Question Paper

Exam Date & Time: 30-Apr-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

FOURTH SEMESTER B.TECH END SEMESTER EXAMINATIONS, APR/MAY 2024

INTRODUCTION TO CONTROL THEORY [ICE 2228]

Marks: 50 **Duration: 180 mins.**

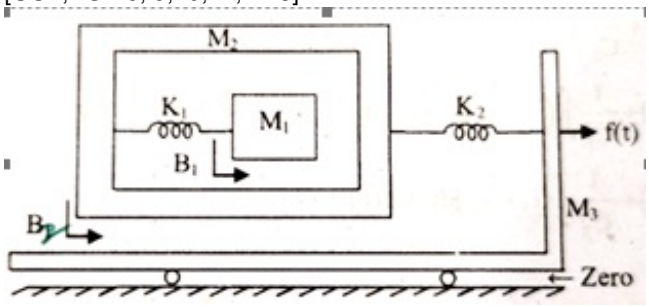
A

Answer all the questions.

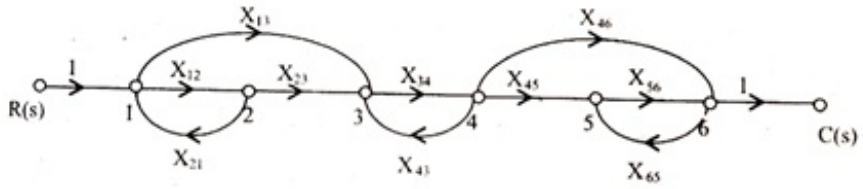
Instructions to Candidates: Missing data may be suitably assumed

1) Bring out the differential equations that best describe the dynamics of the system and using F-V analogy, draw the electrical analogous systems for the mechanical system shown in Fig. Q1A [CO1,PO1-6, 9,10,12, BL3] (5)

A)



B) For the given signal flow graph shown in Fig.Q1B, find the two non-touching loop gains and three non-touching loop gains and obtain overall transfer function. [CO1,PO1-6, 9,10,12, BL3] (3)



C) For a mechanical rotational system, write the expression of reaction torque due to inertia and damper with terminal diagrams. [CO1,PO1-6, 9,10,12, BL2] (2)

2) Derive for the final closed loop expression of a second order underdamped system for a unit step input. [CO2,PO1-6, 9,10,12, BL3] (5)

A)

B) A servo system for position control has the closed loop transfer function $G(s) = \frac{6}{s^2 + 2s + 6}$. (3)

Find the percentage overshoot if the input is suddenly moved to a new position. [CO2,PO1-6, 9,10,12, BL3]

C) Derive for the settling time final derivation from the closed loop expression of an underdamped second order system. [CO2,PO1-6, 9,10,12, BL3] (2)

3) Draw the Bode diagram for the system with transfer function $G(s) = \frac{10}{s(1+0.5s)(1+0.1s)}$ (6)

A)

. Find i) Gain cross over frequency ii) Phase cross over frequency iii) Gain margin iv) Phase margin.

[CO4,PO1-6, 9,10,12, BL4]

B) Sketch the polar plot for $G(s)=\frac{1}{s(1+s)(1+2s)}$ and find the gain margin and phase margin from the graph. [CO4,PO1-6, 9,10,12, BL4] (4)

4) A unity feedback control system has an open loop transfer function $G(s)=\frac{k}{s(s^2+4s+13)}$. (6)

A)

Sketch the root locus plot and determine the following
1. Centroid, no. of asymtotes and angle of asymtotes.
2. Angle of departure and root loci
3. Break away points(if any), Value of K and the frequency at which root loci crosses jw axis.
[CO3,PO1-6, 9,10,12, BL4]

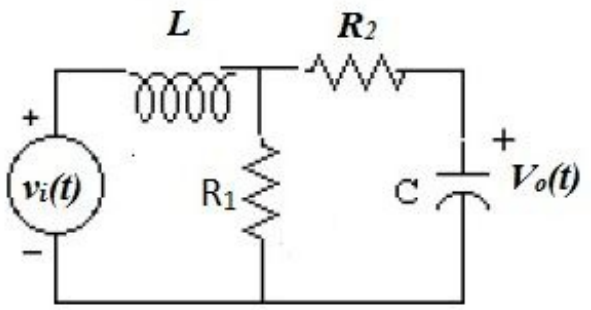
B) Comment on the stability of the system using Routh Hurwitz Criteria (4)

i. $s^5+2s^4+3s^3+6s^2+5s+3=0$

ii. An open loop transfer function $G(s)H(s)=\frac{k(s+1)}{(s+2)(s^2+4s+5)}$, find the range of K using Routh Hurwitz Criteria for stabilizing the system. [CO3,PO1-6, 9,10,12, BL3]

5) Derive a state model for the electrical system shown in Fig. Q5A. [CO5,PO1-6, 9,10,12, BL3] (3)

A)



B) Derive an expression for converting a state model to transfer function. Hence comment on assessing stability of a system represented in state space model. [CO5,PO1-6, 9,10,12, BL2] (3)

C) A system is described by the state model (4)

$$A=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix};\ B=\begin{bmatrix}0\\ 1\end{bmatrix};\ C=\begin{bmatrix}1 & 0\end{bmatrix};\ D=0$$

and initial condition $x(0)=\begin{bmatrix}0\\ 1\end{bmatrix}$. Solve for y(t) when the system is subjected to an unit step input.

[CO5,PO1-6, 9,10,12, BL3]

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