Question Paper

Exam Date & Time: 02-May-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIECES
IV SEMESTER B.Sc. (APPLIED SCIENCES) IN ENGINEERING
END SEMESTER THEORY EXAMINATION-APRIL/MAY 2019
Control Systems [EE 241]

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

Answer ANY FIVE full 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)

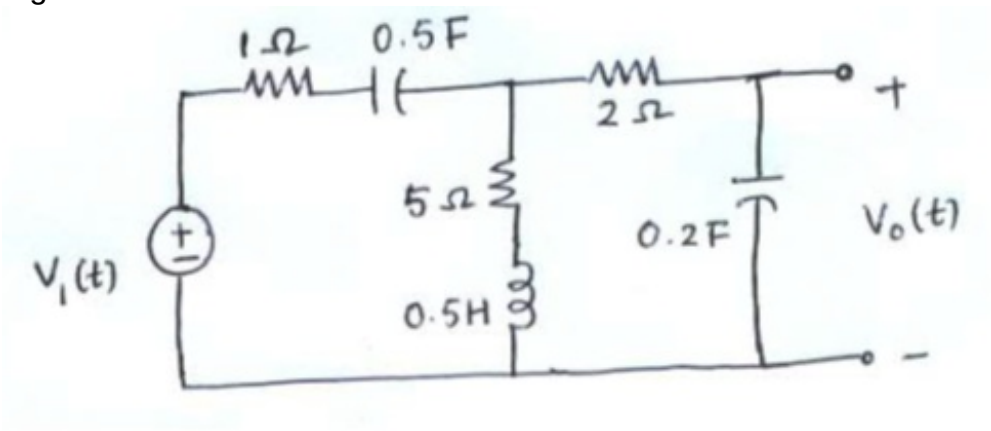

Fig.1A

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) Write the differential equations governing the mechanical system shown in Fig 2A. Draw the force-voltage and force-current electrical analogous circuits and verify by writing mesh and node equations. (10)

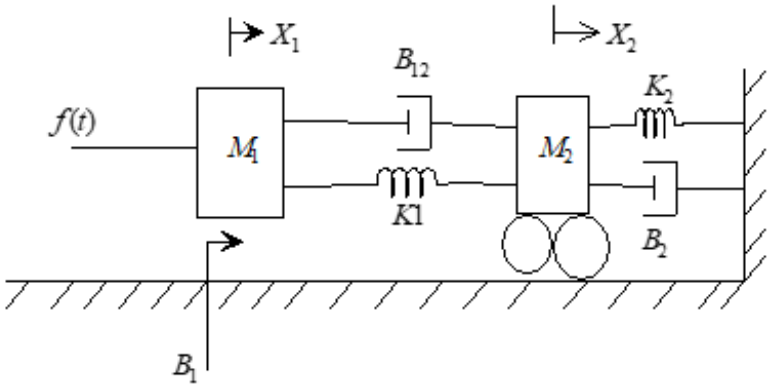

Fig 2A

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

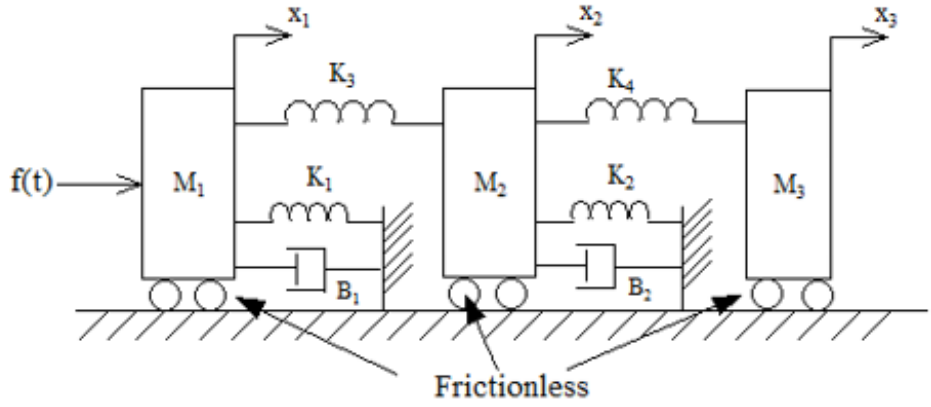

Fig.2B

3) 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)

A)

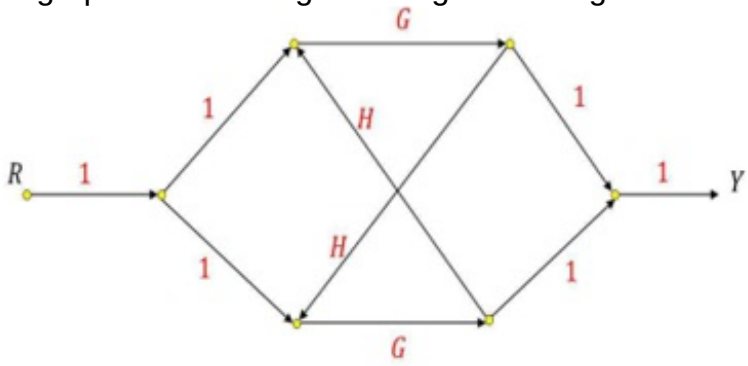

Fig.3A

B) Determine the transfer function C(s)/R(s) for a system represented by the block diagram shown in Fig.3B (10)

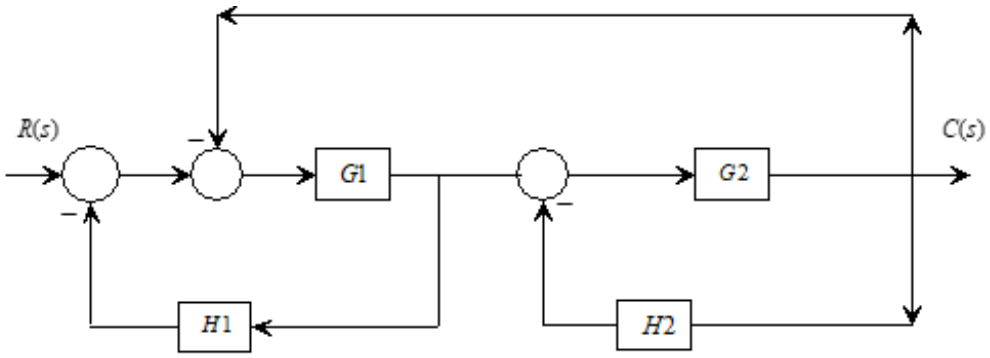

Fig.3B

4) A) (10)

i) For the characteristic equation of a feedback control systems^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.

ii) For the second-order system described by the following transfer function,

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

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. (5+5)

B) (10)

A. Derive the expression for the i) Rise time (tr) ii) Peak time (tp)

B. A unity feedback system has an open loop transfer function of

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

Determine the steady state error for the unit step, ramp and parabolic inputs. (5+5)

5) A) (10)

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.

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

B) (10)

For a unity feedback control system having the plant transfer function as:

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

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

6) A) (10)

Draw the approximate Bode plot for the unity feedback system with open loop transfer function Hence find gain margin and phase margin.

$$G(s)H(s) = \frac{0.5}{s(s^2 + s + 1)}.$$

B) i)Derive the expression of Resonant frequency. ii)A unit step response test is conducted on a second order system yielded peak overshoot Mp=0.12 and peak time t_P=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)

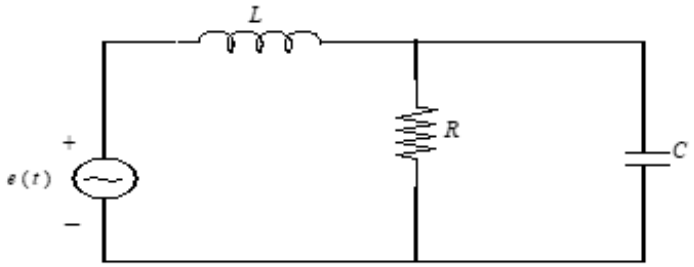

Fig.8

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