Question Paper

Exam Date & Time: 28-Nov-2018 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
IV SEMESTER B.S. ENGG. END SEMESTER EXAMINATION - NOV./ DEC. 2018
Control Systems [EE 241]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.
Missing data, if any, may be suitably assumed

1) A) Write the differential equations governing the electrical network shown in Fig.1A and obtain the transfer function (10)

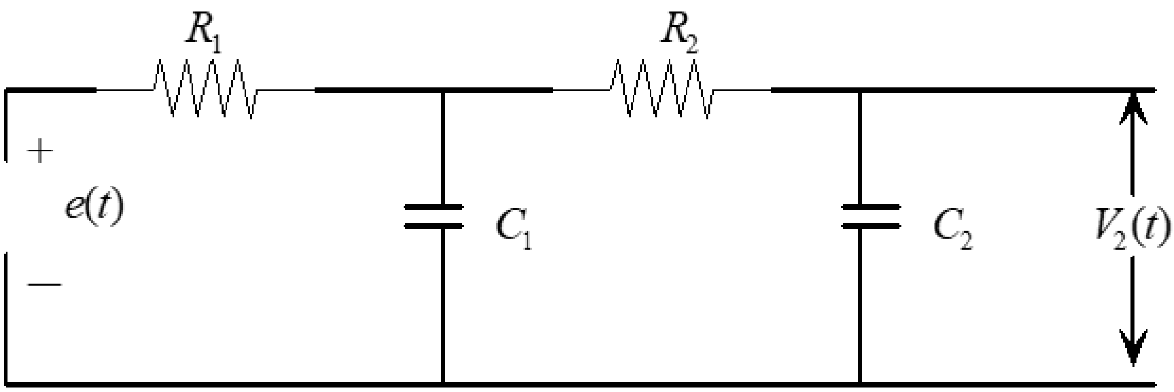
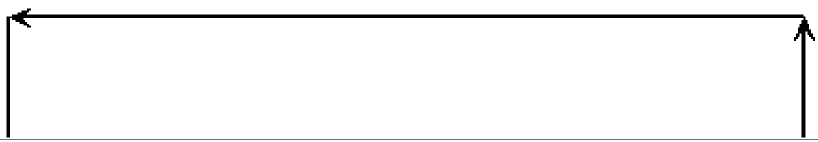


Fig.1A

B) Define Control System terms: Plant, Controller, Feedback Unit, Error, Reference input with block diagram. Also compare an open loop system and closed loop system. (10)

2) A) Determine the transfer function C(s)/R(s) for a system represented by the block diagram shown in Fig.2A (10)



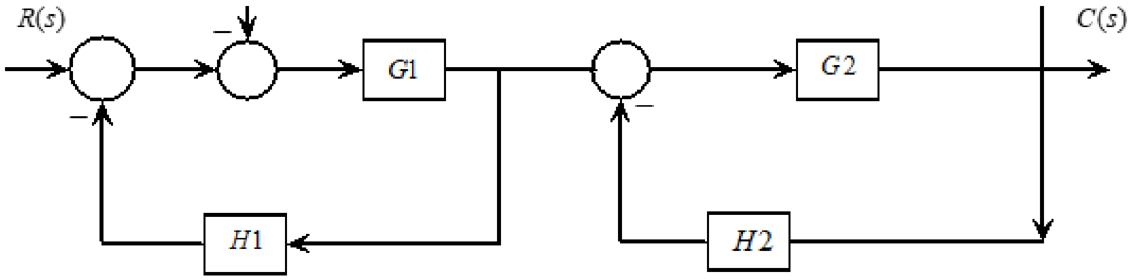


Fig.2A

B) For the mechanical system shown in Fig.2B obtain the transfer function X3(s)/F(s) (10)

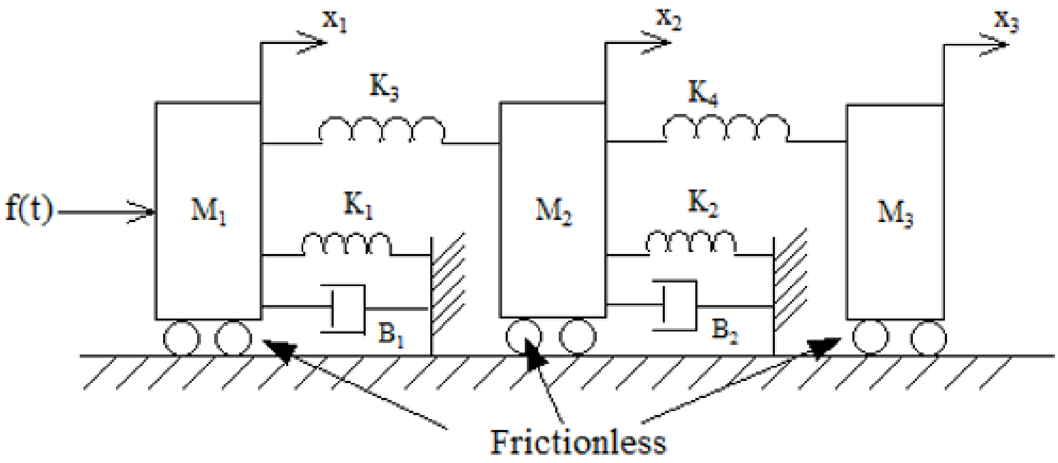


Fig.2B

3) A) Find the transfer function Y(s)/U(s) for the system with the following signal flow graph shown in Fig.3A using mason's gain formula (10)

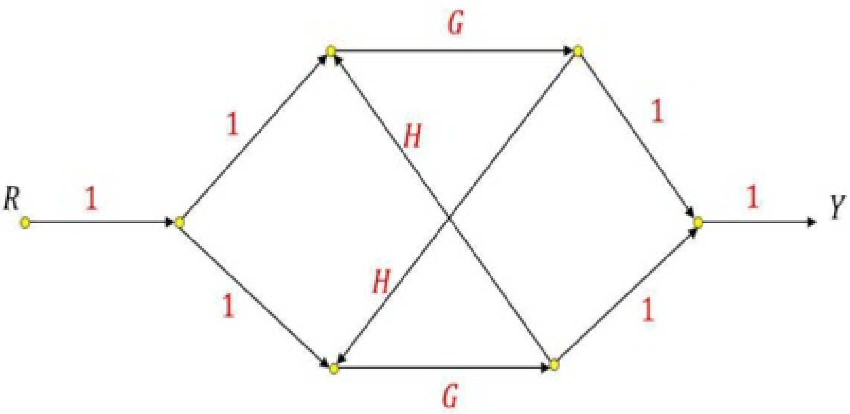


Fig.3A

B) For the second-order system described by the following transfer function, (10)

$$\frac{C(s)}{R(s)} = \frac{144}{s^2 + 9.6s + 144}$$

determine the frequencies of un-damped and damped oscillations, maximum overshoot, peak time, rise time, settling time and the final value due to a unit step input.

4) A) For the characteristic equation of a feedback control system $s^4 + 25s^3 + 15s^2 + 20s + k = 0$, determine the range of K for stability. Determine the value of K so the system is marginally stable and the frequency of sustained oscillations. (10)

B) A unity feedback system has an open loop transfer function of (10)

$$G(s) = \frac{20(s+5)}{s(s+0.1)(s+3)}$$

Determine the steady state error for the unit step, ramp and parabolic inputs.

5) A) Sketch the root locus for unity feedback system with open loop transfer function given and comment on the range of K for system to be stable. (10)

$$G(s) = \frac{K(s+5)}{(s+1)^2}$$

B) For a unity feedback control system having the plant transfer function as: (10)

$$G(s) = \frac{100K}{(s+1)(s+3)(s+10)}$$

Sketch the Nyquist diagram and using Nyquist criterion determine the range of K for the system to be stable.

6) A) The Bode asymptotic magnitude plot of a minimum phase system is shown in Fig.6A with detailed analysis, determine the steady state error of the closed loop unit, with the system connected in a unity feedback being excited by a unit ramp input. (10)

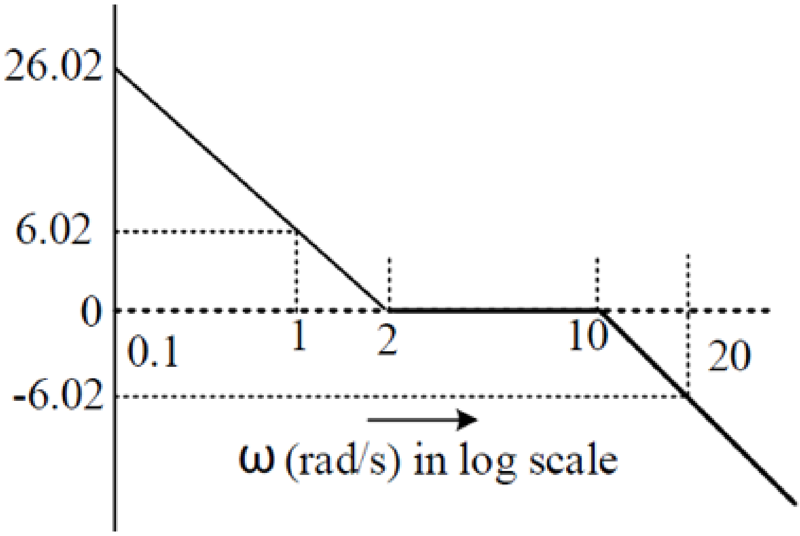


Fig.6A

B) A unit step response test is conducted on a second order system yielded peak overshoot Mp=0.12 and peak time tP=0.2s. Obtain the frequency response specifications for the system. (10)

7) Design a Phase lead compensator using frequency domain approach (use semi-log graph sheet) for negative unity feedback system with plant transfer function (20)

$$G(s) = \frac{K}{s(s+10)(s+1000)}$$

to satisfy the design specifications: Phase margin is at least 45 degrees and Static error constant = 1000s-1

8) Define the terms: (i) State equation (ii) State variables. Also for the electrical network shown in Fig.8. Obtain the state model. Select the inductor current as one of the state variables (20)

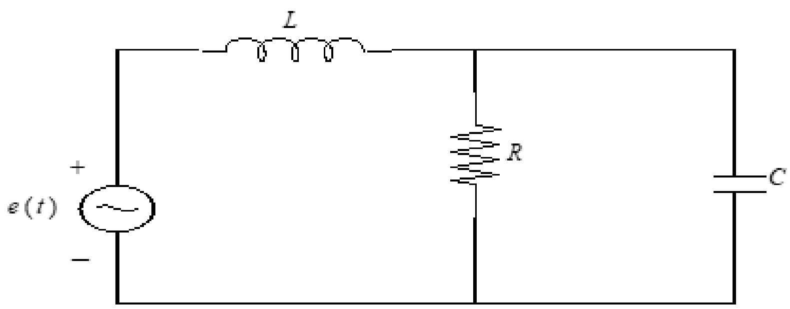


Fig.8

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