

### 3/4 B.Tech. FIRST SEMESTER

EE5T2

CONTROL SYSTEMS

Credits : 4

Lecture : 4 periods/week  
Tutorial: 1 period /week

Internal assessment: 30 marks  
Semester end examination: 70 marks

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#### Objective:

In this course it is aimed to introduce to the students the principles and applications of control systems in everyday life. The basic concepts of block diagram reduction, time domain analysis solutions to time invariant systems and also deals with the different aspects of stability analysis of systems in frequency domain and time domain.

#### Learning Outcomes :

1. Student mainly understands the basic concepts and applications of control systems in day to day life.
2. Understands the transfer function analysis in mathematical modeling of control system which helps mainly in stability and designing of control systems.

#### UNIT I Introduction

Concepts of Control Systems- Open Loop and closed loop control systems and their differences- Different examples of control systems- Classification of control systems, Feed-Back Characteristics, Effects of feedback.

Mathematical models – Differential equations, Impulse Response and transfer functions - Translational and Rotational mechanical systems

#### UNIT II Transfer Function Representation

Transfer Function of DC Servo motor - AC Servo motor- Synchro transmitter and Receiver, Block diagram representation of systems considering electrical systems as examples -Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

#### UNIT III Time Response Analysis

Standard test signals - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications – Steady state response - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems.

#### UNIT IV State Space Analysis of Continuous Systems

Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability

#### UNIT V Stability Analysis In S-Domain

The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability

#### Root Locus Technique:

The root locus concept - construction of root loci-effects of adding poles and zeros to  $G(s)H(s)$  on the root loci.

#### UNIT VI Stability Analysis In Frequency Domain

Polar Plots- Phase margin and Gain margin - Nyquist Plots-Magnitude vs phase plot - Stability Analysis.

## **UNIT VII      Frequency Response Analysis**

Introduction, Frequency domain specifications-Bode diagrams-Determination of Frequency domain specifications and transfer function from the Bode Diagram-Phase margin and Gain margin-Stability Analysis from Bode Plots.

## **UNIT VIII      Classical Control Design Techniques**

Compensation techniques – Lag, Lead, Lead-Lag Controllers design in frequency Domain, PID Controllers.

### **Learning resources**

#### **Text Books:**

1. Automatic Control Systems– by B. C. Kuo 2003– John wiley and son's., 8th edition
2. Control Systems Engineering – by I. J. Nagrath and M. Gopal, New Age International (P) Limited, Publishers, 2<sup>nd</sup> edition.
3. Modern Control Engineering – by Katsuhiko Ogata – Prentice Hall of India Pvt. Ltd., 3<sup>rd</sup> edition, 1998.

#### **Reference Books:**

1. Control Systems by N.K.Sinha, New Age International (P) Limited Publishers, 3<sup>rd</sup> Edition, 1998.
2. Control Systems Engg. by NISE 3<sup>rd</sup> Edition – John wiley
3. “Modelling & Control Of Dynamic Systems” by Narciso F. Macia George J. Thaler, Thomson Publishers.