Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Regular and Supplementary Examination December 2020

Course Code: AE301

Course Name: CONTROL SYSTEM

Max. Marks: 100 Duration: 3 Hours

Provide one graph sheet and one semi-log sheet

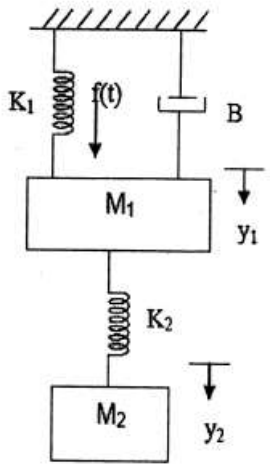
PART A

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

1 a) With the help of a diagram, define closed loop control system. (3)

b) Derive an expression for peak time of a second order system. (4)

c) Develop the differential equations governing the mechanical system shown below by drawing the free body diagrams and determine the overall transfer function. (8)

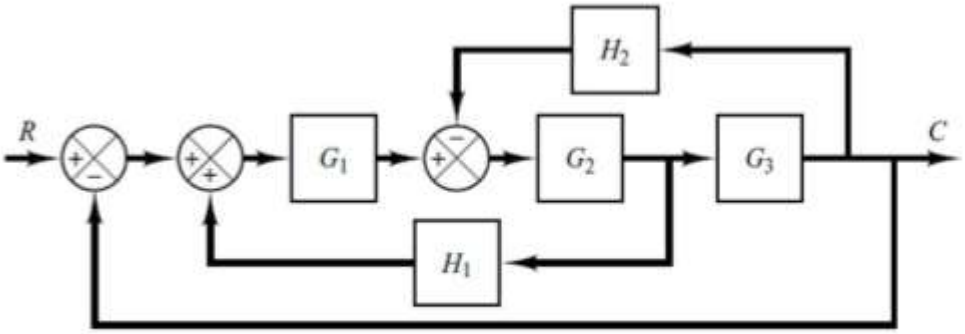


2 a) What are the properties of signal flow graph? State its advantages. (5)

b) Derive an expression for the time response of second order underdamped system. (10)

3 a) Determine the response of unity feedback system whose open loop transfer function is $G(s) = \frac{4}{s(s+5)}$ and when input is unit step. (7)

b) Find the transfer function of the given system using block diagram reduction technique. (8)



PART B

Answer any two full questions, each carries 15 marks.

4 a) Using Routh stability criterion, determine the range of K for stability of unity feedback system whose open loop transfer function is $G(s) = \frac{K}{s(s+1)(s+2)}$ (8)

b) Derive the expression for resonant peak and resonant frequency of second order system. (7)

5 a) Define the terms phase margin and gain margin. (3)

b) Sketch the root locus of the system with open loop transfer function (12)

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

6 a) What are M and N circles? (3)

b) Plot the Bode diagram for the following transfer function and find the gain margin and phase margin. (12)

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

PART C

Answer any two full questions, each carries 20 marks.

7 a) Obtain the state model for given transfer function (10)

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

b) Mention the advantage of diagonalization of system matrix in state space analysis. Discuss the methods for diagonalization. Find the eigen values of the matrix $A = [\ 3\ -2\ -1\ 2\ ]$ and also diagonalize the given matrix without calculating eigenvectors. (10)

8 a) Define the terms state variable and state space. (2)

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

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

c) Find the state transition matrix of the following LTI system (10)

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

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

b) Check the controllability and observability of the following system. (8)

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

c) Express the following transfer function in controllable canonical form. Draw the corresponding signal flow graph. (10)

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

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