II B.Tech – II Semester
(20EE4006) CONTROL SYSTEMS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
30	70	100	3	-	-	3

Pre-Requisites: Electrical Circuit Analysis

Course Objectives: At the end of the course, the students are supposed to

- Develop a mathematical model of Linear Time-Invariant (LTI) systems either by using transfer function/ state-space approach.
- Analyse the time and frequency response of the LTI system and predict the absolute, asymptotic and relative stability of the system.
- Design a controller for the given LTI system to meet the desired time/frequency-domain specifications
- Justify whether the given state-space representation of an LTI system is controllable/stabilizable.

UNIT-I: Introduction to control systems and mathematical modelling
System &Control Systems, Classifications of control systems, Types of feedback control systems, Industrial control system examples, Control components and their models: Potentiometers, Synchro's, Servo motors, Magnetic and Servo Amplifiers.
Transfer function, modelling of electrical, mechanical & electro-mechanical systems, systems representing in the block diagram, signal flow graph and their reduction properties.

UNIT-II: Time response and Stability analysis of dynamical Systems
Standard Test Signals, Time response of the first and second-order system, Steady-state errors and error constants for different test signals, Transient response of a standard second-order system and its performance specifications.
BIBO Stability, Zero-input and Asymptotic Stability, Routh-Hurwitz Criterion, Root-Locus Technique and Construction of Root-Loci

UNIT–III: Frequency response analysis
Frequency domain specifications, Stability analysis using the Bode plots, Polar and Nyquist Plots. Nyquist Stability Criterion. Correlation between the time and frequency response specifications.

UNIT-IV: Introduction to controller design in frequency-domain
Effect of adding Poles and Zeros to the system transfer function, Error analysis of P, PI, PD, PID controllers. Lead Compensator, Lag Compensator, Lag-Lead Compensator, Design of compensators using Root-locus approach and Bode plot.

UNIT-V: Introduction to state space analysis
State-Space modelling of physical systems, Significance of state-space representation, Correlation between transfer function and state-space models, Diagonalization of State Matrix, State transition matrix: significance and properties, Solution to state equations, Controllability and Observability. Principle of duality.

Course Outcomes:

After successful completion of the course, the students will be able to:

S.No	Course Outcome	BTL
1.	Determine the transfer function/state-space model for linear time-invariant (LTI) electrical, mechanical and electro-mechanical systems by extracting their differential equations	L5
2.	Illustrate the second-order LTI system time and frequency responses and anticipate their stability based upon the characteristics and specifications	L3
3.	Design a classic compensator/controller to improve the dynamic performance of the LTI system	L6
4.	Analyze the state-space models of an LTI system and justify their suitability towards the compensator design.	L4

Correlation of COs with POs& PSOs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	-	1	-	-	-	-	-	-	-	-	-	-	2
CO4	3	1	-	-	-	-	-	-	-	-	-	-	-	2

Text Books:

1. *Benjamin C. Kuo*, Farid Golnaraghi., Automatic Control Systems, Prentice-Hall of India Pvt Ltd., New Delhi, 6th edition.
2. Ogata K., Modern Control Engineering, Prentice-Hall of India Pvt Ltd., New Delhi, 3rd edition.
3. M. Gopal, “Control Systems: Principles and Design”, Tata McGraw Hill, 3rd Edition.
4. Nagrath I.J and Gopal M, “Control Systems Engineering”, New Age Publishers, 5thEdition, 2009.

Reference Books:

1. Norman S. Nise, “Control System Engineering”, John Wiley & Sons, 6th Edition.
2. Dorf, R.C and Bishop, R.H, “Modern Control Systems", Addison-Wesley, 12thEdition, 2011.