Reg. No. : | | | | | | | | | | | |

Question Paper Code : 81288

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2025.

Fifth Semester

Electrical and Electronics Engineering

EE 3503 — CONTROL SYSTEMS

(Regulations 2021)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Compare the performance of open-loop and closed-loop systems in terms of accuracy, stability, and disturbance rejection.

2. State the advantages of signal flow graphs over block diagrams.

3. Consider two systems are given with 0.5 and 0.9 damping ratios, determine which has better performance based on time domain criteria.

4. What is a pole and zero in a transfer function?

5. Define gain margin and phase margin with respect to Bode plot.

6. State Nyquist stability criterion.

7. List the properties of the state transition matrix $\Phi(t)$.

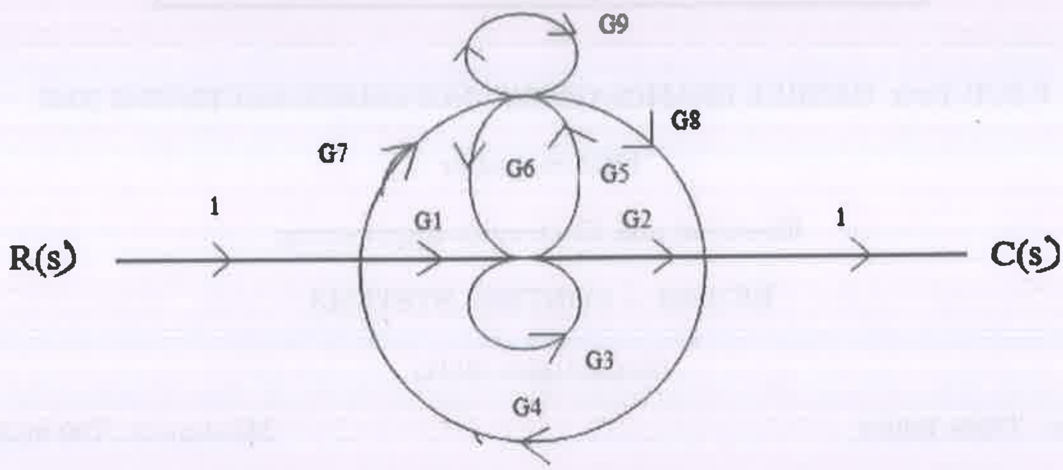
8. Justify the use of canonical forms in state-space representation.

9. Given a system with poor phase margin and slow response, suggest a suitable compensator.

10. Write the general PID controller transfer function.

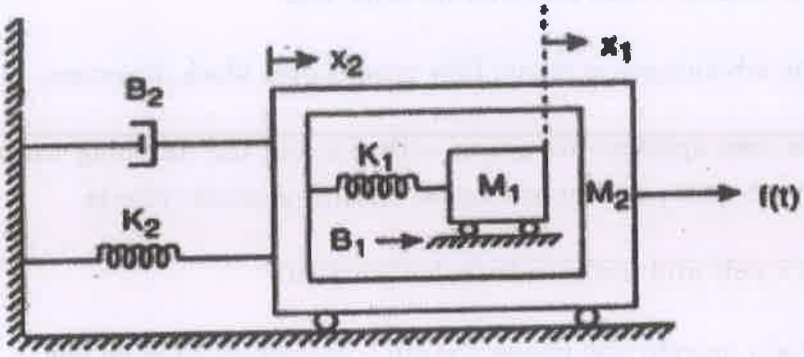
PART B — (5 × 13 = 65 marks)

11. (a) Analyze a given signal flow graph and obtain the overall transfer function C(s)/R(s).



Or

(b) Formulate the transfer function model of the given mechanical system shown below.



12. (a) (i) Explain how Routh array determines system stability. (5)

(ii) Apply the Routh-Hurwitz criterion and determine the stability of a given characteristic equation $P(s) = s^4 + 2s^3 + 3s^2 + 4s + 5$. (8)

Or

(b) Analyze how a decrease in damping ratio affects system oscillations and overshoot.

13. (a) (i) With the help of a diagram, explain the construction of a polar plot for a first-order system. (8)

(ii) Assess relationship between frequency domain specifications with domain behavior. (5)

Or

(b) Given the Bode plot of a system, $G(s) = \dfrac{10}{s(s+2)(s+5)}$.

Estimate the gain crossover and phase crossover frequencies.

14. (a) Derive the state-space model from the given differential equation:

$$\ddot{y} = 5\dot{y} + 6y = u(t)$$

Or

(b) A time-varying system is represented as:

$$A = \begin{bmatrix} 2 & 1 & 0 \\ 0 & 2 & 1 \\ 0 & 0 & 2 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

Examine whether is it Controllable and justify your answer.

15. (a) Explain how PID control laws can be decomposed into equivalent state feedback terms.

Or

(b) Describe how the ultimate gain and period are determined in Ziegler-Nichols method.

PART C — (1 × 15 = 15 marks)

16. (a) Sketch the root locus after adding a zero at $s = -1$ to the system

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

and indicate key features.

Or

(b) A system has poor phase margin. Design a lead compensator to improve the phase margin to at least 50° using Bode plot techniques.

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

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