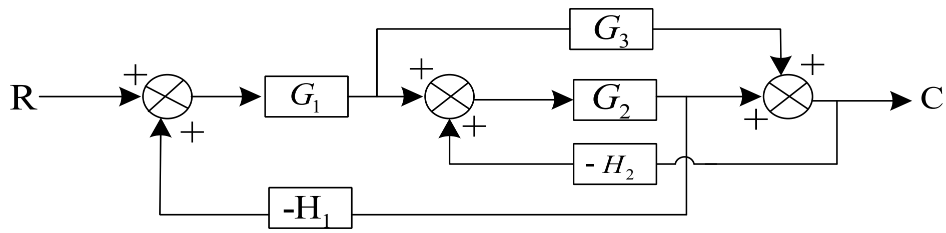
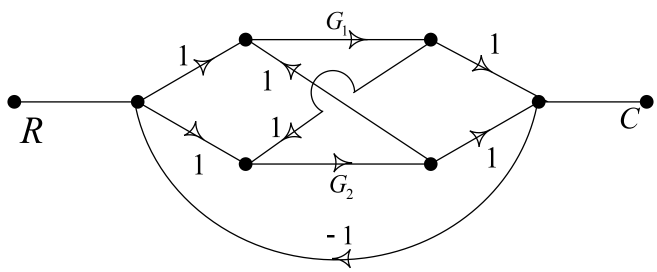
SECTION A

S. No.	Attempt all the questions.	Marks	CO
Q 1	A torque T Nm is applied to a shaft having a moment of Inertia J and coefficient of viscous friction of *f*' produces an angular shift of θ radius. Obtain the transfer function relating θ and T.	5	CO1
Q 2	The diagram given in Figure represents a closed loop control system for regulating the speed of a field controlled DC motor. Determine the value of the reference voltage if the speed is to be maintained at 100 rpm. 	5	CO2
Q 3	Examine the closed loop stability of a system whose open-loop transfer function is given below (Use Routh Hurwitz Criterion method). $$G(s)H(s) = \frac{50}{(s+1)(s+2)}$$	5	CO3
Q 4	Determine the state transition matric (STM) given that $$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$	5	CO4

SECTION B

	Attempt all the questions.		

Q 5	Determine the transfer function C/R for the block diagram given below, 	10	CO1
Q 6	Find the transfer function between C and R of the given signal flow graph using Mason's gain formula, 	10	CO2
Q 7	Sketch the root locus for the open loop transfer function of a unity feedback control system having given, $$G(S) = \frac{K}{s(s+6)^2}$$ Determine the value of centroid and the frequency at which the root locus branches cross the imaginary axis.	10	CO3
Q 8	The state equations of a control system are given below: Examine for complete state controllability, $\dot{X}_1 = -\frac{1}{T_1}x_1 + \frac{1}{T_1}u$ and $\dot{X}_2 = -\frac{1}{T_2}x_2 + \frac{1}{T_2}u$	10	CO4
	SECTION-C		
Q 9	Obtain the transfer function of the system using differential equation. Assume all initial conditions are zero. $$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 4y = \frac{du}{dt} + 3u$$ Design the state model using direct decomposition method.	15	CO4
Q 10	**NOTE: Attempt both the parts.** **(A).** Determine the transfer matrix for the system given below	10+15	CO4+ CO3

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 3 \\ -2 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} u(t) \quad \text{and} \quad y = \begin{bmatrix} 2 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

(B). The open loop transfer function of a feedback control system is given by,

$$G(s)H(s) = \frac{K}{(s+1)(2s+1)(3s+1)}$$

Sketch the bode plot and determine the value of K such that the gain margin is 20 db.