EC317: Control Systems

Details of course:-

Course Title	Course Structure			Pre-Requisite:
	L	T	P	
Control Systems	3	1	0	Signals and Systems, Network Theory

Course Objectives:

1. To introduce students to the fundamental concepts of control systems, including system classification, feedback mechanisms, and mathematical modeling techniques.
2. To help students understand stability and performance analysis of control systems using tools like root locus, Bode plots, and Nyquist plots.
3. To develop the ability to design compensators, such as lead-lag compensators, to meet specific system requirements
4. To enable students to analyze the effects of system parameters on stability and performance using classical and frequency-domain approaches.
5. To provide a comprehensive understanding of state-space modeling, including controllability, observability, and state-feedback design in control systems.

Course Outcomes:

CO1: Explain the classification of control systems, their mathematical models, and the role of feedback in achieving stability and performance improvement.

CO2: Apply classical techniques, including root locus, Bode plots, and Nyquist criteria, to determine the stability and performance of control systems.

CO3: Analyze system responses in time and frequency domains to assess transient and steady-state behavior and evaluate system performance indices.

CO4: Investigate the impact of controllers and compensators, such as P, PI, PID, lead, and lag compensators, on the dynamic behavior and stability of control systems

CO5: Assess state-space representations for controllability and observability, and design state-feedback solutions to enhance control system performance.

S. No.	Content	Contact Hours
Unit 1	Introduction to Control System: Linear, Non Linear, Time Varying and Linear Time Invariant System, Mathematical Modelling of Physical Systems, Differential Equations of Physical Systems, Transfer Functions, Block Diagram Algebra and Signal Flow Graphs. Feedback and Non feedback Systems. Reduction of Parameter Variations by use of Feedback Control Over System Dynamics. Feedback Control of Effects of Disturbance	10
Unit 2	Time Response Analysis: Standard Test Signals, Time Response of First-order Systems, Time Response of Second-Order Systems, Steady-State Error and Error Constants, Effect of Adding a Pole/ Zero to a System, P, PI and PID Control Action and Their Effect, Design Specifications of Second-Order Systems and Performance Indices. The Concept of Stability, Necessary Conditions for Stability, Hurwitz Stability Criterion, Routh Stability Criterion and relative Stability Analysis. The Root Locus Concept, Construction of Root Loci, Root Contours, Systems with Transportation Lag, Sensitivity of the Roots of the Characteristic equation, MATLAB: Analysis and Design of Control Systems	12
Unit 3	Frequency Response Analysis: Correlation Between Time and Frequency Response, Polar Plots, Nyquist plots Bode Plots. Stability in Frequency Domain: Mathematical Preliminaries, Nyquist Stability Criterion, Calculation of Gain Margin and Phase Margin in Nyquist Plot and Bode Plot, Assessment of Relative Stability Using Nyquist Criterion and Closed-Loop Frequency Response	10
Unit 4	Compensator and Physical System Design: Design of Lag, Lead, Lead Lag compensator; DC and AC Servomotors,Synchro Error Detector and Tacho Generator.	04
Unit 5	Control Systems Analysis in State Space: State-Space Representations of Transfer-Function Systems in physical variable, phase variable and canonical form, Solving the Time-Invariant State Equation, state transition matrix and its properties,controllability and observability.	06
	Total	42

Books:-

S. No	Name of Books/Authors/Publisher
1	Modern Control Engineering/ Katsuhiko Ogata/Fifth Edition Prentice Hall 2015
2	Automatic Control Systems/ Dr. Farid Golnaraghi, Dr. Benjamin C. Kuo/ 10th Edition Tata McGraw Hills 2017
3	Control System Engineering: I J Nagrath , M Gopal/ 7th Edition New Age International Private Limited 2021