

Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017

Course Code: AE301

Course Name: CONTROL SYSTEM(AE)

Max. Marks: 100

Duration: 3 Hours

Graph sheets and semi log sheets to be supplied.

PART A

Answer any two full questions, each carries 15 marks.

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|---|--|-------|
| | | Marks |
| 1 | a) Why transfer function approach need zero initial condition? | (3) |
| | b) Write any 2 advantages and any 2 disadvantages of closed loop control systems. | (2) |
| | c) Obtain the overall transfer function $\frac{C}{R}$ from the signal flow graph shown in fig. 1 | (10) |

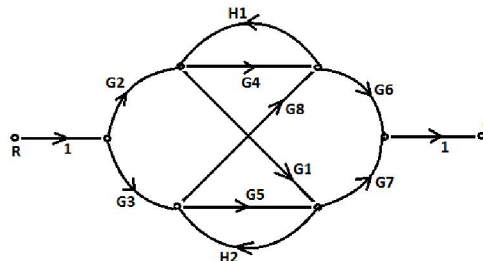
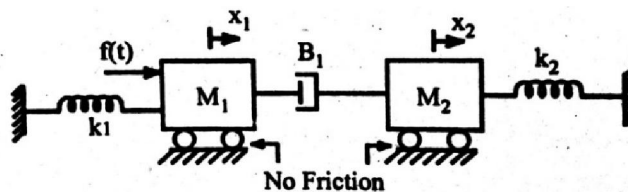


Fig. 1

- | | | |
|---|---|------|
| 2 | a) The closed loop transfer function of a second order system is given by $\frac{200}{s^2+20s+200}$. Determine the damping ratio and natural frequency of oscillation | (3) |
| | b) What is the difference between order and type of a system? | (2) |
| | c) Evaluate the static error constants for a unity feedback system having a forward path transfer function $G(s) = \frac{50}{s(s+10)}$. Estimate the steady state errors of the system for the input $r(t)$ given by $r(t) = 1 + 2t + t^2$ | (10) |
| 3 | a) Obtain the differential equations of mechanical system and hence draw the electrical analogous circuit based on force current analogy. | (8) |



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|----|---|-----|
| b) | The open loop transfer function of a unity feedback control system is given by $G(s) = \frac{K}{s(ST+1)}$ where K and T are positive constants. By what factor should the | (7) |
|----|---|-----|

amplifier gain be reduced so that the peak overshoot of unit step response of the system is reduced from 75% to 25%?

PART B

Answer any two full questions, each carries 15 marks.

- 4 a) For a unity feedback system, the open loop transfer function is given by (10)

$$G(s) = \frac{K}{s(s^2+6s+10)}$$

Sketch the root locus for $0 \leq K \leq \infty$

- b) Explain BIBO stability (2)

- c) Find the value of K for which the unity feedback system $G(s) = \frac{k}{s(s+2)(s+4)}$ cross (3)
the imaginary axis

- 5 a) Construct the Bode plot for unity feedback control system with $G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$. Find its gain margin and phase margin. (10)

- b) Explain Nyquist stability criterion. What is Nyquist Contour? (2)

- c) Explain minimum and non-minimum phase system (3)

- 6 a) The open loop transfer function of a unity feedback control system is given by (7)

$G(s) = \frac{K}{s(s+2)(s+4)(s^2+6s+25)}$. By applying the Routh criterion, discuss the stability of the closed loop system as a function of K. Determine the value of K which will cause sustained oscillations in the closed loop system. What are the corresponding oscillating frequencies?

- b) For the given system $G(s) = \frac{K}{s(1+0.5s)(1+4s)}$; sketch the Nyquist plot and (8)
determine the value of K so that (i) Gain margin is 20db and (ii) phase margin is 30° .

PART C

Answer any two full questions, each carries 20 marks.

- 7 a) Derive the state space model of armature controlled dc motor. (8)

- b) Compute the transfer function of system represented by (8)

$$\dot{X} = \begin{bmatrix} -2 & -2 \\ 4 & -8 \end{bmatrix} X + \begin{bmatrix} 1 \\ 1 \end{bmatrix} U; \quad Y = [1 \quad 0] U$$

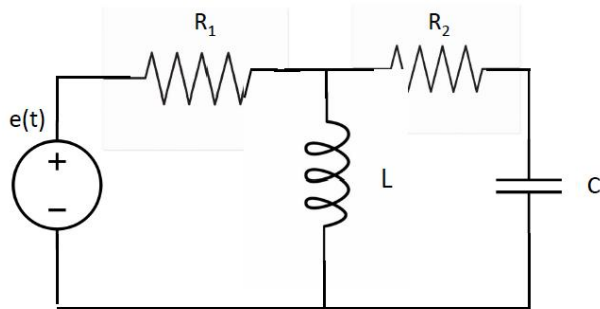
- c) What is a state variable? What are the main advantages of state space representation? (4)

- 8 a) For a system represented by state equation $\dot{X}(t) = A X(t)$. The response is (12)

$$X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix} \text{ and } X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}.$$

Determine the system matrix A and the state transition matrix.

- b) Obtain the state model of the electrical network shown. (8)



- 9 a) Examine the controllability and observability of the given system $\dot{X} = AX + BU$; (10)

$$Y = CX. \text{ Where } A = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 1 \\ 0 & 0 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, C^T = \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix}$$

- b) A feedback system is characterized by the closed loop transfer function (10)

$$T(s) = \frac{s^2 + 3s + 3}{s^3 + 2s^2 + 3s + 1}$$

Construct a canonical state model of the system.
