

USN

Course Code 2 2 E C 4 3

Fourth Semester B.E. Degree Examinations, July 2026

CONTROL SYSTEMS

Duration: 3 hrs

Max. Marks: 100

Note: 1. Answer any FIVE full questions choosing ONE full Question from each Module.
2. Missing data, if any, may be suitably assumed

- | <u>Q. No</u> | <u>Question</u> | <u>Marks</u> | <u>(RBTL:CO: PI)</u> |
|-----------------|---|--------------|----------------------|
| Module-1 | | | |
| 1. | a. (i) Define control systems. Identify different types of control systems.
(ii) Find the transfer function of the SFG shown in Fig. Q1(a) using Mason's Gain Formula. | 10 | (2 : 1 : 1.3.1) |

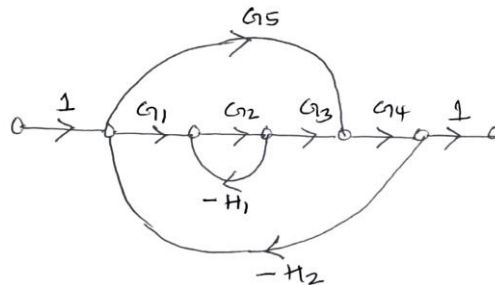


Fig. Q1(a)

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|----|---|----|-----------------|
| b. | Derive the Force-Voltage and Force-Current analogy for the translational mechanical system shown in Fig. Q1(b) and draw its analogous electrical circuit. | 10 | (3 : 1 : 2.1.2) |
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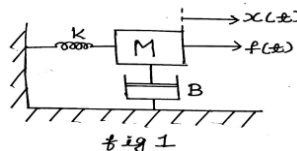


Fig. Q1(b)

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| 2. | a. Draw the equivalent mechanical system of the physical system shown in Fig. Q2(a). Write the set of equilibrium equations and obtain electrical analogous circuits using (i) F-V Analogy (ii) F-I Analogy. | 10 | (3 : 1 : 2.1.2) |
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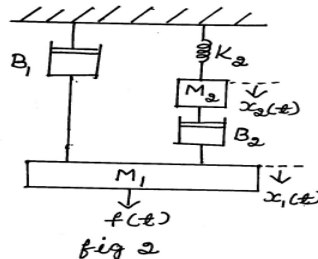


Fig. Q2(a)

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| b. | Determine the transfer function of the system shown in Fig. Q2(b) using block diagram reduction technique. | 10 | (3 : 1 : 2.1.2) |
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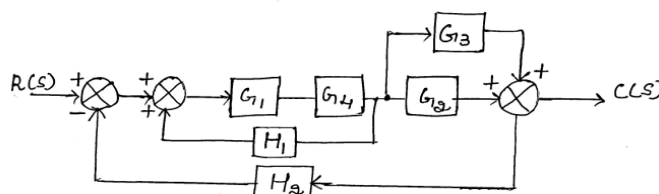


Fig. Q2(b)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI- Performance Indicator)

Module-2

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| 3. | a. | Derive the expression of steady state error e_{ss} . Also find e_{ss} for test inputs step, ramp and impulse. | 10 | (2 : 2 : 1.4.1) |
| | b. | Derive the unit step response of a second order for under damped control system | 10 | (3 : 2 : 2.1.2) |

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|----|----|---|----|-----------------|
| 4. | a. | Find Type, system gain, K_p , K_v , K_a and steady state error for a system whose open loop transfer function is
$G(S)H(S) = \frac{10(S+2)(S+3)}{S(S+1)(S+5)(S+6)}$, Where $r(t) = 4 + t + t^2$. | 10 | (2 : 2 : 1.4.1) |
| | b. | A system is given by differential equation $\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 6y = 6x$. where y is output and x is input. Determine Peak time, Peak overshoot, Settling time and time response $C(t)$. | 10 | (3 : 2 : 1.4.1) |

Module-3

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| 5. | a. | For a unity feedback system, $G(S)=K/S(1+0.4S)(1+0.25S)$ find the range of values of K; marginal value of K, and frequency of sustained oscillations | 10 | (3 : 3 : 2.1.2) |
| | b. | Examine the stability of the given system with characteristic equation $F(S)=S^6+3S^5+4S^4+6S^3+5S^2+3S+2=0$, also determine the following
(i) Number of roots on LHS of S-plane
(ii) Number of roots on RHS of S-plane
(iii) Number of roots on the Imaginary axis | 10 | (3 : 3 : 2.1.2) |

(OR)

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| 6. | a. | For the system with characteristic equation $S^4+22S^3+10S^2+S+K=0$ find K_{mar} and ω at K_{mar} | 10 | (3 : 3 : 2.1.2) |
| | b. | Examine the stability of the given system with characteristic equation $F(S)=S^6+S^5+5S^4+S^3+2S^2-2S-8=0$, also determine the following
(i) Number of roots on LHS of S-plane
(ii) Number of roots on RHS of S-plane
(iii) Number of roots on the Imaginary axis | 10 | (3 : 3 : 2.1.2) |

Module-4

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|----|----|---|----|-----------------|
| 7. | a. | Draw the appropriate root locus diagram for a closed loop system whose transfer function is given by $G(S)H(S)= K/S(S+5)(S+10)$ and Comment on stability. Write MATLAB CODE for the above system to simulate the results. | 10 | (3 : 4 : 2.1.2) |
| | b. | Define the following with respect to frequency plot:
(i) Gain margin (ii) phase margin (iii) gain crossover frequency
(iv) phase crossover frequency | 10 | (2 : 4 : 1.3.1) |

(OR)

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| 8. | a. | A unity feedback control system has $G(S)=80/S(S+2)(S+20)$ Draw the bode plot. Determine G.M, P.M, ω_{gc} , ω_{pc} . Comment on stability. | 10 | (3 : 4 : 2.1.2) |
| | b. | Draw the appropriate root locus diagram for a closed loop system whose transfer function is given by $G(S)H(S)=K/S(S+1)(S+2)(S+3)$ and Comment on stability. Write MATLAB CODE for the above system to simulate the results. | 10 | (3 : 4 : 2.1.2) |

Module-5

9. a. Find the state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$ 10 (3 :5 : 2.1.2)
- b. Obtain the transfer function of the state model if 10 (3 :5 : 2.1.2)

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \quad D = [0]$$

(OR)

10. a. Find the transfer function for the system having the state model given below 10 (3 :5 : 2.1.2)

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u; \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

- b. Obtain state model of the electrical system shown in Fig. Q10(b) 10 (3 :5 : 2.1.2)

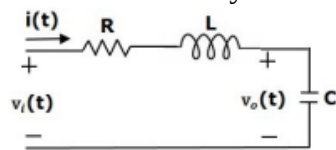


Fig. Q10(b)

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