Reg No.:_______________ Name:___________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: AE301

Course Name: CONTROL SYSTEM

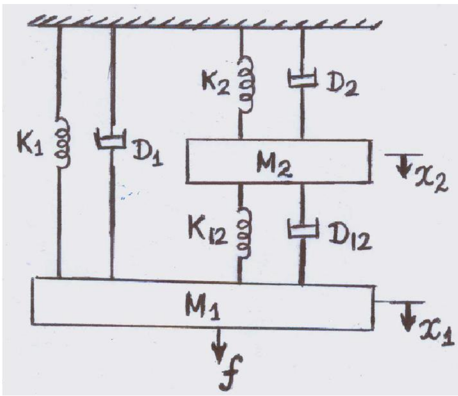
Max. Marks: 100 Duration: 3 Hours

PART A

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

1 a) Distinguish between stochastic and deterministic systems. (2)

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



c) For the unity feedback system with the following open loop transfer function, determine the type of the system and steady state error for the input (5)

$r(t) = 1 + 3t + \frac{t^2}{2}$ where $G(s) = \frac{20(s+2)}{s^2(s+1)(s+5)}$

2 a) Define transfer function. Establish the relationship between transfer function and impulse response of a system. (3)

b) Obtain overall transfer function for the given system using Mason's gain formula. (8)

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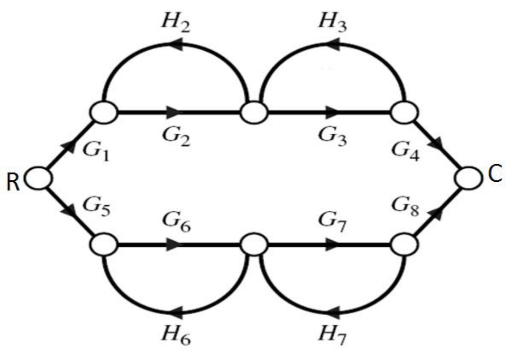
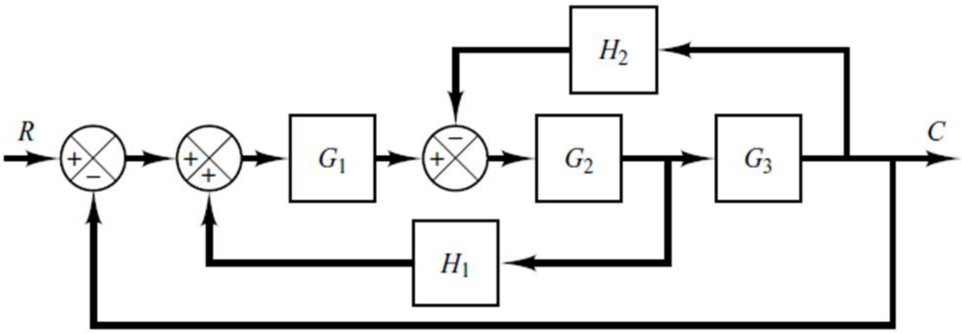


c) A unity feedback control system having the following forward path transfer function is fed by unit step function. Determine the following parameters. (4)

1) Natural frequency 2) damping ratio 3) peak time.

$$G(s) = \frac{144}{s(s+12)}$$

3 a) Find the transfer function of the given system using block diagram reduction method. Draw the corresponding signal flow graph and identify forward path gains. (10)



b) The open loop transfer function of a unity feedback control system is (5)

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

i) Determine the type and order of the system

ii) Find the minimum value of ***K*** for which the steady state error is less than or equal to 0.2 for a unit ramp input.

PART B

Answer any two full questions, each carries 15 marks.

4 a) Differentiate between absolute and relative stability. (2)

b) For a unity feedback system having the following forward transfer function, (6) determine the range of values of **K** for system stability. Also find the frequency of sustained oscillation in rad/sec.

$$G(s) = \frac{K}{s(1+0.6s)(1+0.4s)}$$

c) sketch the polar plot for the given open loop transfer function (7)

$$G(s) = \frac{14}{s(s+1)(s+2)}$$

5 a) Explain the effect of addition of poles to the root locus and system stability. (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*). (12)

$$G(s)H(s) = \frac{K}{s(s+3)(s+5)}$$

6 a) 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)

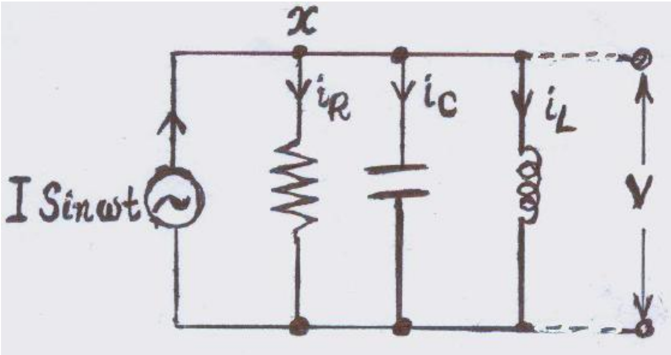
$$G(s) = \frac{40}{s(s+2)(s+5)}$$

b) What is principle of argument? State Nyquist stability criterion. (3)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Obtain the state model for the electrical network shown. (8)



b) Determine the transfer function for the system described by the following state variable model. (12)

$$\dot{X} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U; \quad Y = [\,0 \quad 1 \quad 0\,]\, X$$

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)

$A = \begin{bmatrix} -3 & 0 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$, find the state transition matrix $\phi(t)$.

c) Mention the advantage of diagonalization of system matrix in state space analysis. Discuss the methods for diagonalization. Find the eigen values of matrix $A = \begin{bmatrix} -3 & 1 \\ 1 & -3 \end{bmatrix}$ 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 observable 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.

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U; \quad Y = \begin{bmatrix} 1 & 0 \end{bmatrix} X$$ (8)

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