7/12/24 F.N

Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)
B.E/ B.Tech (Full Time) END SEMESTER EXAMINATIONS – NOV / DEC 2024

ELECTRONICS AND COMMUNICATION ENGINEERING
Semester – V
EC5503 – CONTROL SYSTEMS ENGINEERING

Allowed to use Polar Graph, Semi-Log Graph, and Plain Graph Paper

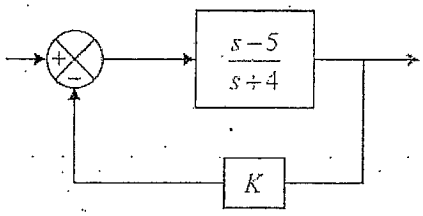
(Regulation 2019)

Time: 180 minutes | Answer ALL Questions | Max. Marks : 100

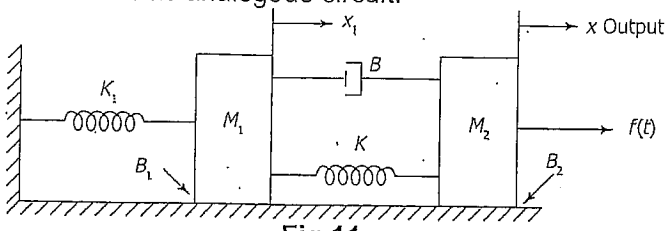
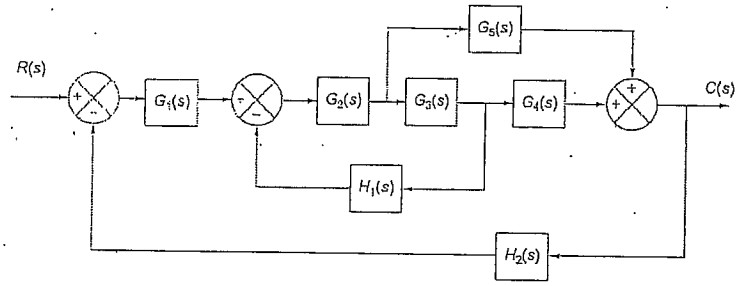
CO 1	Ability to comprehend the systems components and their representation using various control system
CO 2	Ability to compute the steady-state response using various time domain parameters for various system
CO 3	Ability to analyze the frequency response characteristics for both open loop and closed loop system
CO 4	Ability to analyze the stability of various systems using Routh Hurwitz Root locus techniques
CO 5	Ability to illustrate the state space model of various control system

BL – Bloom's Taxonomy Levels
(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)

Q. No	Questions	Marks	CO	BL
1	Define transfer function.	2	1	2
2	Draw the signal flow graph for the following set of algebraic equations. $y_2 = ay_1 - gy_3;\quad y_3 = ey_2 + cy_4;\quad y_4 = by_2 - dy_4$	2	1	2
3	How is the system classified depending on the value of the damping?	2	2	2
4	What is a dominant pole?	2	2	2
5	Why are compensators used in control systems?	2	3	2
6	How do gain and phase margins relate to system stability?	2	3	2
7	A unity feedback system has open loop poles $(-2 \pm j2)$ and 0. It has a single zero at $(-4 \pm j0)$. Find the angle of departure of the root locus branch starting from the pole $(-2 - j2)$.	2	4	3
8	For what range of K the system shown in fig.8 is asymptotically stable?  Fig.8	2	4	2
9	What are the advantages of state variable analysis?	2	5	2
10	What is meant by controllability and observability?	2	5	1

PART- B (5 x 13 = 65 Marks)

Q. No	Questions	Marks	CO	BL
11 (a)	Obtain the transfer function of the mechanical system shown in Fig.11a and draw its analogous circuit.  Fig.11a	13	1	3
	OR			
11 (b)	For the block diagram of the system shown in Fig.11b, determine the transfer function using the block diagram reduction technique.  Fig.11b	13	1	3
12 (a)	The open-loop transfer function of a system is $G(s) = \frac{K(s+2)}{s^2(s^2+7s+12)}$ and it has a feedback with a transfer function of H(s)=1. Determine the i) type of system, ii) error constant K_p, K_v, and K_a, and iii steady-state error for parabolic input.	13	2	3
	OR			
12 (b)	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.	13	2	3
13 (a)	The loop transfer function of a certain control system is given by $G(s)H(s) = \frac{50}{(s+1)(s+2)}$. Sketch the Nyquist plot and examine the stability of the system.	13	3	3
	OR			
13 (b)	The loop transfer function of a unity feedback system is given by $G(s)H(s) = \frac{(s+2)}{s^2(s+1)(2s+1)}$. Sketch the polar plot for the system.	13	3	3
14 (a)	The open-loop transfer function of a unity feedback system is given by $\frac{K}{(s+2)(s+4)(s^2+6s+25)}$. By applying the Routh-Hurwitz criterion, discuss the stability of the closed-loop system as a function of K. Determine the value of K which will cause sustained oscillations in the closed-loop system. What are the corresponding oscillation frequencies?	13	4	5
	OR			

14 (b)	A unity feedback control system has an open-loop transfer function $G(s)=\frac{K}{s(s^2+4s+13)}$. Draw the root locus as the value of K changes from 0 to ∞. Also, find the value of K and the frequency at which the root loci crosses the jω axis.	13	4	5
15 (a)	Consider the system defined by $\dot{x}=Ax+Bu$ $y=Cx$ $where, A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}, B=\begin{bmatrix}1\\0\\1\end{bmatrix}, C=\begin{bmatrix}10 & 5 & 1\end{bmatrix}$ Check the system for (i) complete state controllability and (ii) complete observability	13	5	3
	OR			
15 (b)	Obtain the transfer function for the state-space representation of a system given by $\begin{bmatrix}\dot{x}_1(t)\\ \dot{x}_2(t)\\ \dot{x}_3(t)\end{bmatrix}=\begin{bmatrix}-2 & 1 & 0\\ 0 & -3 & 1\\ -3 & -4 & -5\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\\ x_3(t)\end{bmatrix}+\begin{bmatrix}0\\0\\1\end{bmatrix}u(t)$ $y(t)=\begin{bmatrix}0 & 1 & 0\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\\ x_3(t)\end{bmatrix}$	13	5	2

PART- C (1 x 15 = 15 Marks)

Q. No	Questions	Marks	CO	BL
16	For the following transfer function draw the Bode plot and obtain the Gain crossover frequency, Phase crossover frequency, Gain Margin, and Phase Margin. $G(s)H(s)=\frac{20}{s(1+3s)(1+4s)}$.	15	5	5