Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: AE301

Course Name: CONTROL SYSTEM

Max. Marks: 100 Duration: 3 Hours

Provide one graph sheet and one semi-log sheet.

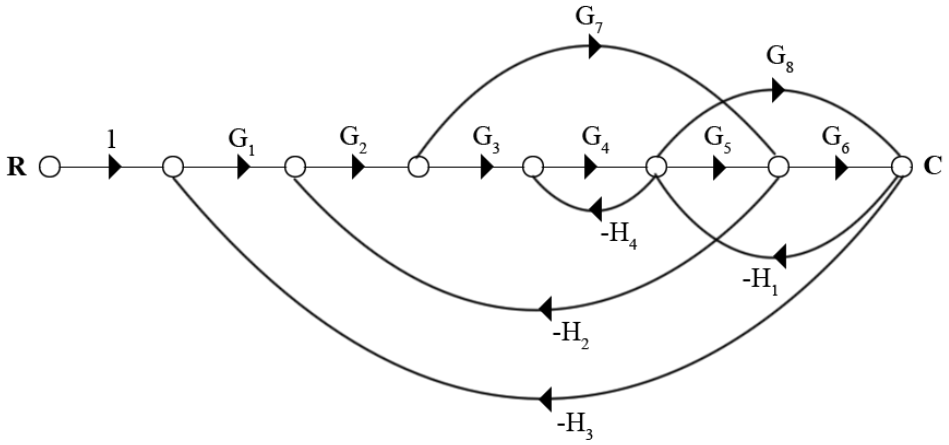
PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain Mason's Gain formula. (3)

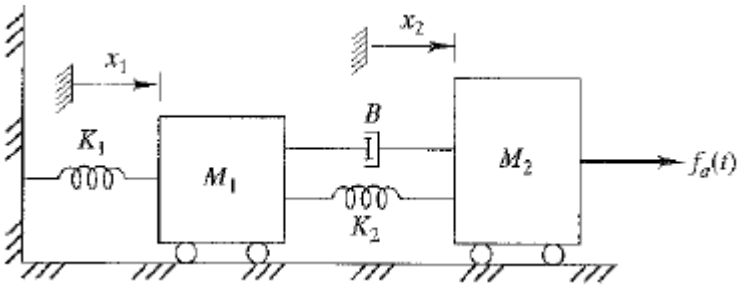
b) Differentiate Open-Loop Control Systems and Closed-Loop Control Systems with examples. (4)

c) Obtain the overall transfer function from the signal flow graph shown in figure. (8)



2 a) What is order and type of a system? (2)

b) Obtain the differential equations of mechanical system shown in figure and find transfer function of the system. (8)



c) Derive an expression for steady state error of a unity negative feedback system. (5)

3 a) For a unity feedback control system, the open loop transfer function (4)

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

Find the position, velocity and acceleration error constants.

b) Obtain the response of unity feedback system whose open loop transfer function is (6)

$$G(s) = \frac{4}{s(s+5)}$$

and when the input is unit step.

c) Derive the expression for c(t), the time response of an undamped second order control system. (5)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Explain BIBO stability. (2)

b) Explain Routh Hurwitz Criterion. (4)

c) Construct Routh array and determine the stability of the system whose characteristic equation is $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Also determine the number of roots lying on right half of s plane, left half of s plane and on imaginary axis. (9)

5 a) Explain frequency domain specifications. (5)

b) Sketch the root locus of a unity feedback system whose open-loop transfer function is (10)

$$G(s) = \frac{K(s+9)}{s(s^2+4s+11)}$$

6 a) The open loop transfer function of a system is (5)

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

Determine the value of K so that the gain margin is 6dB.

b) Plot the Bode diagram for the following transfer function. (8)

$$G(s) = \frac{10}{s(1+0.4s)(1+0.1s)}$$

c) Explain the concept of encircled and enclosed. (2)

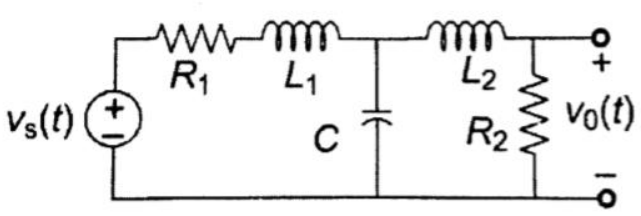
PART C

Answer any two full questions, each carries20 marks.

7 a) What are the drawbacks of transfer function model analysis? (4)

b) Define the following terms: i) State ii) State Vector iii) State variables (6)

c) Obtain the state model of the electrical network shown in figure. (10)



8 a) Consider the matrix $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$. Compute the state transition matrix by Laplace transform method. (8)

b) Obtain the state model of the system whose transfer function is (8)

$$\frac{Y(s)}{U(s)} = \frac{10}{s^3 + 4s^2 + 2s + 1}$$

c) Explain Bush form or Companion Form. (4)

9 a) Determine the controllability and observability of the system $\dot{X} = AX + BU$ where Y=CX (10)

$$\begin{bmatrix} \dot{x}1 \\ \dot{x}2 \\ \dot{x}3 \end{bmatrix} = \begin{bmatrix} 2 & -2 & 3 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} + \begin{bmatrix} 11 \\ 1 \\ -14 \end{bmatrix} u$$

$$y = \begin{bmatrix} -3 & 5 & -2 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix}$$

b) Obtain the state transition matrix **Φ (t)** of the following system (7)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Obtain the inverse of the state transition matrix.

c) Define Controllability of LTI system. (3)

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