II Year II Semester	**L**	**T**	**P**	**C**
17EE403	**3**	**1**	**0**	**3**

CONTROL SYSTEMS

Preamble:
This course introduces the elements of linear control systems and their analysis. Classical methods of design using frequency response. The state space approach for design, modeling and analysis of simple PD and PID controllers.

Learning Objectives:
- To learn the mathematical modelling of physical systems and to use block diagram algebra and signal flow graph to determine overall transfer function
- To analyse the time response of first and second order systems and improvement of performance by proportional plus derivative and proportional plus integral controllers
- To investigate the stability of closed loop systems using Routh's stability criterion and the analysis by root locus method.
- To present the Frequency Response approaches for the analysis of linear time invariant (LTI) systems using Bode plots, polar plots and Nyquist stability criterion.
- To discuss basic aspects of design and compensation of linear control systems using Bode plots.
- Ability to formulate state models and analyse the systems. To present the concepts of Controllability and Observability.

Unit – I
Mathematical Modelling of Control Systems:
Classification of control systems, Open Loop and closed loop control systems and their differences, Feed-Back Characteristics, transfer function of linear system, Differential equations of electrical networks, Translational and Rotational mechanical systems, Transfer Function of DC Servo motor - AC Servo motor- Synchro, transmitter and receiver – Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

Unit – II
Time Response Analysis:
Standard test signals - Time response of first and second order systems - Time domain specifications - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems.

Unit – III
Stability and Root locus Technique:
The concept of stability – Routh's stability criterion –limitations of Routh's stability –Root locus concept - construction of root loci (Simple problems)

Unit – IV
Frequency Response Analysis:
Introduction to Frequency domain specifications-Bode diagrams- transfer function from the Bode Diagram-Phase margin and Gain margin-Stability Analysis from Bode Plots, Polar Plots, Nyquist Stability criterion.

Unit – V:
Classical Control Design Techniques
Lag, Lead, Lag-Lead compensators, design of compensators – using Bode plots

Unit – VI:
State Space Analysis of LTI Systems:
Concepts of state, state variables and state model, state space representation of transfer function, Diagonalization- Solving the time invariant state equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

Course Outcomes:
- Ability to derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
- Capability to determine time response specifications of second order systems and to determine error constants.
- Acquires the skill to analyse absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- Capable to analyse the stability of LTI systems using frequency response methods.
- Able to design Lag, Lead, Lag-Lead compensators to improve system performance from Bode diagrams.
- Ability to represent physical systems as state models and determine the response. Understanding the concepts of controllability and observability.

Text Books:
1. Control Systems principles and design, M.Gopal, Tata McGraw Hill education Pvt Ltd., 4th Edition.
2. Automatic control systems, Benjamin C.Kuo, Prentice Hall of India, 2nd Edition.

References:
1. Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India.
2. Control Systems, ManikDhanesh N, Cengage publications.
3. Control Systems Engineering, I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition.
4. Control Systems Engineering, S.Palani,TataMcGraw Hill Publications.