

# CBCS SCHEME

18EC43

## Fourth Semester B.E. Degree Examination, June/July 2023 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. Define control system and explain with an example. (04 Marks)
- b. Compare open loop and closed loop control system. (06 Marks)
- c. Find the transfer function of the electromechanical system shown in Fig.Q1(c).

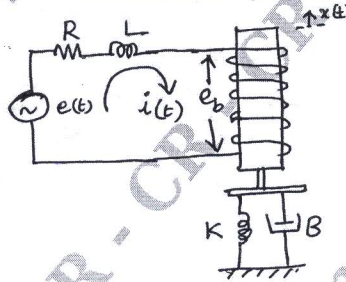


Fig.Q1(c)

(10 Marks)

### OR

- 2 a. What are the effects of feedback in a control system? (06 Marks)
- b. Write the differential equation for the given mechanical system shown in Fig.Q2(b). Find the analogous electrical circuit based on Force-Voltage analogy.

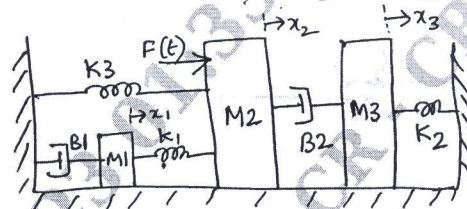


Fig.Q2(b)

(10 Marks)

- c. Find the Torque - Voltage Analogous circuit for the Fig.Q2(c) shown.



Fig.Q2(c)

(04 Marks)

### Module-2

- 3 a. Find the overall transfer function  $\frac{C(s)}{R(s)}$  for the block diagram shown in Fig.Q3(a).

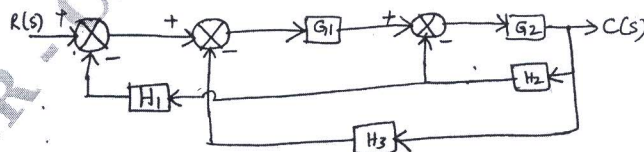


Fig.Q3(a)

(10 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.

- b. Find the transfer function by constructing a block diagram for the circuit shown in Fig.Q3(b)

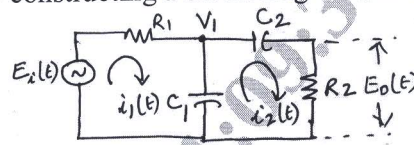


Fig.Q3(b)

(10 Marks)

OR

- 4 a. Find  $\frac{C(s)}{R(s)}$  when  $N(s) = 0$  for the diagram shown in Fig.Q4(a).

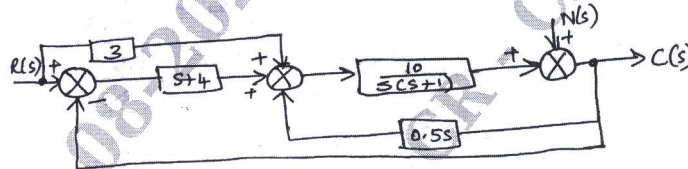


Fig.Q4(a)

(10 Marks)

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

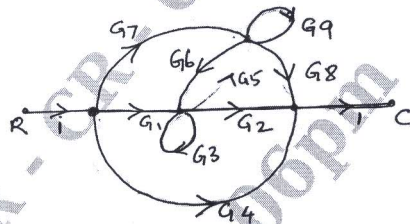


Fig.Q4(b)

(10 Marks)

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**Module-3**

- 5 a. A unity feedback system is characterized by an open loop transfer function

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

Find the value of K so that the system will have a damping ratio of 0.6, for this value of K find  $M_p$ ,  $T_p$  and  $T_s$  for a unit step input. (08 Marks)

- b. Find the error constants  $k_p$ ,  $k_v$  and  $k_a$  for the unity feedback control system whose open loop transfer function

$$G(s) = \frac{100}{s^2(s+2)(s+5)}$$

Find the steady state error when the input  $r(t) = 1 + t + 2t^2$ . What is the type and order of the system? (08 Marks)

- c. With the neat diagram write a note on PID controller. (04 Marks)

OR

- 6 a. Starting from output equation  $C(t)$ , derive the expression for peak time, peak overshoot, settling time of an under damped second order system subjected to unit step input. (10 Marks)  
 b. Obtain rise time, peak time, % peak overshoot, settling time for the unit step response of a closed loop system given by

$$\frac{C(s)}{R(s)} = \frac{25}{s^2 + 6s + 25}$$

Also find the expression for the output. (10 Marks)

**Module-4**

- 7 a. For a unity feedback system whose open loop transfer function is  $G(s) = \frac{k(s+4)}{s(s+1)(s+2)}$   
 Find the range of  $k$  that keeps the system stable using R-H criteria. (08 Marks)  
 b. Sketch the Root Locus diagram for the unity feedback control system with  
 $G(s) = \frac{k}{s(s^2 + 8s + 17)}$ . Determine the value of  $k$  for a damping ratio of 0.5. (12 Marks)

**OR**

- 8 a. For a system having open loop transfer function given by  $G(s) = \frac{10(1+0.125s)}{s(1+0.5s)(1+0.25s)}$   
 Draw the Bode magnitude and phase plot. Determine the Phase margin and Gain margin.  
 Comment on the stability. (10 Marks)  
 b. Find the transfer function of the system whose Bode diagram is shown in Fig.Q8(b).

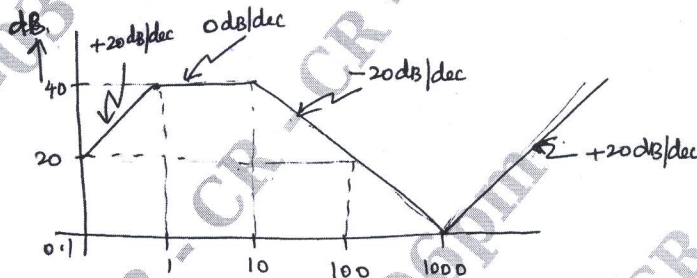


Fig.Q8(b)

(10 Marks)

**Module-5**

- 9 a. The open loop transfer function of a unity negative feedback control system is given by  
 $G(s) = \frac{k(s+3)}{s(s^2 + 2s + 2)}$   
 using Nyquist criteria find the value of  $k$  for which the closed loop system is stable. (10 Marks)  
 b. Explain lead-lag compensating network. (04 Marks)  
 c. Represent the differential equation given below in state model  
 $\frac{d^3 y(t)}{dt^3} + 3\frac{d^2 y(t)}{dt^2} + 6\frac{d y(t)}{dt} + 7y(t) = 2u(t)$  (06 Marks)

**OR**

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- 10 a. Mention the properties of State Transition Matrix. (04 Marks)  
 b. Obtain the state model of the given network shown in Fig.Q10(b) in standard form.

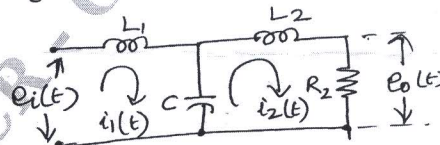


Fig.Q10(b)

(08 Marks)

- c. Find the state transition matrix for the state equation given below.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

(08 Marks)

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