Reg. No.															

Question Paper Code	13280

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Fifth Semester

Electronics and Communication Engineering

20ECEL508 - CONTROL SYSTEMS ENGINEERING

Regulations - 2020

(Use of Graph, Semilog sheet, Polar graph is permitted)

Duration: 3 Hours Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)

Answer ALL Questions

		Marks	*K – Level*	*CO*
1.	In force-voltage analogy, velocity is analogous to (a) Current (b) Charge (c) inductance () capacitance	*1*	*K1*	*CO1*
2.	The transfer function is applicable to which of the following? (a) Linear and time-invariant systems (b) Linear and time-variant systems (c) Linear systems (d) Non-linear systems	*1*	*K1*	*CO1*
3.	The difference between the reference input and the actual output is called (a) Error signal (b) Controlling signal (c) Actuating signal (d) Transfer function	*1*	*K1*	*CO1*
4.	A node having only outgoing branches. (a) Input node (b) Output node (c) Incoming node (d) Outgoing node	*1*	*K1*	*CO2*
5.	The overall transfer function of two blocks in parallel are : (a) Sum of individual gain (b) Product of individual gain (c) Difference of individual gain (d) Division of individual gain	*1*	*K1*	*CO2*
6.	Which of the following is applicable even for non-zero initial conditions? (a) Time domain analysis (b) None of the mentioned (c) Frequency response analysis (d) State space analysis	*1*	*K1*	*CO2*
7.	The system with the open loop transfer function 1/s(1+s) is: (a) Type 2 and order 1 (b) Type 1 and order 1 (c) Type 0 and order 0 (d) Type 1 and order 2	*1*	*K1*	*CO3*
8.	An increase in damping ratio (a) Decrease rise time (b) Increase rise time (c) Remains same (d) Can't be determined	*1*	*K1*	*CO3*
9.	The open-loop transfer function for unity feedback system is given by $\frac{5(1+0.1S)}{S(1+5S)(1+20S)}$ Consider the following statement: 1. The steady-state error for a step input of magnitude 10 is equal to zero. 2. The steady-state error for a ramp input of magnitude 10 is 2. 3. The steady-state error for an acceleration input of magnitude 10 is infinity. Which of the statements is correct? (a) 1 and 2. (b) 1 and 3. (c) 2 and 3. (d) 1, 2 and 3.	*1*	*K1*	*CO3*
10.	Which of the following statement is true about polar plot? (a) Polar graph sheet consists of Concentric circles and radial lines (b) The concentric circles represent magnitudes (c) Radial lines represent phase angles (d) All the mentioned are true	*1*	*K1*	*CO4*
11.	By adding a pole at the origin of s-plane, the Nyquist plot of a system will rotate by (a) 90° in anti-clockwise direction (b) 90° in clockwise direction (c) 180° in anti - clockwise direction (d) 180° in clockwise direction	*1*	*K1*	*CO4*

12. The time constant of a first order factor of a transfer function is T, the corner frequency is _____. *1 K1 CO4*
(a) 10T (b) T (c) 1/T (d) 10/T

13. Which one of the following options correctly describes the locations of the roots of the equation $s^4+s^2+1=0$ on the complex plane? *1 K1 CO5*
(a) Four left half plane (LHP) roots
(b) One right half plane (RHP) root, one LHP root and two roots on the imaginary axis
(c) Two RHP roots and two LHP roots
(d) All four roots are on the imaginary axis

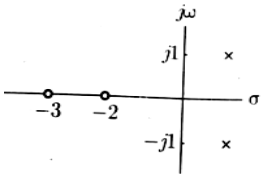
14. The Routh table of a system is shown below. The poles of system and stability of a system are respectively _____. *1 K1 CO5*

s^4	1	−5	4
s^3	0	0	0

(a) S = ±1, S = ±4 and stable (b) S = ±1, S = ±4 and unstable
(c) S = ±1, S = ±2 and stable (d) S = ±1, S = ±2 and unstable

15. How many roots with positive real parts do the equation $s^3+s^2-s+1=0$ have ? *1 K1 CO5*
(a) Zero (b) 1 (c) 2 (d) 3

16. A open-loop pole-zero plot is shown below *1 K1 CO5*



The break point is
(a) breakaway at σ = -1.30 (b) breakin at σ = -2.44
(c) breakaway at σ = -2.44 (d) breakin at σ = -1.30

17. Disadvantage of proportional controller is *1 K1 CO6*
(a) Improves steady state error (b) Provides constant steady state error
(c) Improves stability of the system (d) None of the mentioned

18. Output in three terms is produced by _____ *1 K1 CO6*
(a) P (b) PID (c) PI (d) PD

19. Lag compensation _____ the system gain at higher frequencies without reducing the system gain at lower frequencies. *1 K1 CO6*
(a) Decreases (b) Increases (c) Remains constant (d) None of the mentioned

20. A lag-lead network is essentially a *1 K1 CO6*
(a) Low pass filter (b) High pass filter (c) Band pass filter (d) Band reject filter

PART - B (10 × 2 = 20 Marks)

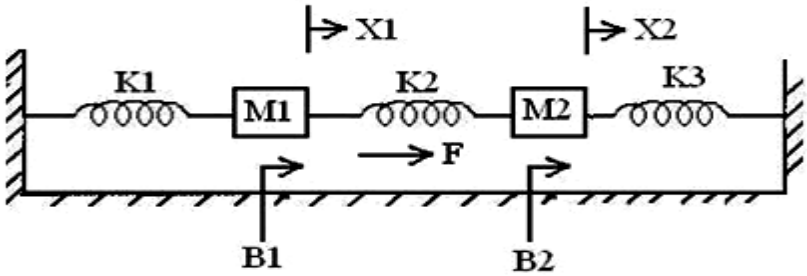
Answer ALL Questions

21. Distinguish between open loop and closed loop system. *2 K2 CO1*
22. Write the torque balance equation of ideal rotational mass element. *2 K1 CO1*
23. Define non-touching loop. *2 K1 CO2*
24. What is block diagram? What are the basic components of block diagram? *2 K1 CO2*
25. How are the systems classified depending on the value of damping ratio? *2 K2 CO3*
26. A second order system has a damping ratio 0.6 and natural frequency of oscillations is 10 rad/sec. Determine the damped frequency of oscillations. *2 K2 CO3*
27. List the main advantages of Bode plot. *2 K1 CO4*
28. Sketch the polar plot of an integral term transfer function. *2 K2 CO4*
29. State Routh's criterion for stability. *2 K1 CO5*
30. List the three types of compensators. *2 K1 CO6*

PART - C (6 × 10 = 60 Marks)

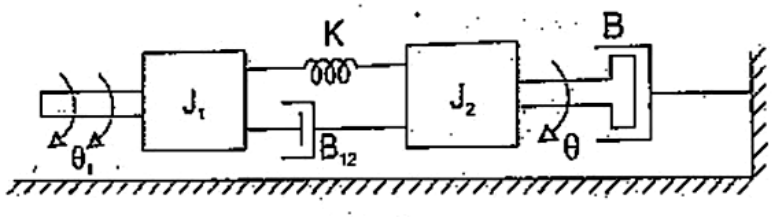
Answer ALL Questions

31. a) Draw the force voltage and force current analogous circuit of the mechanical system shown below. *10 K2 CO1*

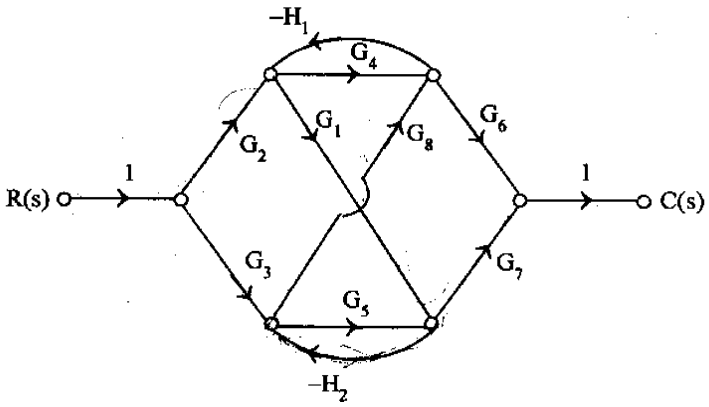


OR

b) Write down the differential equation governing the mechanical rotational system shown figure and determine the transfer function. *10 K2 CO1*



32. a) Demonstrate the usage of Mason's gain formula to derive the transfer function of the given signal flow graph. *10 K2 CO2*



OR

b) Determine the transfer function for the system which is represented in state space representation as follows *10 K2 CO2*

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

33. a) Derive the response of an underdamped second order system for unit step input. *10 K2 CO3*

OR

b) A unity feedback system has the forward path transfer function *10 K2 CO3*

$$G(S) = \frac{S(2S+1)}{S(5S+1)(1+S)}$$

When the input r(t) = 1+6t, determine the minimum value of K, So that the steady state error is less than 0.1.

34. a) The open loop transfer function of a unity feedback system is given by *10 K3 CO4*
$G(S) = \frac{1}{S(1+S)(1+2S)}$.
Sketch the polar plot and determine the gain margin and phase margin.

OR

b) Given *10 K3 CO4*
$G(S) = \frac{Ke^{-0.2S}}{S(S+2)(S+8)}$.
Draw the Bode plot and Calculate K for Phase margin equal to 45 degree.

35. a) Sketch the root locus of the system whose open loop transfer function is *10 K3 CO5*
$G(S) = \frac{K}{S(S+2)(S+4)}$.
Find the value of K so that the damping ratio of the closed loop system is 0.5.

OR

b) Determine the location of roots on S- Plane and stability for the polynomial $S^7+9S^6+24S^5+24S^4+24S^3+24S^2+23S+15=0$. *10 K3 CO5*

36. a) Describe the effect of adding PD and PID in feedback control systems. *10 K3 CO6*

OR

b) The open loop transfer function of the uncompensated system is *10 K3 CO6*

$$G(S) = \frac{5}{S(S+2)}$$

Design a suitable lag compensator for the system so that the static velocity error constant K_v is 20/sec, the phase margin is at least 55 degree and the gain margin is at least 12 db.