Exam Date & Time: 16-Jun-2022 (09:00 AM - 12:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

IV Semester B Tech. End Semester Examinations
Electronics and Instrumentation Engineering

LINEAR CONTROL THEORY [ICE 2253]

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

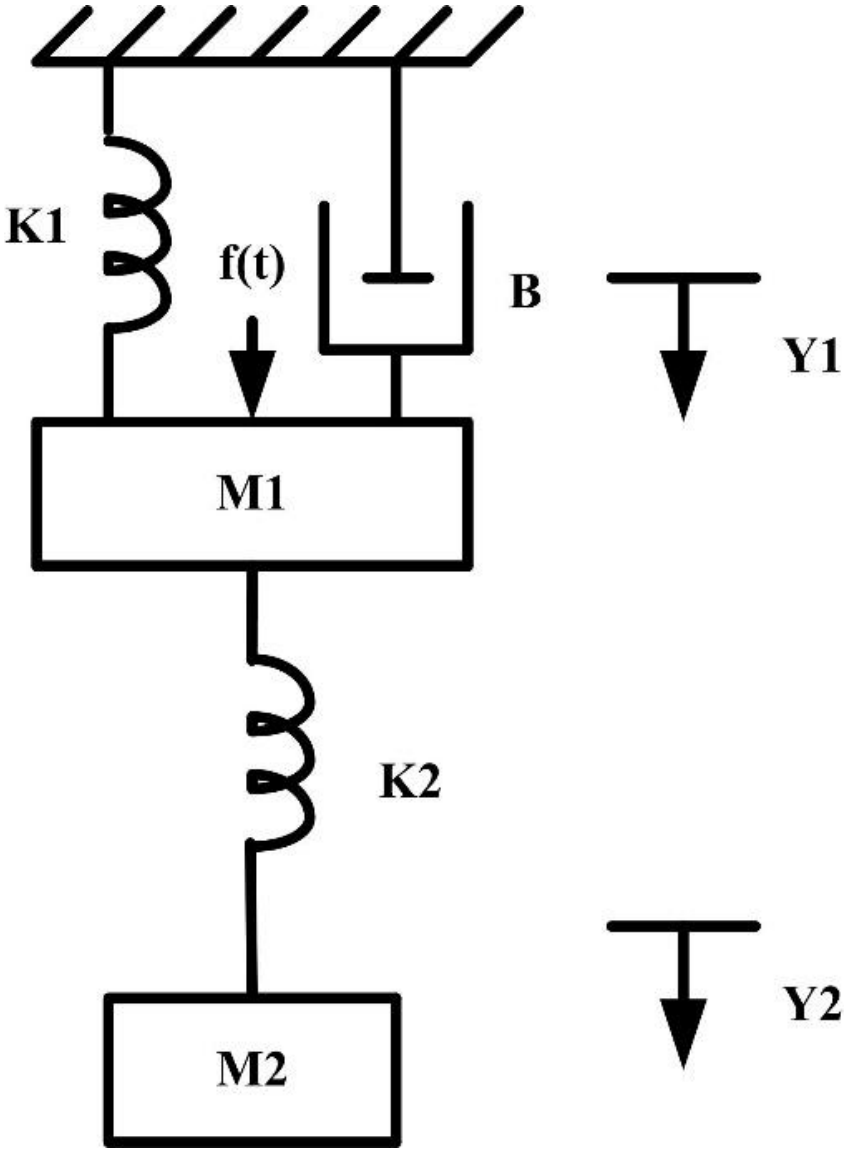
Descriptive Questions

Answer all the questions. Section Duration: 180 mins

Missing Data May be Assumed Suitably

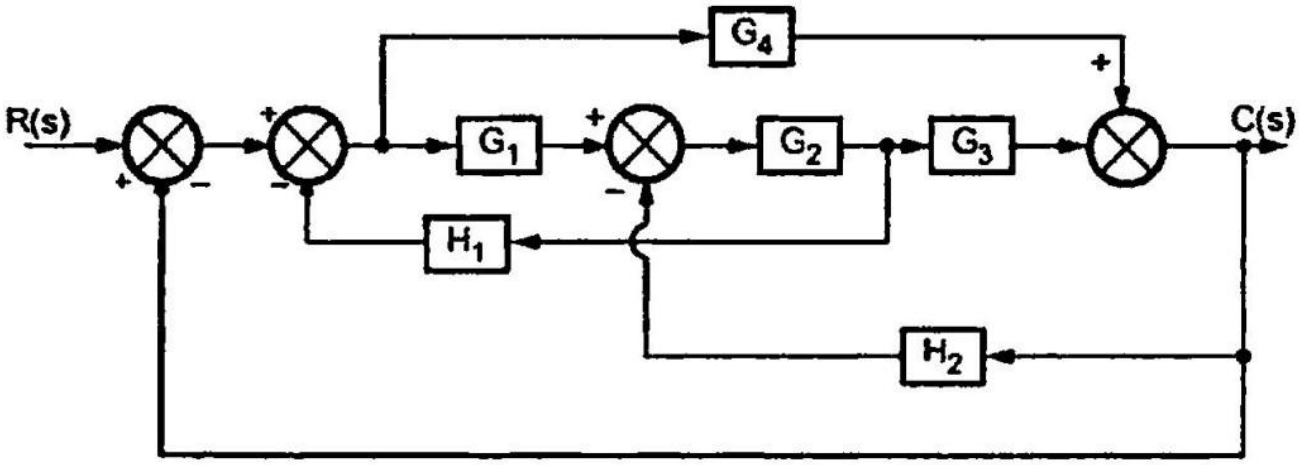
1) Convert the following mechanical model into its equivalent transfer function Y2(s) / F(s).

A)



(3)

B) Determine the transfer function C(s)/R(s) of the block diagram shown below using Mason's gain formula (4)



C) Derive an expression for Rise time and Peak over shoot of second order underdamped system, assuming unit step response expression. (3)

2) A unity feedback system is characterized by an open-loop transfer function

A) $G(s) = \frac{20}{s^2(s+1)(s+4)}$ (4)

Calculate the steady state error for Unit-step, Unit ramp and Unit acceleration input

B) Using the Routh-Hurwitz's criterion, comment on stability of the system $\mathbf{s^5+s^4+2s^3+2s^2+3s+15 = 0}$ (4)

C) Compute the value of valid breakaway / breakin point for the system,

$G(s) = \frac{K(S+5)}{(s^2+4s+5)}$ (2)

3) $G(s) = \frac{K(S+4)}{s(s^2+2s+2)}$

A) For a unity feedback system , sketch the rough nature of root locus showing all details on it. Comment on stability of the system. (5)

B) Consider a system with $G(s)H(s) = \frac{K}{s(s+4)}$. Test a point S = -2+j5 for its existence on root locus (2)

C) Derive the expressions for resonant peak M_r and resonant frequency ω_r for a standard second order system in terms of ζ and ω_n. (3)

4) Explain the design procedure for Lag - Lead compensator using Bode plot.

A) (4)

B) Compare the contributing parameters utilised in reshaping the Frequency response using

i) Lag compensator ii) Lead Compensator (2)

C) The open loop transfer function of a unity feedback system is given by (4)

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

Sketch the polar plot and comment on closed loop stability. If stable, determine gain margin.

5) The open loop transfer function of certain unity feedback control system is given by

$G(s) = \frac{K}{s(s+4)(s+80)}$

A) Draw the Bode plot for the above system by considering the velocity error constant (4)

K_v=30sec^{-1}

B) Refer Q5A, and determine the phase margin and gain margin. Also comment on stability. (2)

C) Refer Q5A and design a phase lag series compensator with the phase margin to be atleast 33º. What is the gain margin of compensated system ? (4)

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