Exam Date & Time: 14-Jun-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

MIT MPL BTech IV - End Semester Makeup Examination - June 2024

INTRODUCTION TO CONTROL THEORY [ICE 2228]

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

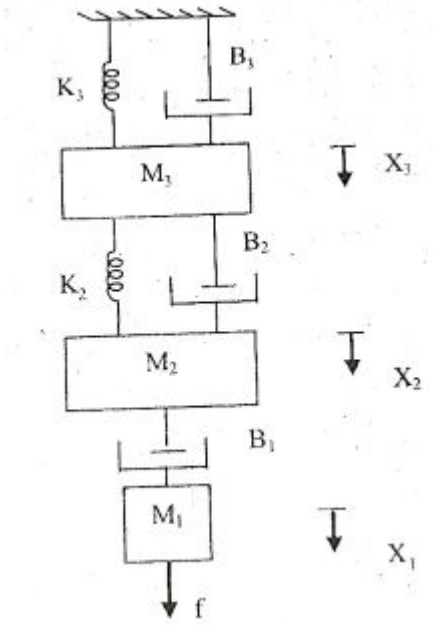
Descriptive

Answer all the questions.

* Semi-Log sheets will be provided

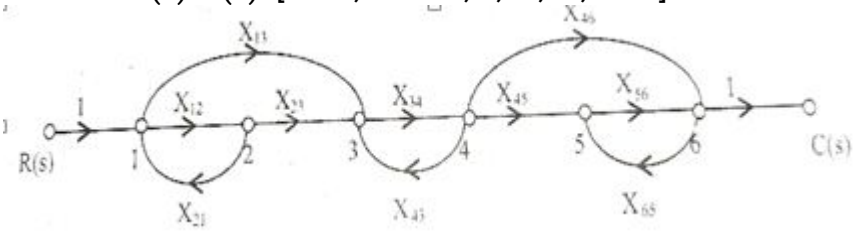
1) Write the equations that best describe the dynamics of the system. Also, draw the electrical analogous circuit of the system as shown in Figure below using F-V analogy. [CO-1, PO1-6, 9,10,12, BL-3]

A)



(5)

B) For the given signal flow graph shown in Figure below, find the over all transfer function C(s)/R(s). [CO-1, PO-1-6, 9,10,12, BL-3]



(3)

C) For a mechanical rotational system, write the expression of reaction torque due to inertia element and damper element with terminal diagrams. [CO-1, PO-1-6, 9,10,12, BL-2] (2)

2) A unity feedback system is characterized by an open loop transfer function $G(s)=\frac{K}{s(s+20)}$.

A) Determine the gain 'K' so that the system has a damping ratio of 0.6 for this value of K. Calculate settling time and peak overshoot for the unit step input. [CO-1, PO-1-6, 9,10,12, BL-2] (5)

B) For the different values of damping ratio, plot the respective pole locations and corresponding step response. [CO-2, PO-1-6, 9,10,12, BL-2] (3)

C) Derive final expression for rise time from the closed loop expression of an underdamped second order system, with step input. [CO-2, PO-1-6, 9,10,12, BL-2] (2)

3) A) Draw the Bode diagram for the system with transfer function $G(s)=\frac{100}{s^2+4s+25}$. Find i) Gain cross over frequency
ii) Phase Margin. [CO-4, PO-1-6, 9,10,12, BL-4] (6)

B) A unity feedback system has the following forward transfer function $G(s)=\frac{K}{s(s+2)(s+2.5)}$. An input $r(t)=6+8t$ is applied to the system. Determine the value of K to achieve the steady state error equal or less than 1.6 with this input. [CO-2, PO-1-6, 9,10,12, BL-3] (4)

4) A) Sketch the polar plot for the given transfer function $G(s)=\frac{3}{s(s+1)(s+4)}$ and find the Gain Margin and Phase Margin. [CO-3, PO-1-6, 9,10,12, BL-4] (6)

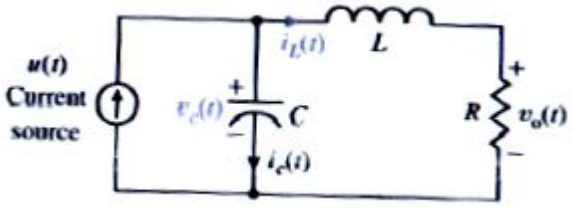
B) Comment on the stability of the system using Routh Hurwitz Criteria [CO-3, PO-1-6, 9,10,12, BL-3]

i) $s^5+2s^4+6s^3+12s^2+8s+16=0$

ii) $s^5+2s^4+24s^3+48s^2-25s-50=0$ (4)

5) Derive a state model for the electrical system as shown in Figure below. Consider Vo(t) as the output of the system
Fig Q 5A. [CO-5, PO-1-6, 9,10,12, BL-3]

A)



(3)

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B) Obtain the state model for the system whose transfer function is given by

$$\frac{Y(s)}{U(s)} = \frac{3s^2 + 18s + 26}{s^3 + 9s^2 + 26s + 24} \quad (3)$$

, with the helpf of signal flow graph. [CO-5, PO-1-6, 9,10,12, BL-3]

C) A system is described by the state model

$$A = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix}; B = \begin{bmatrix} 4 \\ -5 \end{bmatrix}; \; C = \begin{bmatrix} 1 & -1 \end{bmatrix}; \; D = 0; \quad (4)$$

and initial condition $x(0) = \begin{bmatrix} 1 & 0 \end{bmatrix}^T$. Solve for y(t) when the system is subjected to an unit step input. [CO-5, PO-1-6, 9,10,12, BL-3]

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