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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FOURTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)

END SEMESTER DEGREE EXAMINATION, JUNE - 2019

SUBJECT: LINEAR CONTROL THEORY [ICE 2203]

TIME: 3 HOURS MAX. MARKS: 50

Instructions to candidates :*Answer ALL questions and missing data may be suitably assumed.*

1A Compare the electrical and mechanical analogous systems using force voltage analogy.

1B Find the overall transfer function of the system shown in Fig.Q1B, using block diagram reduction technique.

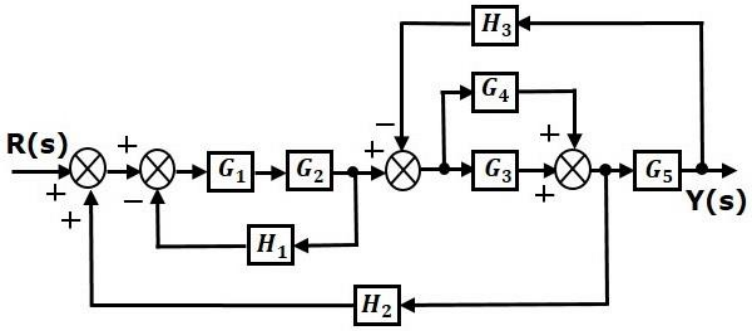

Fig.Q1B

1C For the Mechanical system shown in Fig.Q1C, write down the differential equation for the system. Also draw the analogous electrical circuit for the system and write down the electrical system differential equation in force current analogy.

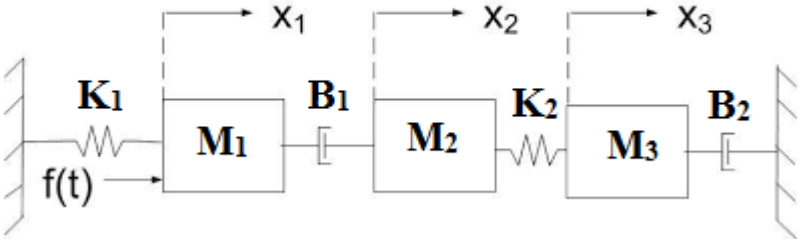

Fig.Q1C

(2+3+5)

2A Obtain the closed loop unit step response of unity feedback system whose open loop transfer function is $G(s) = \frac{4}{s(s+5)}$.

2B The open loop transfer function of a unity feedback control system is given by $G(s) = \frac{150}{(s+2)(s+5)}$ subjected to (i) Step input (ii) Ramp input. Find its steady state errors.

2C A unity feedback control system is described by the characteristic equation

$s^5 + 2s^4 + 5s^3 + 10s^2 + 4s + 8 = 0$. Test its stability by Routh Hurwitz criterion and find the roots on the imaginary axis.

(3+3+4)

3A Find the (i) Breakaway point (ii) Range of K for stability for the system having open loop transfer function $G(s)H(s) = \frac{K}{s(s+2)(s+5)}$.

3B The open loop transfer function of a unity feedback control system is given by $G(s) = \frac{10}{s(1+0.1s)(1+0.01)}$. Determine the stability of the closed loop system using Bode plots. Also determine gain to achieve a desired phase margin of 45°.

(4+6)

4A With reference to Nyquist plot how (i) Gain margin (ii) Phase margin are determined?

4B Draw the circuit diagram of a Phase lag compensation network using RC elements and derive the transfer function of the network. What are its characteristics?

4C The open loop transfer function of a unity feedback control system is given by $G(s)H(s) = \frac{10}{s(s+5)(s+10)}$. Determine the Gain margin and Phase margin using Nyquist plots and comment on the stability of the closed loop system. Verify the result using Nyquist stability criteria.

(2+3+5)

5A Write down the steps involved in designing a Lag compensator in time domain.

5B The plant transfer function of a unity feedback control system $G(s) = \frac{K}{s^2}$. Design a lead compensator to stabilize the system so that the unit step response has a maximum overshoot is less than 16.5% and setting time is less than 2 Sec, using Root locus.

(4+6)

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