Roll No. | | | | | | | | | | |

# ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

## B.E / B. Tech (Full Time) END SEMESTER EXAMINATIONS – APRIL/ MAY 2024

**Electrical & Electronics Engineering**
Fourth Semester
**EE5402 & CONTROL SYSTEMS**
(Regulation2019)

Time:3hrs Max.Marks: 100

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|---|---|
| CO1 | Represent simple systems in transfer function and state variable forms. |
| CO2 | Analyze simple systems in time domain. |
| CO3 | Analyze simple systems in frequency domain. |
| CO4 | Infer the stability of systems in time and frequency domain |
| CO5 | Interpret characteristics of the system and find out solution for simple control problems. |

**BL – Bloom's Taxonomy Levels**
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

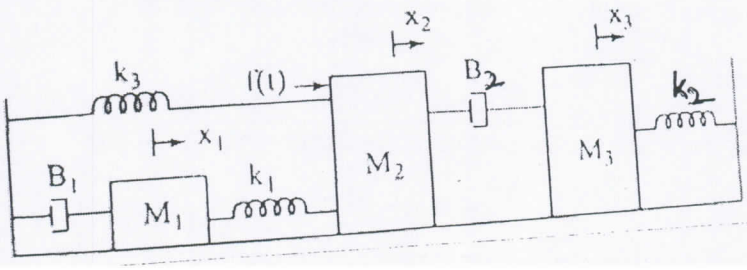
## PART- A(10x2=20Marks)

(Answer all Questions)

| Q.No | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 1 | Compare linear and nonlinear system with example. | 2 | 1 | 1 |
| 2 | Define a transfer function with example. | 2 | 1 | 1 |
| 3 | Define type and order of a system with example. | 2 | 2 | 2 |
| 4 | Compare the step response of the first and second order systems. Also draw the response. | 2 | 2 | 2 |
| 5 | Define gain margin and phase margin for a polar plot. | 2 | 3 | 1 |
| 6 | List the frequency domain specifications. | 2 | 3 | 1 |
| 7 | The differential equation that represent the system is $\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = r(t)$ where $y(t)$ is the output and $r(t)$ is the input. Obtain a state space model. | 2 | 4 | 2 |
| 8 | List out the properties of state transition matrix. | 2 | 4 | 2 |
| 9 | Compare series compensator and feedback compensator. | 2 | 5 | 2 |
| 10 | List the advantages and disadvantages of P and D controller. | 2 | 5 | 2 |

## PART- B(5x 13= 65Marks)

| Q.No | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 11 (a) (i) | Derive the transfer function for armature controlled DC motor. | 5 | 1 | 3 |
| (ii) | Obtain the differential equations of the mechanical system shown in Figure. | 8 | 1 | 3 |



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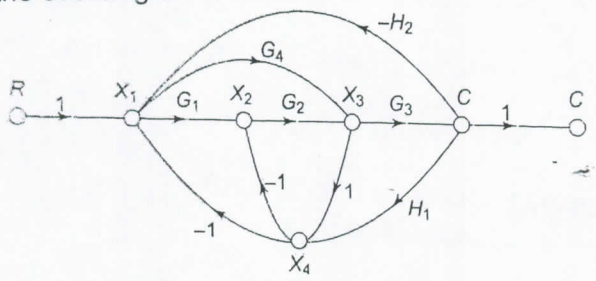
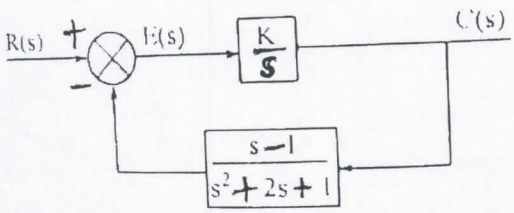
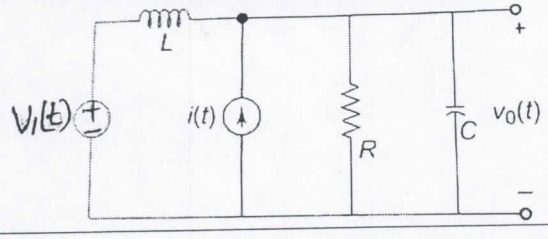
|---|---|---|---|---|
| | **OR** | | | |
| 11.(b) (i) | Find the overall gain of the SFG.<br>  <br> | **8** | 1 | 3 |
| (ii) | State the basic elements for modeling in translational and rotational mechanical system with respect to voltage and current source. | **5** | 1 | 2 |
| 12 (a) (i) | For the second-order system described by the following transfer function, determine the frequency of un-damped and damped oscillations, maximum over shoot, peak time, rise time, settling time and the final value due to a unit step input.<br>$G(s) = \frac{144}{S^2+9.6\,S+144}$ | **8** | 2 | 3 |
| (ii) | The unit step response of second-order underdamped system is known to be, $c(t) = 1 - Ae^{-5t}\sin(\beta t + 0.8957)$<br>Determine the value of $A$ and $\beta$. | **5** | 2 | 3 |
| | **OR** | | | |
| 12 (b) | Sketch the root locus of closed loop poles of the feedback control system with open loop transfer function, $G(s)H(s) = \frac{K\,(S+5)}{S(S^2+4\,S+5)}$. | **13** | 2 | 3 |
| 13 (a) | For a unity negative feedback system, the open loop transfer function is $G(s) = \frac{90}{s(S^2+2S+9)}$. Find the gain crossover frequency and the phase margin. Also find the gain and phase margin. | **13** | 3 | 4 |
| | **OR** | | | |
| 13 (b) | If the system function $G(s) = \frac{40}{(S+4)\,(S^2+4s+8)}$ is the open loop transfer function of a unity feedback system, find the gain margin and phase margin of the system. Use polar plot. | **13** | 3 | 4 |
| 14 (a) | A state model for a linear time in variant system is given by,<br>$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -24 & -26 & -9 \end{bmatrix}[X] + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$<br>$y = [1 \quad 2 \quad 1\,]\,[X]$<br>Determine the Eigen values and the transfer function Y(s)/R(s). | **5 +8** | 4 | 4 |
| | **OR** | | | |
| 14 (b) (i) | Check the controllability and observability of the system<br>$\dot{X} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$<br>$y = [1 \quad 2]\,X$ | **7** | 4 | 4 |
| (ii) | Determine the state transition matrix for the given state matrix<br>$A = \begin{bmatrix} -3 & 1 \\ 0 & -3 \end{bmatrix}$ | **6** | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| 15. (a). | Design a lag compensator for a unity feedback system with transfer function, $G(s) = \frac{K(S+4)}{(S+2)(S+8)(S+12)}$ given the following specifications: Static error constant = 100, phase margin = 40°. | 13 | 5 | 4 |
| | OR | | | |
| 15 (b) (i) | Write down the design procedure for lead compensator. | 8 | 5 | 4 |
| (ii) | With the suitable block diagrams and equations explain the P, PI and PID controllers. | 5 | 5 | 4 |

## PART- C(1x 15=15Marks)

| Q.No | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 16. (i) | Find the range of K to keep the system shown in Figure to be stable   | 8 | 2 | 5 |
| (ii) | For the electrical network shown in figure, write down the necessary equations to get an expression for $V_0(s)$ in terms of the sources $V_1(s)$ and I(s).   | 7 | 4 | 5 |