COURSE CONTENT

CONTROL SYSTEMS								
II Semester: EEE								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
2540229	**Core**	3	0	0	3	40	60	100
Contact Classes:45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:45**		
Prerequisites: Electrical Engineering.								

Course Overview:

This course introduces control systems, covering system modeling, time- and frequency-domain analysis, stability, classical controllers, compensators, and state-variable methods. It equips students with skills to analyze and design reliable feedback control systems.

Course Objectives:

1. To understand the fundamental concepts of control systems, including open-loop and closed-loop systems, feedback, and its effects on system performance.
2. To mathematically model physical systems and analyze them using transfer functions, block diagrams, and signal flow graphs.
3. To analyze the dynamic behavior of systems in both time and frequency domains, including stability assessment and system performance evaluation.
4. To design and implement classical controllers such as P, PI, PD, and PID controllers, as well as compensators like lead, lag, and lead-lag.
5. To apply state-space techniques for modeling, solving state equations, and analyzing controllability and observability of dynamic systems.

Course Outcomes: After Completion of the Course, Students should be able to

1. Model mechanical and electrical systems mathematically using transfer function and state-space approaches.
2. Analyze transient and steady-state response of first and second-order systems and assess their performance in time domain.
3. Evaluate system stability and relative stability using Routh-Hurwitz, Root Locus, Bode, Nyquist, and polar plot techniques.
4. Design classical controllers and compensators meeting desired system specifications.
5. Determine complete system response, controllability, and observability of systems using state-space techniques.

UNIT - I: Mathematical modelling of physical systems: Open – loop and Closed loop Systems, Concept of Feedback Control, Benefits of Feedback and Effects of feedback, Linear, Non-Linear, Time Variant and Time Invariant systems, Mechanical and Electrical Systems. Transfer function, Block-Diagram Techniques, Signal flow graph, Controller Components: DC Servo motors, AC Servomotors, Synchro's.

UNIT - II: Time-Domain Analysis with Input-Output Models: Time response of first and second order systems for standard test inputs. Analysis of standard Second order systems with step input, Types of System, Error Analysis for Linear time Invariant Systems, Design specifications for second-order systems based on the time response. Concept of Stability: Routh-Hurwitz Criteria. Relative Stability analysis, Root-Locus technique: Construction of Root-loci.

UNIT - III: Frequency Domain Analysis: Introduction to frequency response, Relationship between time and frequency response, Concept of Bode plots and construction. Polar plots, Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin.

UNIT - IV: **Classical Controllers and Compensators:** Proportional, Integral and Derivative Controllers- PI, PD and PID controllers, Lead, Lag and Lead-Lag compensators (elementary treatment only).

UNIT - V: State Variable Analysis: Concept of State, State variables and State model. State Representation, Transformation of State variables, Solution of state equations and Complete response of the Systems. Concept of controllability and observability.

TEXT BOOKS:

1. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.
2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
3. Norman S Nise, "Control Systems Engineering", Wiley, 2019 8th Edition.

REFERENCE BOOKS:

1. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
2. K. R. Varmah, "Control Systems", McGraw Hill Education, 2010.

ELECTRONIC RESOURCES:

1. https://nptel.ac.in/courses/108/105/108105086/
2. https://www.electrical4u.com/control-systems-time-domain-analysis/
3. https://www.electrical4u.com/frequency-response-analysis/
4. https://www.electrical4u.com/control-systems-controllers-and-compensators/
5. https://www.electrical4u.com/state-space-analysis/
6. https://archive.nptel.ac.in/courses/108/105/108105086/

MATERIALS ON LINE:

1. Course template
2. Tutorial question bank
3. Tech talk and Concept Video topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper–I
8. Model question paper–II
9. Lecture notes
10. E-Learning Readiness Videos (ELRV)