

II Year - II Semester

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## CONTROL SYSTEMS

### Course objectives

1. To introduce the concepts of open loop and closed loop systems, mathematical models of mechanical and electrical systems, and concepts of feedback
2. To study the characteristics of the given system in terms of the transfer function and introducing various approaches to reduce the overall system for necessary analysis
3. To develop the acquaintance in analyzing the system response in time-domain and frequency domain in terms of various performance indices
4. To analyze the system in terms of absolute stability and relative stability by different approaches
5. To design different control systems for different applications as per given specifications
6. To introduce the concepts of state variable analysis, design and also the concepts of controllability and observability

### UNIT-1

#### Introduction

System Control System, Open Loop Control System, Closed loop Control System, Different Examples

#### Mathematical models of Physical Systems

Differential equations of physical systems, Transfer functions, Block diagram Algebra, Signal flow graphs with illustrative examples

#### Effects of Feedback

Feedback Characteristics and its advantages, Linearizing effect of feedback

### UNIT-2

#### Controller Components

DC Servomotor (Armature Controlled and Field Controlled) with necessary derivation for transfer function, AC Servomotor and its transfer function, AC Tachometer, Potentiometer, Synchros, AC Position Control Systems

#### Time Response Analysis

Standard test Signals, Time response of first and second order systems, steady state errors and error constants, Effect of adding a zero to a system, Design specifications of second order systems, Performance indices

### UNIT-3

#### Concepts of Stability and Algebraic Criteria

The concept of Stability, Necessary Conditions for Stability, Routh-Hurwitz Stability Criterion, Relative stability analysis,

#### The Root Locus Technique

Introduction, The Root Locus concepts, Construction of Root Loci

## **UNIT-4**

### **Frequency response analysis**

Introduction, Correlation between time and frequency response, Polar Plots, Bode Plots, Nyquist Stability Criterion

## **UNIT-5**

### **Introduction to Design**

The design problem, Preliminary consideration of classical design, Realization of basic Compensators, Cascade compensation in time domain and frequency domain, Tuning of PID Controllers

## **UNIT-6**

### **State Variable Analysis and Design**

Introduction, Concepts of State, State Variables and State models, State models for linear continuous-time systems, State variables and linear discrete-time systems, Solution of state equations and Concepts of Controllability and Observability.

### **Text Book**

I.J.Nagarath and M.Gopal, “ **Control System Engineering,**” New Age International Publishers, Fifth Edition

### **Reference Books**

1. Katsuhiko Ogata, “Modern Control Engineering,” Pearson, Fifth Edition
2. S. Salivahanan, R. Rengaraj, and G. R. Venkata Krishnan, “ Control Systems Engineering,” Pearson, First Impression
3. Benjamin C. Kuo, Farid Golnaraghi, “ Automatic Control Systems,” Wiley Student Edition, Eighth Edition
4. PadmaRaju and Reddy , “ Instrumentation and Control Systems “, McGrawHill Education ,2016

### **Course Outcomes**

1. This course introduces the concepts of feedback and its advantages to various control systems
2. The performance metrics to design the control system in time-domain and frequency domain are introduced.
3. Control systems for various applications can be designed using time-domain and frequency domain analysis.
4. In addition to the conventional approach, the state space approach for the analysis of control systems is also introduced.