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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, APRIL/MAY - 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 current analogy.

1B Find the overall transfer function of the given signal flow graph shown in Fig.Q1B.

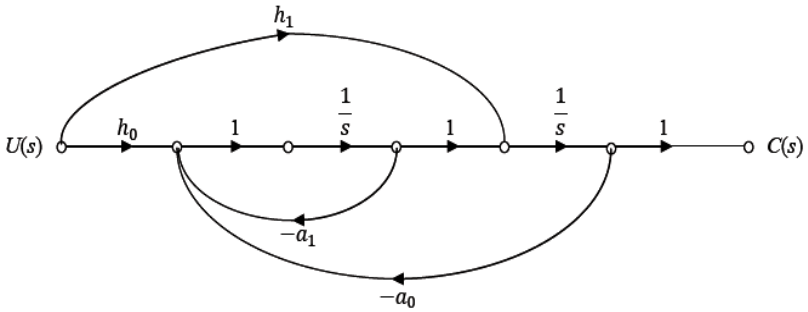


Fig.Q1B

1C For the mechanical system shown in Fig.Q1C, write down the governing equations and also draw the equivalent electrical force-voltage analogous system. Also, write down the electrical system equations.

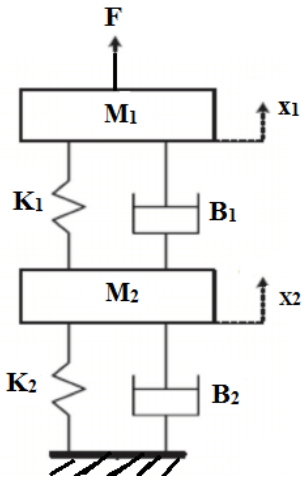


Fig.Q1C

(2+3+5)

2A A unity feedback control system is described by the characteristic equation $s^4 + 4s^3 + 7s^2 + 16s + 12 = 0$. Test its stability by Routh Hurwitz creterian and find the roots on the imaginary axis.

2B For the unity feedback system having open loop transfer function

$G(s) = \frac{K(s+2)}{s(s^3+7s^2+12s)}$. Determine the type of the system. Find the error constants $K_p$, $K_v$ and $K_a$. Also find steady state error for an input $10 + t^2$.

2C Sketch the polar plot of the open loop transfer function

$G(s) = \frac{10}{(s+1)(s+2)}$. What frequency the polar plot intersects the imaginary axis.

(3+3+4)

3A Explain the terms (i) Gain cross over frequency (ii) Phase cross over frequency (iii) Gain margin (iv) Phase margin.

3B A closed loop control system, when subjected to a unit step input has an expression for the time response is given by $C(t) = 0.5 + 1.25e^{-3t} - 1.75e^{-12t}$. Determine the overall transfer function of the system.

3C The open loop transfer function of a unity feedback control system is given by

$G(s) = \frac{K}{s(s+4)(s+8)}$. Sketch the root locus plot and determine the range of K for stability.

(2+3+5)

4A Draw the structure of PID controller and highlight its characteristics.

4B The open loop transfer function of a unity feedback control system is given by

$G(s)H(s) = \frac{K}{s(s+2)(s+5)}$. Determine the closed loop stability of the system and verify the result by Nyquist stability criterion.

4C Write down the steps involved in designing a Lag compensator in time domain.

(2+4+4)

5A Draw the circuit diagram of a Phase lead compensation network using RC elements and derive the transfer function of the network. List the characteristics.

5B The open loop transfer function of a unity feedback control system is given by

$G(s)H(s) = \frac{K}{s(1+0.1s)(1+0.05s)}$.

(i) Find Phase margin and Gain margin, when K=10, comment on closed loop stability.

(ii) Find K, if Gain Margin =20dB

(3+7)

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