



B.E/B.TECH DEGREE EXAMINATIONS: APRIL / MAY 2024

(Regulation 2018)

Fifth Semester

ELECTRICAL AND ELECTRONICS ENGINEERING

U18EEI5203: Control Systems

COURSE OUTCOMES

- CO1:** Derive the transfer function model of electromechanical systems.
CO2: Analyse the system response in time and frequency domains.
CO3: Analyse system stability in time and frequency domain.
CO4: Construct the state space model of Linear systems.
CO5: Identify and measure Electrical and Non-Electrical quantities using appropriate instruments.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 2 = 20 Marks)

(Answer not more than 40 words)

- | | | |
|---|-----|-------------------|
| 1. Draw the block diagram of a closed loop feedback control system. | CO1 | [K ₂] |
| 2. Recall Mason's gain formula. | CO1 | [K ₁] |
| 3. Name the type of signals used in time response analysis. | CO2 | [K ₁] |
| 4. Define rise time for under-damped systems and over-damped systems. | CO2 | [K ₁] |
| 5. List the frequency domain specifications. | CO2 | [K ₂] |
| 6. Define Phase margin and Gain margin. | CO2 | [K ₁] |
| 7. Recall the two conditions for a liner time invariant system to be stable. | CO3 | [K ₃] |
| 8. Recall the argument (w.r.t no.of encirclements) used in Nyquist stability criterion. | CO3 | [K ₁] |
| 9. Summarise the conditions for selecting the state variables during state space formulation. | CO4 | [K ₂] |
| 10. Label the properties of state transition matrix. | CO4 | [K ₂] |

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. a) Compare a feedback control system with a feed forward control system. 4 CO1 [K₂]
 b) Consider the block diagram shown in Fig.1. Simplify (reduce) this block diagram using the block diagram reduction rules to obtain the transfer function. 12 CO1 [K₃]

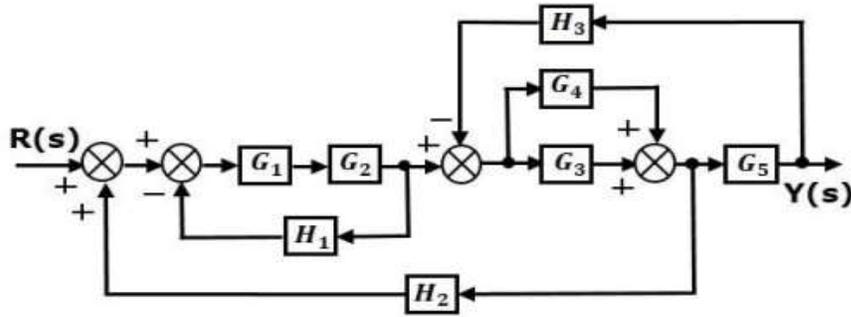


Fig.1.

12. a) Construct the signal flow graph for the following block diagram shown in Fig.2. Also identify nodes for summing and take off points. 8 CO1 [K₂]

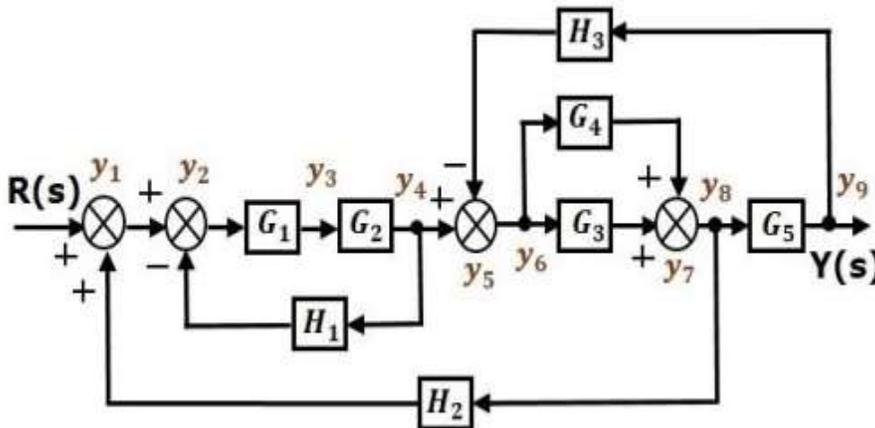


Fig.2

- b) Determine the close loop transfer function using Mason's gain formula for the system shown in Fig.3. 8 CO1 [K₆]

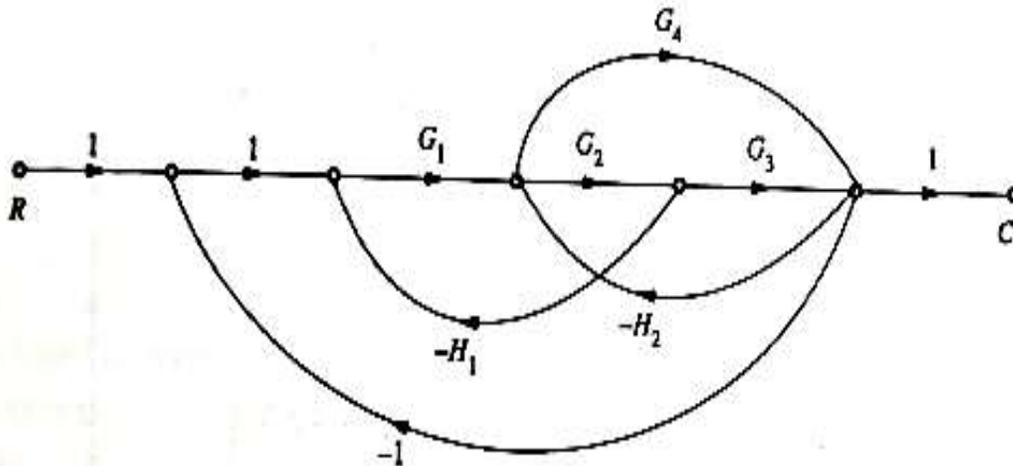


Fig.3.

13. a) Determine the steady state error for an input signal $r(t) = (5 + 2t + \frac{t^2}{2}) u(t)$ of unity negative feedback control system with

$$G(s) = \frac{5(s+4)}{s^2 (s+1) (s+20)}$$

8 CO2 [K₅]

- b) The response of a feedback system to a step input is $c(t) = (1+0.2e^{-60t} + 1.2e^{-10t})$
- Obtain the expression for the close loop transfer function
 - Determine the un-damped natural frequency and damping ratio of the system.

8 CO2 [K₅]

14. a) The specification given on a certain second order feedback control system is that the overshoot of the step response should not exceed 25%. Calculate the limiting values for the damping ratio (δ), peak resonance M_r and resonant frequency when $\omega_n = 10$ rad / sec.

4 CO3 [K₅]

- b) Explain the procedure to construct Bode plot and also illustrate how to find the Gain Margin and Phase Margin from bode graph(show as example) to understand stable and unstable status of system.

12 CO3 [K₃]

15. a) Using Routh-Harwitz criteria, examine the stability of the continuous system having the characteristic polynomial of a third order system is given below and interpret on the placement of roots from result.

$$s^3 + s^2 + 2s + 24 = 0$$

4 CO3 [K₄]

- b) Construct the root locus as the value of k varies from zero to infinity for the open loop transfer function of a unity negative feedback system is given by

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

12 CO3 [K₃]

Also comment on the value of k at any point of locus.

16. a) Determine the state transition matrix for the matrix A given below.

8 CO4 [K₅]

$$A = \begin{bmatrix} 5 & 0 \\ 0 & -10 \end{bmatrix}$$

- b) Consider the following state equations and determine the controllable canonical form.

8 CO4 [K₅]

$$\dot{x}_1 = x_2(t),$$

$$\dot{x}_2 = x_3(t),$$

$$\dot{x}_3 = -6x_1(t) - 11x_2(t) - 6x_3(t) + 6u(t),$$

$$y = x_1(t),$$
