Code No: AEEB16

# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

**Dundigal, Hyderabad - 500 043**

## MODEL QUESTION PAPER

B. Tech IV Semester Regular Examinations, April/May 2020

Regulations: R18

## CONTROL SYSTEMS

(**Common to EEE & ECE**)

**Time: 3 hours** **Max. Marks: 70**

**Answer ONE Question from each Module**

**All Questions Carry Equal Marks**

**All parts of the question must be answered in one place only**

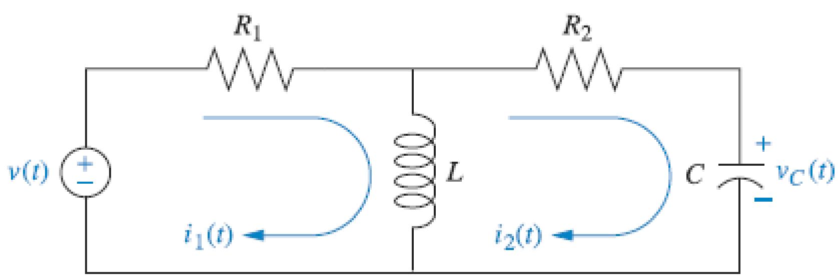
---

### MODULE - I

1. a) Describe the effect of feedback on Gain, Stability, Noise and Sensitivity of a closed loop control system. **[7M]**

   b) Explain the open loop and closed loop configurations of a temperature control system. **[7M]**

2. a) Find the transfer function $I_2(s)/V(s)$ of the electrical network shown in figure. **[7M]**

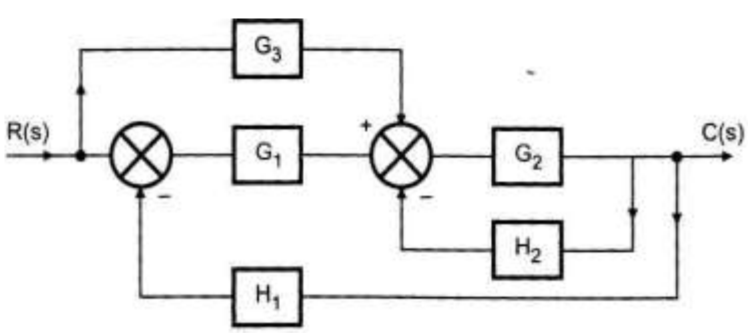



   b) Write the torque balance equations of idealized elements of mechanical rotational systems. **[7M]**

### MODULE – II

3. a) Derive the transfer function of a field controlled DC servomotor and develop its block diagram. State the assumptions made if any. **[7M]**

   b) Find the transfer function for the block diagram shown as below **[7M]**




4. a) Derive the transient response of critically damped second order system when excited by unit step input? **[7M]**

   b) The closed loop transfer function of a unity feedback control system is given by- **[7M]**

$$\frac{C(s)}{R(s)} = \frac{10}{s^2+4s+5}$$

Determine

(i) Damping ratio

(ii) Natural undammed resonance frequency

(iii) Percentage peak overshoot

(iv) Expression for error response

**MODULE – III**

5. a) What are the necessary conditions to have all the roots of characteristics equation in the left half of s-plane? **[7M]**

b) With the help of Routh Hurwitz criterion comments upon the stability of the system having the following characteristic equation $S^6+s^5-2s^4-3s^3-7s^2-4s-4=0$ **[7M]**

6. a) State the effect of addition of poles and zeros on root locus and the stability of the system. **[7M]**

b) Sketch the complete Root Locus of the system given by **[7M]**

$$G(s) = \frac{K}{S(S+2)(S^2+4S+13)}$$

**MODULE – IV**

7. a) Derive expression for resonant peak and resonant frequency and hence establish correlation between time and frequency response. **[7M]**

b) Sketch the Bode plot for the open loop transfer function **[7M]**

$$G(s) = \frac{10(S+3)}{S(S+2)(S^2+4S+100)}$$

8. a) For a second order system with unity feedback G(s)=$\frac{200}{s(s+8)}$.find various frequency domain specifications. **[7M]**

b) Sketch polar plot for G(S) = $\frac{1}{S^2(1+s)(1+2s)}$ with unity feedback system. Determine gain margin and phase margin. **[7M]**

**MODULE – V**

9. a) Write the necessary and sufficient conditions for complete state controllability and observability? **[7M]**

b) Convert the following system matrix to canonical form and hence calculate the STM. A=$\begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$ **[7M]**

10. a) The transfers function of a control system given by $\frac{C(s)}{R(s)} = \frac{6(s+1)}{s(s+2)(s+3)}$. Construct three different state models for this system and draw realization structure for any one of the state models. **[7M]**

b) Design a suitable lag compensator root locus for the system with, **[7M]**

G(S) = $\frac{K}{S(S+1)(S+2)}$ to meet the specifications as

a. Damping ratio = 0.5

b. $K_v \geq 5\ sec^{-1}$

Undamped natural frequency = 0.7 rad/sec

# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

**Dundigal, Hyderabad - 500 043**

## COURSE OBJECTIVES:

**The course should enable the students to:**

| **The course should enable the students to:** | |
|---|---|
| I | Organize modeling and analysis of electrical and mechanical systems. |
| II | Analyze control systems by block diagrams and signal flow graph technique. |
| III | Demonstrate the analytical and graphical techniques to study the stability. |
| IV | Illustrate the frequency domain and state space analysis. |

## COURSE OUTCOMES (COs):

| | |
|---|---|
| CO 1 | Classify the types and configurations of control systems and describe the mathematical models of dynamic systems. |
| CO 2 | Apply various techniques to obtain transfer functions and examine the time response of control systems using standard test signals. |
| CO 3 | Analyze the system response and stability in time domain |
| CO 4 | Examine the characteristics and stability of control systems in frequency domain. |
| CO 5 | Obtain the models of control systems in state space form and design compensators to meet the desired specifications. |

## COURSE LEARNING OUTCOMES (CLOs):

| | |
|---|---|
| AEEB16.01 | Differentiate between open loop, closed loop system and their importance in real time applications. |
| AEEB16.02 | Predict the transfer function of translational and rotational mechanical, electrical system using differential equation method. |
| AEEB16.03 | Analyze the analogy between electrical, translation and rotational mechanical systems. |
| AEEB16.04 | Apply the block diagram and signal flow graph technique to determine transfer function of an control systems. |
| AEEB16.05 | Demonstrate the response of first order and second order systems with various standard test signals. |
| AEEB16.06 | Estimate the steady state error and its effect on the performance of control systems and gives the importance of PID controllers. |
| AEEB16.07 | Summarize the procedure of Routh – Hurwirtz criteria to study the stability of physical systems |
| AEEB16.08 | List the steps required to draw the root – locus of any control system and predict the stability. |
| AEEB16.09 | Explain the effect on stability by adding zeros and poles to the transfer function of control system. |

| | |
|---|---|
| AEEB16.10 | Discuss the method of Bode plot and Polar plot to calculate gain margin and phase margin of control system. |
| AEEB16.11 | Describe the characteristics of control system and its stability by plotting Nyquist plot. |
| AEEB16.12 | Compare the behavior of control system in terms of time domain and frequency domain response. |
| AEEB16.13 | Define the state model of control system using its block diagram and give the role of diagonalization in state space analysis. |
| AEEB16.14 | Formulate the state transmission matrix and explain the concept of controllability and observability. |
| AEEB16.15 | Design of lag, lead, lag – lead compensator to improve stability of control system. |
| AEEB16.16 | Apply the concept of different stability criterions and time, frequency response solution to solve real time world applications. |
| AEEB16.17 | Explore the knowledge and skills of employability to succeed in national and international level competitive examinations. |

## MAPPING OF SEMESTER END EXAMINATION - COURSE OUTCOMES

| **SEE Question No** | | **Course Learning Outcomes** | | **Course Outcomes** | **Blooms Taxonomy Level** |
|---|---|---|---|---|---|
| 1 | a | AEEB16.01 | Differentiate between open loop, closed loop system and their importance in real time applications. | CO 1 | Analyze |
| | b | AEEB16.01 | Differentiate between open loop, closed loop system and their importance in real time applications. | CO 1 | Analyze |
| 2 | a | AEEB16.02 | Predict the transfer function of translational and rotational mechanical, electrical system using differential equation method. | CO 1 | Apply |
| | b | AEEB16.03 | Analyze the analogy between electrical, translation and rotational mechanical systems. | CO 1 | Analyze |
| 3 | a | AEEB16.04 | Apply the block diagram and signal flow graph technique to determine transfer function of an control systems. | CO 2 | Apply |
| | b | AEEB16.04 | Apply the block diagram and signal flow graph technique to determine transfer function of an control systems. | CO 2 | Apply |
| 4 | a | AEEB16.05 | Demonstrate the response of first order and second order systems with various standard test signals. | CO 2 | Apply |
| | b | AEEB16.05 | Demonstrate the response of first order and second order systems with various standard test signals. | CO 2 | Apply |
| 5 | a | AEEB16.05 | Demonstrate the response of first order and second order systems with various standard test signals. | CO 3 | Apply |

| | | | | | |
|---|---|---|---|---|---|
| | b | AEEB16.05 | Demonstrate the response of first order and second order systems with various standard test signals. | CO 3 | Apply |
| 6 | a | AEEB16.08 | List the steps required to draw the root – locus of any control system and predict the stability. | CO 3 | Understand |
| | b | AEEB16.09 | Explain the effect on stability by adding zeros and poles to the transfer function of control system. | CO 3 | Understand |
| 7 | a | AEEB16.10 | Discuss the method of Bode plot and Polar plot to calculate gain margin and phase margin of control system. | CO 4 | Understand |
| | b | AEEB16.10 | Discuss the method of Bode plot and Polar plot to calculate gain margin and phase margin of control system. | CO 4 | Understand |
| 8 | a | AEEB16.10 | Discuss the method of Bode plot and Polar plot to calculate gain margin and phase margin of control system. | CO 4 | Understand |
| | b | AEEB16.10 | Discuss the method of Bode plot and Polar plot to calculate gain margin and phase margin of control system. | CO 4 | Understand |
| 9 | a | AEEB16.14 | Formulate the state transmission matrix and explain the concept of controllability and observability. | CO 5 | Apply |
| | b | AEEB16.14 | Formulate the state transmission matrix and explain the concept of controllability and observability. | CO 5 | Apply |
| 10 | a | AEEB16.14 | Formulate the state transmission matrix and explain the concept of controllability and observability. | CO 5 | Apply |
| | b | AEEB16.15 | Design of lag, lead, lag – lead compensator to improve stability of control system. | CO 5 | Create |

**Signature of Course Coordinator** **HOD, EEE**