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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S7 (S, FE) / S7 (PT) (S, FE) Examination December 2023 (2015 Scheme)

Course Code: EC409

Course Name: CONTROL SYSTEMS

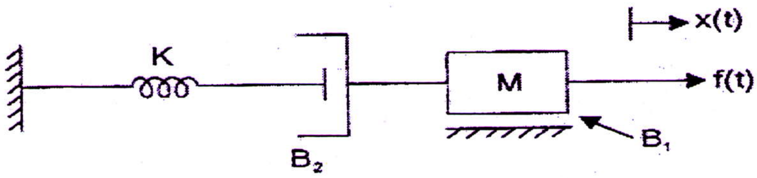
Max. Marks: 100 Duration: 3 Hours

(Graph sheet and semi- log sheets will be provided)

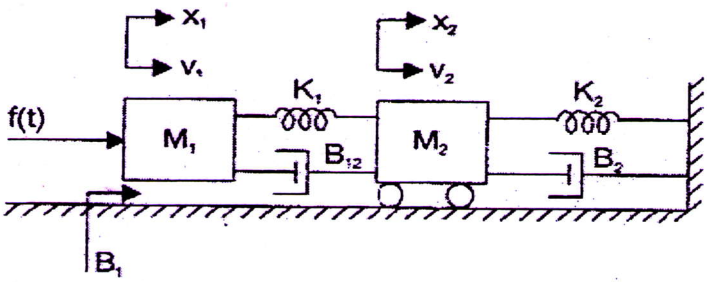
PART A

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

1 a) Write the equations of motion in S-domain for the system shown in fig. Determine the transfer function of the system (8)



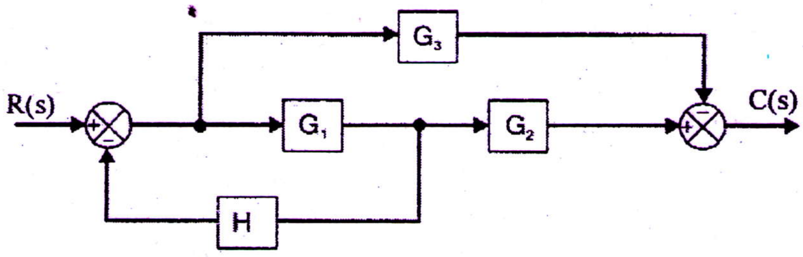
b) Write the differential equations governing the mechanical system shown in fig. Draw the force-voltage and force current electrical analogous circuits and verify by writing mesh and node equations. (7)



2 a) Obtain the response of unity feedback system whose open loop transfer function is $G(S) = \frac{4}{S(S+5)}$ and when the input is unit step. (8)

b) The unity feedback system is characterized by an open loop transfer function $G(S) = \frac{K}{S(S+10)}$. Determine the gain **K**, so that the system will have a damping ratio of **0.5** for this value of **K**. Determine peak time and percentage overshoot for a unit step input. (7)

3 a) Convert the given block diagram to signal flow graph and determine **C(S)/R(S).** (8)



b) Explain about the standard test signals? (7)

PART B

Answer any two full questions, each carries 15 marks.

4 a) 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. (8)

b) The open loop transfer function of a unity feedback system is given by **$G(S)=K(S+9)/S(S^2+4S+11)$** .Sketch the root locus of the system. (7)

5 a) Sketch Bode plot for the following transfer function and determine the system gain **K** for the gain cross over frequency to be **5** rad/sec. (10)

$$G(S) = \frac{KS^2}{(1+0.2S)(1+0.02S)}$$

b) What is lead compensator? Give an example. (5)

6 a) Explain correlation between time and frequency response. (8)

b) Explain different types of controllers employed in control system. (7)

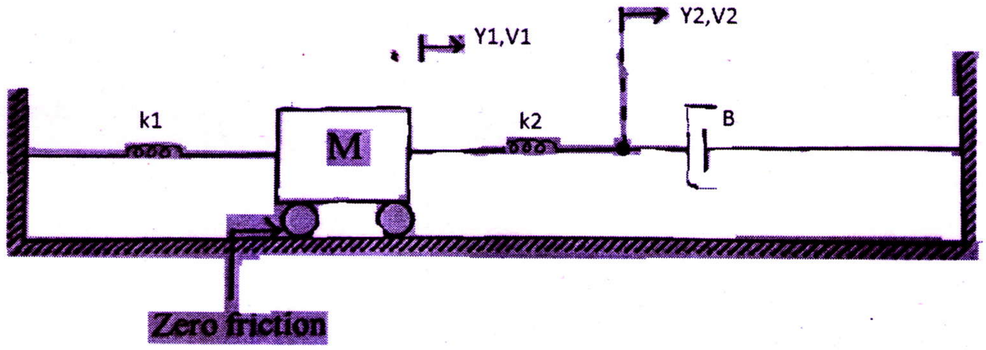
PART C

Answer any two full questions, each carries 20 marks.

7 a) Explain the properties of state transition matrix. Find state transition matrix for (10)

$$A = \begin{bmatrix} -3 & 0 \\ 0 & -2 \end{bmatrix}$$

b) Obtain the state model of the mechanical system shown in fig by choosing a minimum of three state variables. (10)



8 a) Check for stability of sampled data control system represented by **F (z) =Z⁴-1.8Z³+1.09Z²-0.26Z+0.025=0**. Use Jury's test. (10)

b) Solve the difference equation **c(k+2)+3c(k+1)+2c(k)=u(k)**,where **c(0)=1; c(1)= -3; c(k)=0** for **k<0**.Determine Z transform. (10)

9 a) Consider the system with state equation (10)

$$\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\\ \dot{X}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}X_1\\ X_2\\ X_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}U$$

Estimate state controllability by Gilbert Test.

b) The state model in the matrix form is shown below. Check the system controllability and observability. (10)

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & 0 & 1\\ -2 & -3 & 0\\ 0 & 2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 2\\ 0\end{bmatrix}u \quad ; \quad y = \begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

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