

KATHMANDU UNIVERSITY
End Semester Examination
July/August, 2024

Marks Scored:

Level : B.E./B.Sc.
Year : III

Course : COEG 301
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 08 AUG 2024

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option from each set of choices

1. The open loop transfer function of the system $G(s)H(s) = \frac{K}{s(s+4)(s+2)}$. The point on the imaginary axis which satisfies the magnitude and angle criteria is
 a. $\pm j2$ b. $\pm j5$ c. $\pm j2.83$ d. ± 5.83

2. The forward path transfer function of a unity feedback system is given by $G(s) = \frac{100}{s^2 + 10s + 100}$. The frequency response of this system will exhibit resonance peak at
 a. 10 rad/sec b. 8.88 rad/sec c. 7.07 rad/sec d. 5 rad/sec

3. In an open loop system, the control action _____
 a. depends on the input signal b. depends on system variable
 c. depends on the size of the system d. is independent of the output signal

4. The characteristic equation of the closed-loop system of Figure 1 is _____
 a. $s^2+11s+10 = 0$ b. $s^2+11s+130 = 0$ c. $s^2+10s+120 = 0$ d. $s^2+10s+12 = 0$

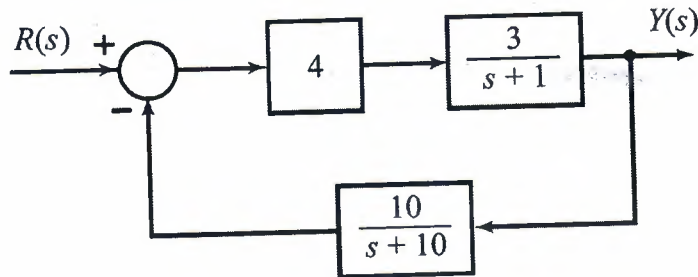


Figure 1

5. A signal which actuates the control element of a closed loop control system is the difference between the signal from _____
 a. the plant and the output signal
 b. the controller and the input signal
 c. the feedback element and the input signal
 d. the plant and the input signal

6. The number of roots which lie on the imaginary axis of the s-plane for the system with characteristics equation $s^6+2s^5+8s^4+12s^3+20s^2+16s+16 = 0$ is _____
 a. one b. two c. three d. four

14. The maximum overshoot for the time domain response shown in Figure 5 is _____ %.
- a. 2.48 b. 24 c. 48 d. 248

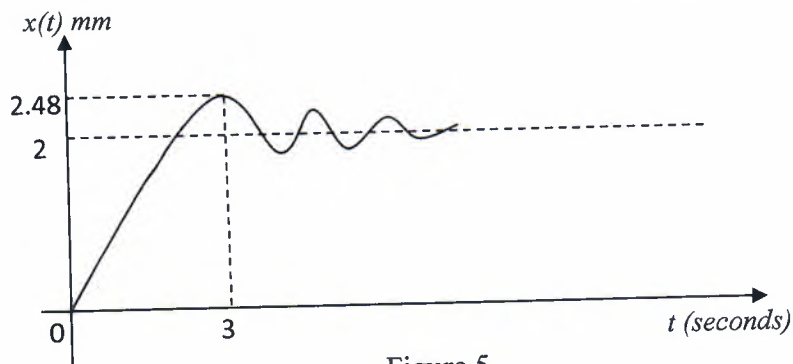


Figure 5

15. For a second-order system with the closed-loop transfer function $G(s) = 9/(s^2+4s+9)$ the settling time for 2% band, in seconds, is _____
- a. 1.5 b. 2 c. 3 d. 4

16. A system is represented by the equations
- $$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -10 & -7 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t) \text{ and } y(t) = [1 \ 0]x(t).$$

The transfer function $G(s)$ of the system is _____

a. $\frac{-1}{s^2+7s+10}$ b. $\frac{1}{s^2+7s+10}$ c. $\frac{1}{s^2-7s-10}$ d. $\frac{1}{s^2-7s+10}$

17. In the Bode plot of a unity feedback control system, the value of phase of $G(j\omega)$ at the gain cross over frequency is -125° . The phase margin of the system is _____
- a. -125° b. 125° c. -55° d. 55°

18. The transfer function $C(s)/R(s)$ for the block diagram shown in Figure 6 is _____
- a. 10 b. 18 c. 21 d. 24

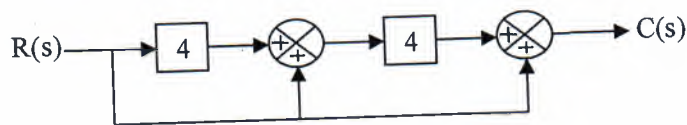


Figure 6

19. A mechanical system is described by the equation $10\ddot{y} + 5\dot{y} + 4y = u$. Considering y and \dot{y} as the state variables and u as input variable the input matrix is _____
- a. $\begin{bmatrix} 0 \\ 0.1 \end{bmatrix}$ b. $\begin{bmatrix} 0 \\ 0.2 \end{bmatrix}$ c. $\begin{bmatrix} 0 \\ 0.5 \end{bmatrix}$ d. $\begin{bmatrix} 0 \\ 0.4 \end{bmatrix}$
20. For a system with open loop transfer function $G(s)H(s) = \frac{K}{(s+1)(s+3)(s^2+4s+8)}$, choose the correct option related to the two points $s_1 = -1 + 2j$ and $s_2 = 2.345j$.
- a. s_1 lies on root locus but not s_2 b. s_2 lies on root locus but not s_1
- c. Both s_1 and s_2 lie on root locus d. s_1 and s_2 do not lie on root locus

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SECTION "B"
[5Q. × 8 = 40 marks]

Attempt ANY FIVE questions. Assume necessary data if required.

1. Determine voltage/velocity and voltage/position transfer functions for a permanent magnet DC motor with the following specifications:
Maximum speed= 500rad/sec, Maximum armature current= 2.0A,
Voltage constant (K_e)= 0.06 V-s/rad, Torque constant (K_T)= 0.06 N-m/A,
Friction Torque =0.012 N-m, Armature resistance= 1.2Ω, Armature inductance= 0.020H,
Armature inertia= $6.2 \times 10^{-4} \text{ N-m-s}^2 / \text{rad}$ and Armature viscous friction= $1 \times 10^{-4} \text{ N-m-s} / \text{rad}$. [8]
2. a. Obtain a state-space representation of the system shown in Figure 1. [5]

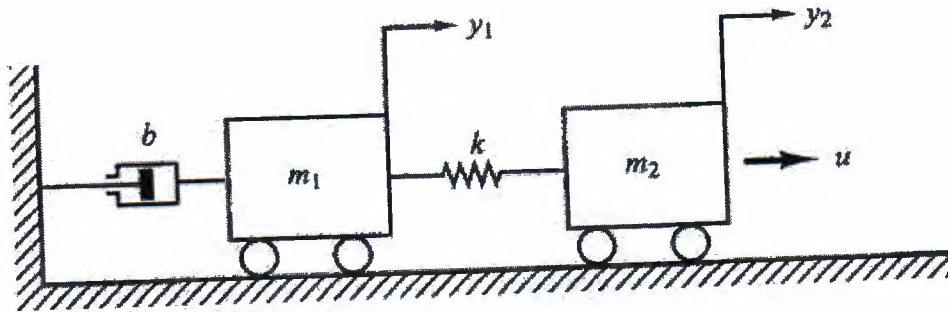


Figure 1

- b. The characteristic equation of a closed loop transfer function is given by $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Identify stability of the system using Routh Hurwitz Criterion. [3]
3. a. A unit step first-order response curve is shown in Figure 2. Find the closed-loop transfer function of this system. [3]

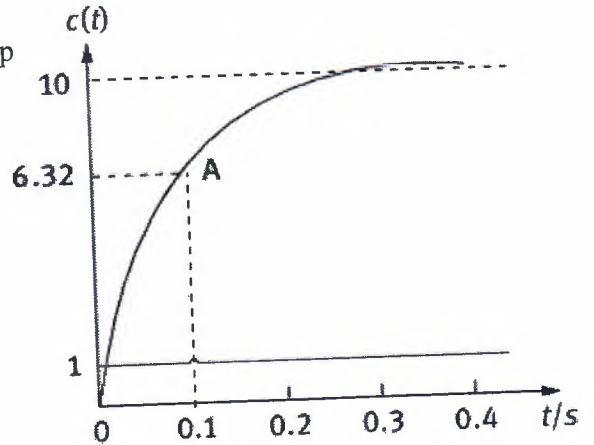


Figure 2

P.T.O.

- b. Draw the Signal Flow Graph for the system shown in **Figure 3** and obtain closed loop transfer function $C(s)/R(s)$ using Mason gain formula. [5]

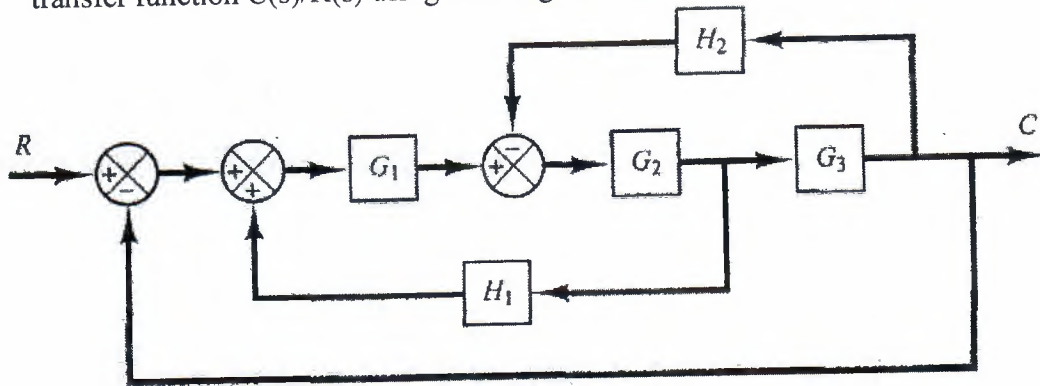


Figure 3

4. a. The open-loop transfer function of a control system is $G(s)H(s) = \frac{K}{s(s+2)}$. Determine whether $s = -1 - j$ lie on the root locus. If so, find the value of 'K'. What do the break-away and break-in point signify in root locus plot? [2+1]
- b. Plot root locus for the unity feedback system with open loop transfer function $G(s) = \frac{K}{(s+1)^4}$. [5]
5. State the significance of cut-off frequency. Consider a unity-feedback system whose open-loop transfer function is $G(s) = \frac{Ke^{-0.8s}}{s+1}$. Determine the critical value of K for stability using Nyquist plot. [2+6]
6. Consider a unity feedback system with feed forward transfer function:

$$G(s) = \frac{K}{s(0.1s+1)(0.001s+1)}$$

Design a lead compensator for the system such that phase margin is at least 35° and $K_v = 50\text{sec}^{-1}$. Use Bode plot for the design and plot the responses on a semi-log graph paper. [8]