Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: AE301

Course Name: CONTROL SYSTEM

Max. Marks: 100 Duration: 3 Hours

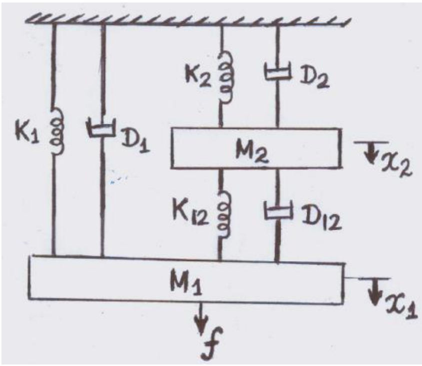
(Use appropriate graph sheets if required)

PART A

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

1 a) Compare open loop and closed loop systems. (3)

b) Obtain the differential equations governing the mechanical system shown below and draw the *force-voltage* electrical analogous circuit (8)

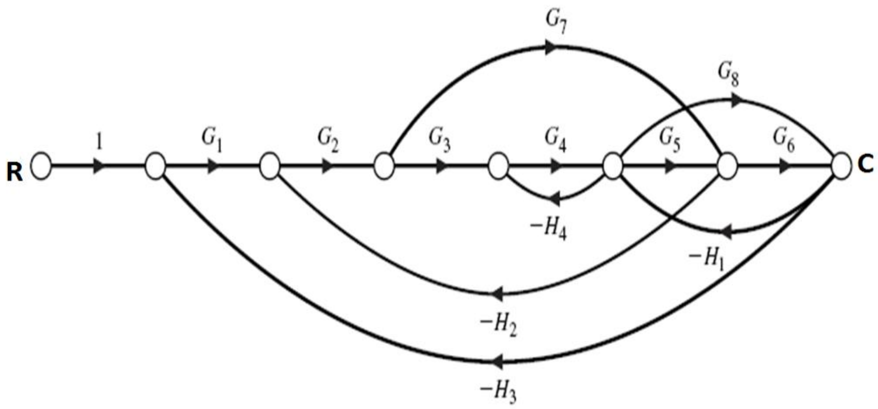


c) A unity feedback system has the following forward path transfer function. (4)

$G(s) = \frac{180}{s(s+6)}$ and $r(t) = 4t$. Determine the corresponding static error coefficient and the steady state error.

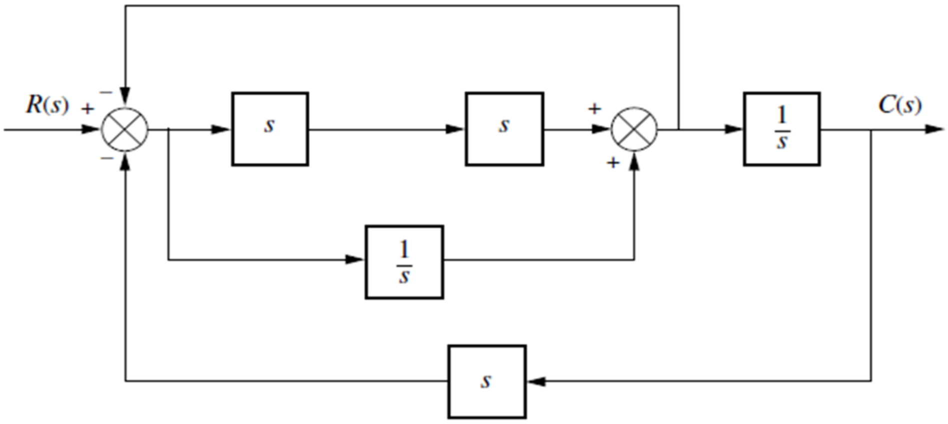
2 a) Compare any two features of transient and steady state part of the system response. (2)

b) Obtain overall transfer function for the given system using Mason's gain formula (10)



c) Define type and order of a system. Give one example. (3)

3 a) Find the transfer function of the given system using block diagram reduction method. Draw the corresponding signal flow graph also. (7)



b) A unity feedback system has the following open loop transfer function, where **K** and **T** are constants. Determine the factor by which **K** should be multiplied to reduce the overshoot from 85% to 35%. (8)

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

PART B

Answer any two full questions, each carries 15 marks.

4 a) Explain the effect of addition of zeros to the root locus and system stability. (3)

b) Given the characteristic equation of a system. Using R.H criterion, Find the location of roots in s-plane and hence comment whether the system is fully stable, unstable or conditionally stable. (6)

$$F(s) = s^4 + 2s^3 + 11s^2 + 18s + 18 = 0$$

c) sketch the polar plot for the open loop transfer function (6)

$$G(s) = \frac{8}{(s+1)(s+2)}$$

5 a) Define the terms phase margin and gain margin. What is the value of gain margin in dB for critically stable system? (3)

b) Sketch the root locus for the given open loop transfer function and find the value of K and ω for marginal stability where K>0. (*use graph sheet*).

$$G(s)H(s) = \frac{K}{s(s+2)(s+3)}$$ (12)

6 a) Differentiate minimum and non-minimum phase system. Give example. (3)

b) A unity feedback control system with given G(s), draw the Bode plot. Find the gain margin and phase margin. Also check for the stability. (*Use semi-log sheet*) (12)

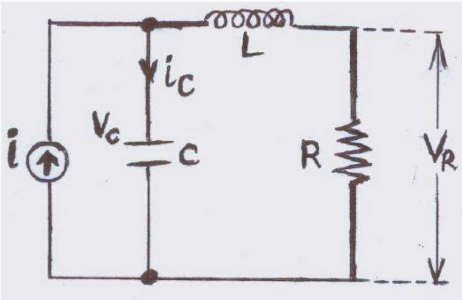
$$G(s) = \frac{5(1+2s)}{(1+4s)(1+0.25s)}$$

PART C

Answer any two full questions, each carries20 marks.

7 a) Define the terms state variable and state space. Mention any four distinct advantages of state space representation. (6)

b) Obtain the state model for the electrical network shown. (6)



c) Determine the transfer function of a system represented by (8)

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

8 a) Mention any four properties of state transition matrix. (4)

b) An LTI system is represented by the state equation $\dot{X} = A\,X + BU$, where (8)

A = $\begin{bmatrix} 0 & 1 & 2 \\ 0 & 3 & 4 \\ 1 & 3 & 2 \end{bmatrix}$ and B = $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$, find the characteristic equation and the poles of the system. Comment on the system stability.

c) Mention the advantage of diagonalization of system matrix in state space analysis. Discuss the methods for diagonalization. Find the eigen values of matrix$A = \begin{bmatrix} 3 & -2 \\ -1 & 2 \end{bmatrix}$ and also diagonalize the given matrix without calculating eigenvectors. (8)

9 a) Define controllability and observability of a system. (2)

b) Express the following transfer function in controllable canonical form. Draw the corresponding signal flow graph also.

$$\frac{Y(s)}{U(s)} = \frac{5s^2 + 2s + 6}{s^3 + 7s^2 + 11s + 8}$$ (10)

c) Check the controllability and observability of the following system.

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

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