Q. P. Code: 40552

[Time: 3 Hours]

Total Marks: 80

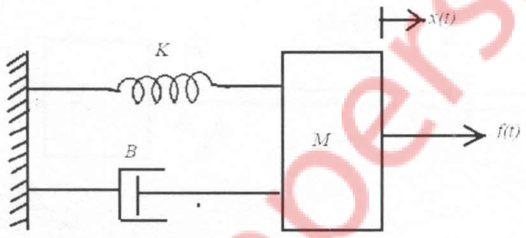
Instructions:

- **Q1** is compulsory
- Answer any **Three** out of remaining **Five** questions
- Assumptions made should be clearly stated
- Assume any suitable data wherever required but justify the same
- Figure to the right indicate gets full marks
- Illustrate answers with sketches wherever required

Q1. Answer the following. (20)

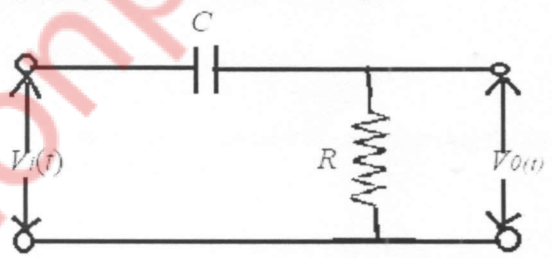
(a) Discuss how are feedback control systems are classified based on – method of analysis and design, on parameter, type of signals, application, number of input/output, number of open-loop poles of the system, order of the system and damping.

(b) Obtain the differential equations governing the mechanical system shown in following figure. Find transfer function X(s)/F(s).



(c) Explain the transient and steady – state response. Draw these responses for first and second – order systems.

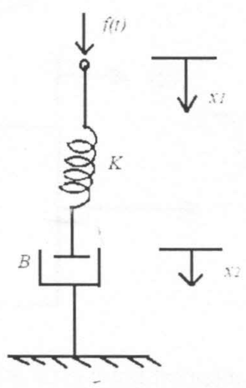
(d) Obtain the time response of the following electrical network.



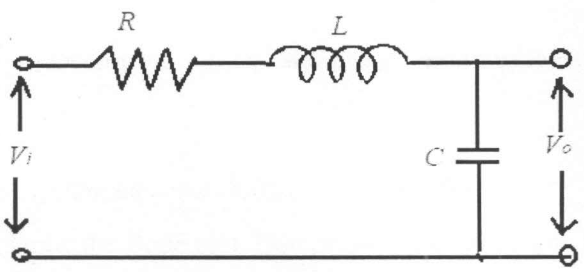
Assume C= 1F, and R= 2Ω.

Q2. (a) Define open-loop and closed-loop systems and differentiate between them. (05)

(b) What is meant by analogous systems? Obtain the electrical analogous of following mechanical system using F-V analogy. (05)



(c) Find the transfer function of the network shown in following Figure using Mason's gain formula. (10)

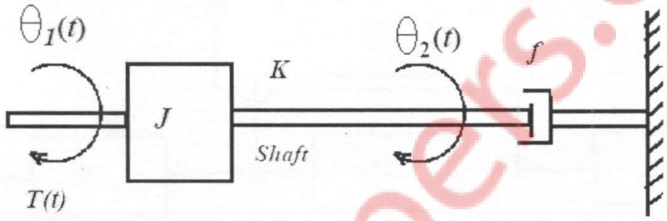


Q3. (a) Explain the correlation between time and frequency response specifications. (05)

(b) Test the stability of the system represented by following characteristic equation. (05)

$$s^5 + s^4 + 3s^3 + 9s^2 + 16s + 10 = 0$$

(c) Write torque equations of the following rotational mechanical system. Obtain the analogous electrical circuit based on Torque-Current and Torque-Voltage analogies. (10)



Q4. (a) Sketch the root-locus of the unity feedback system having (10)

$$G(s) = \frac{k}{s(s+2)(s+4)}$$, where k is varied from $-\infty$ to $+\infty$.

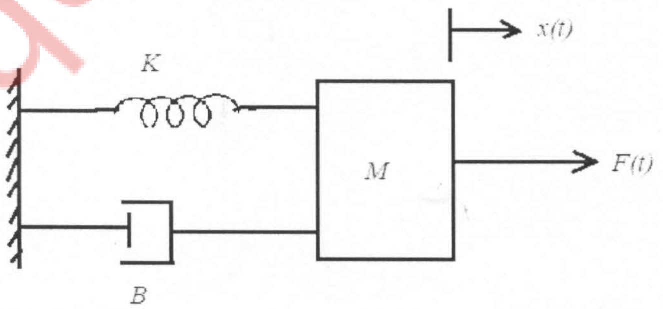
Hence obtain the value of k for which the system is stable.

(b) Determine the position, velocity and acceleration constant of the following feedback control systems for which the open-loop transfer functions are –

i) $$G(s) = \frac{20}{(0.5s+1)(s+10)}$$ (05)

ii) $$G(s) = \frac{K}{s(s+5)(s+20)}$$ (05)

Q5. (a) For the system shown in following Figure – (10)



Find i) Transfer function, ii) Damping factor, ii) Natural frequency, iii) Percent overshoot, iv) Peak time, Assume: K = 33N/m, B = 15 N-s/m, M = 35kg

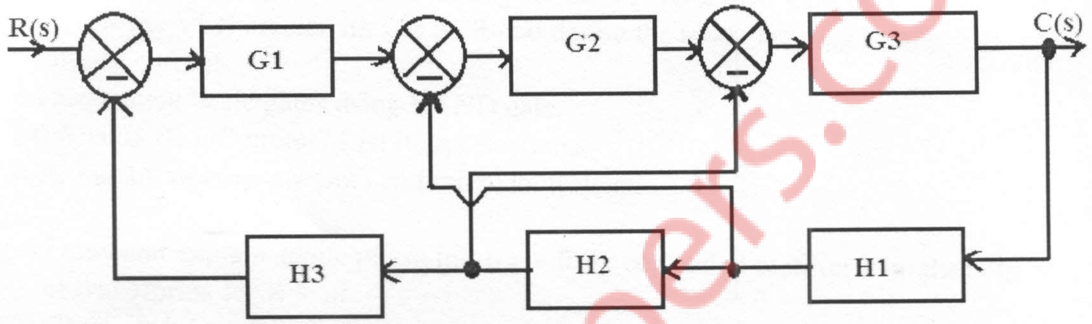
(b) Sketch the polar plot for the following system. (10)

$$G(s) = \frac{1}{s(s+1)(s+2)}$$, Determine the gain and phase margin of the system.

Q6. (a) A unity feedback control system has open-loop transfer function - (10)

$$G(s) = \frac{10}{s(0.1s+1)}$$, Draw the Bode plot. Determine the gain margin, phase margin, gain cut off frequency, phase cut off frequency

(b) Reduce the system block diagram of the following and obtain the transfer function C(s)/R(s). (10)



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