Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 4 – EXAMINATION – SUMMER 2026

Subject Code: BE04000041 **Date: 25/05/2026**

Subject Name: Control Systems

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions:

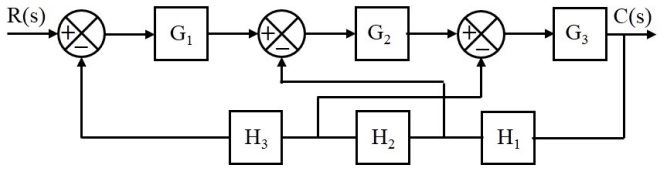
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1 **(a)** Draw the block diagram of a closed loop control system and explain its components. **03**

(b) For a unity feedback system with forward path transfer function as given below, obtain the steady state error coefficients for step, ramp and parabolic input. **04**

$$\mathbf{G(s) = \frac{10(s+1)}{s(s+2)(s+5)}}$$

(c) Obtain the transfer function for the block diagram shown in the fugure below **07**



Q.2 **(a)** Derive the expression of time response of a first order system to a unit step input. **03**

(b) For the closed loop transfer function given below, obtain the range of K for which the system is stable. **04**

$$\mathbf{\frac{C(s)}{R(s)} = \frac{K}{s(s+4)(s^2+s+1)}}$$

(c) Define (1) time response (2) rise time (3) peak time (4) delay time (5) peak overshoot (6) settling time (7) steady state error **07**

OR

Q.2 **(c)** Derive the time response expression of a second order system with closed loop transfer function as given below to a step imput. **07**

$$\mathbf{\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}}$$

Q.3 **(a)** Comments on the correlation between time and frequency domain. **03**

(b) Determine the stability of a system having characteristics equation as given below using routh's criteria and comment on the location of roots **04**

$$\mathbf{s^5 + s^4 + 24s^3 + 48s^2 - 25s - 5 = 0}$$

(c) Draw the root locus plot for a system having open loop transfer function as following **07**

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

OR

Q.3 **(a)** Discuss Nyquist stability criterion in brief. **03**

(b) Comment on the stability of a system having following characteristics equation **04**

$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$

(c) Obtain the root locus plot of a system with open loop transfer function as following **07**

$$G(s)H(s) = \frac{K}{s(s+1)(s+2)(s+4)}$$

Q.4 **(a)** Can the use of proportional controller result in zero steady state error? Why? **03**

(b) Write down the steps to construct a polar plot. **04**

(c) Obtain gain margin and phase margin for a system with following open loop transfer function. Also comment on the stability. **07**

$$G(s) = \frac{800(s+2)}{s^2(s+10)(s+40)}$$

OR

Q.4 **(a)** What is a controller? Why there is a need of a controller in a closed loop control system? **03**

(b) Define (1)gain margin (2)phase margin (3)gain crossover frequency (4)phase crossover frequency **04**

(c) A unity gain feedback system has forward path transfer function as following, obtain gain margin, phase margin and comment on the stability. **07**

$$G(s) = \frac{80}{s(s+2)(s+20)}$$

Q.5 **(a)** Write and prove any three property of state transition matrix. **03**

(b) Write the standard transfer function of a phase lag network and draw it's bode plot. **04**

(c) Obtain the state transition matrix for the system described by following state model **07**

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u,\ y = \begin{bmatrix} 1 & -1 \end{bmatrix} x$$

OR

Q.5 **(a)** Define (1) state variable (2) state vector (3) state space **03**

(b) Classify the compensation techniques and explain any one in brief. **04**

(c) For the given state model obtain the transfer function. **07**

$$\dot{x} = \begin{bmatrix} -2 & -3 \\ 4 & 2 \end{bmatrix} x + \begin{bmatrix} 3 \\ 5 \end{bmatrix} u,\ y = \begin{bmatrix} 1 & 1 \end{bmatrix} x$$

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