

USN

## Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024 Control Systems

Time: 3 hrs.

Max. Marks: 100

**Note:** Answer any FIVE full questions, choosing ONE full question from each module.

### Module-1

- 1 a. What are the properties of a good control system? (04 Marks)
- b. Write the comparison between open loop control system and closed loop control system. (08 Marks)
- c. For the mechanical system shown in Fig Q1(c), write the differential equations of performance. Find write loop equations based on Force – Voltage analogy and write electrical analogous circuit.

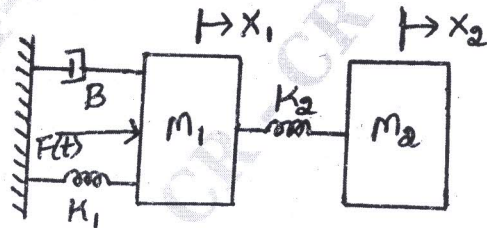


Fig Q1(c)

(08 Marks)

OR

- 2 a. Obtain the transfer function of an armature controlled DC servomotor. (08 Marks)
- b. Write the differential equations governing the mechanical system shown in Fig Q2(b). Draw the torque – current electrical analogous circuit.

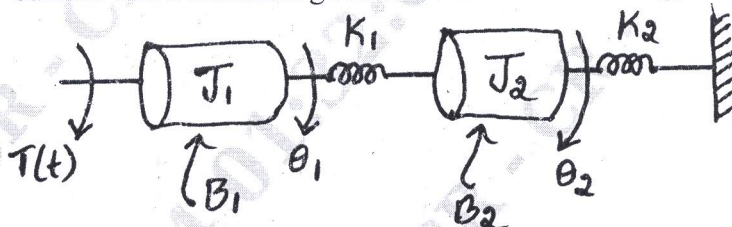


Fig Q2(b)

(08 Marks)

- c. Explain translational motion of mechanical system. (04 Marks)

### Module-2

- 3 a. Define the following terms : i) Source node ii) Sink node iii) Forward path iv) Self loop. (04 Marks)
- b. What is Block diagram? List the properties of Block diagram. (08 Marks)
- c. Obtain the transfer function for the block diagram, shown in Fig Q3(c), using block diagram reduction technique.

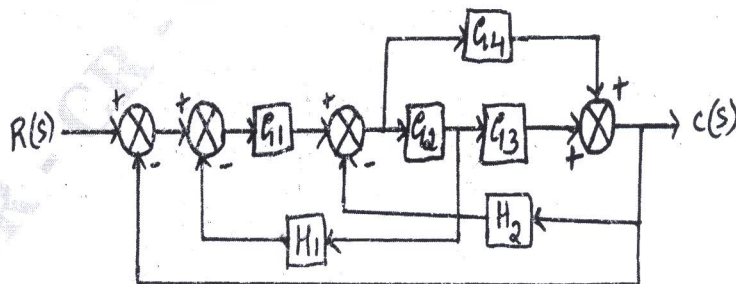


Fig Q3(c)

(08 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

- 4 a. Explain the procedure of Block diagram reduction technique. (06 Marks)  
 b. Construct the signal flow graph and determine the transfer function using Mason's gain formula for Fig Q4(b).

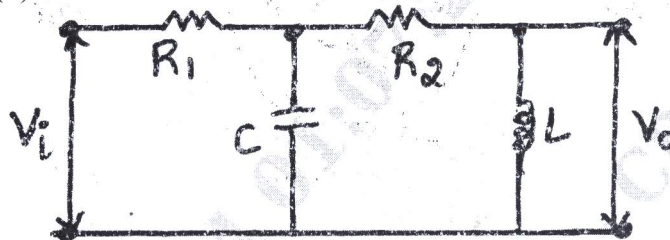


Fig Q4(b)

(07 Marks)

- c. Find  $\frac{C(s)}{R(s)}$  for the signal flow graph shown in Fig Q4(c), using Mason's gain formula.

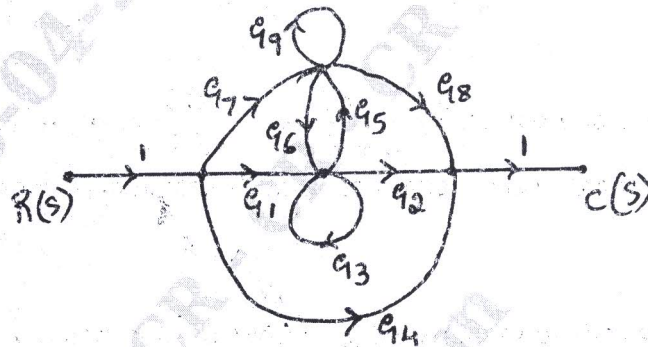


Fig Q4(c)

(07 Marks)

**Module-3**

- 5 a. Define and derive the expression for i) Rise time ii) Peak overshoot of an underdamped second order control system subjected to step input. (07 Marks)  
 b. Determine the stability of the following characteristic equations of the system  
 $s^4 + 6s^3 + 26s^2 + 56s + 80 = 0$   
 $s^4 + 2s^3 + 4s^2 + 6s + 8 = 0$  (06 Marks)  
 c. A second order system is given  $\frac{C(s)}{R(s)} = \frac{25}{s^2 + 6s + 2s}$ . Find the rise time, peak time, settling time and peak overshoot if subjected to unit step input. Also obtain the expression for its output response. (07 Marks)

OR

- 6 a. Explain Routh-Hurwitz criterion for determining the stability of the system and mention its limitations. (06 Marks)  
 b. The open loop transfer function of a unity feedback control system is given by the characteristic equation. Determine the range of values of K for the system stability. What is the value of K which gives sustained oscillations? What is the oscillation frequency?

$$G(s) = \frac{K}{(s+2)(s+4)(s^2+6s+2s)}$$

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(07 Marks)

- c. A unity feedback system is characterized by an open loop transfer function  $G(s) = \frac{K}{s(s+10)}$ . Determine the gain 'K', so that system will have a damping ratio of 0.5. For the value of K determine the settling time, peak overshoot, peak time for a unit step input. (07 Marks)

**Module-4**

- 7 a. Define the following terms : i) Angle of asymptotes ii) Asymptote iii) Breakaway points (06 Marks)
- b. Draw the appropriate root locus diagram for a closed loop system whose loop transfer function is given by  $\frac{G(s)}{H(s)} = \frac{K}{s(s+1)(s+2)}$ . Comment on the stability. (14 Marks)

**OR**

- 8 a. Define the following terms :  
i) Gain margin ii) Phase margin iii) Gain crossover frequency (06 Marks)
- b. A unity feedback control system has  $G(s) = \frac{80}{s(s+2)(s+20)}$ . (14 Marks)

**Module-5**

- 9 a. The open loop transfer function of a control system is  $G(s)H(s) = \frac{K}{s(s+2)(s+10)}$ . Sketch the Nyquist plot and calculate the value of K. (14 Marks)
- b. Write short notes on PID controller. (06 Marks)

**OR**

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- 10 a. What is controller? Explain the effect of P, I, PI and PID controller of a second order system. (12 Marks)
- b. Explain the steps to solve problems by Nyquist criterion. (08 Marks)

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