CONTROL SYSTEMS

IV Semester: ECE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AEE009	Core	L	T	P	C	CIA	SEE	Total
		3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes:15		Practical Classes: Nil			Total Classes: 60		

OBJECTIVES:

The course should enable the students to:

I. Organize modeling and analysis of electrical and mechanical systems.
II. Evaluate systems by applying block diagrams, signal flow graphs to study the time response.
III. Demonstrate the analytical and graphical techniques to study the stability to design the control system.
IV. Illustrate the frequency domain and state space analysis.

COURSE LEARNING OUTCOMES (CLOs):

1. Understand the concept of open loop and closed loop systems with real time examples.
2. Derive the mathematical model for electrical and mechanical systems using differential equations.
3. Identify the equivalent model for electrical and mechanical systems using force voltage and force current analogy.
4. Discuss the block diagram reduction techniques and effect of feedback in open loop and closed loop systems.
5. Evaluate the transfer function of signal flow graphs using Mason's gain formula and apply standard test signals for transient analysis.
6. Evaluate steady state errors and error constants for first and second order systems by using step, ramp and impulse signals.
7. Apply Routh Hurwitz stability criterion to find the necessary and sufficient conditions for stability.
8. Analyze and apply the design procedures of root locus for stability and discuss the effect of poles and zeros on stability.
9. Implement controllers using proportional integral, proportional derivative and proportional integral derivative controllers.
10. Understand the concept of frequency domain and discuss the importance of resonant frequency, resonant peak and bandwidth on stability.
11. Evaluate the performance of stability using bode plot; polar plot and nyquist plot and calculate the gain crossover frequency and phase crossover frequency.
12. Analyze the gain margin and phase margin for higher order systems and demonstrate the correlation between time and frequency response.
13. Understand the concept of state, state variables and derive the state models from block diagrams.
14. Apply state space design techniques for modeling and control system design. Formulate and solve state-variable models of linear systems.
15. Apply analytical methods to system models: controllability, observability, and stability. Design a lag, lead and lag lead networks for stability improvement.

16. Applications of the principles of communication engineering and digital signal processing.		
UNIT-I	**INTRODUCTION AND MODELING OF PHYSICAL SYSTEMS**	**Classes: 08**
Control systems: Introduction, open loop and closed loop systems, examples, comparison, mathematical models and differential equations of physical systems, concept of transfer function, translational and rotational mechanical systems, electrical systems, force voltage and force current analogy.		
UNIT - II	**BLOCK DIAGRAM REDUCTION AND TIME RESPONSE ANALYSIS**	**Classes: 10**
Block Diagrams: Block diagram representation of various systems, block diagram algebra, characteristics of feedback systems, servomotors, signal flow graph, Mason‘s gain formula; Time response analysis: Standard test signals, shifted unit step, ramp and impulse signals, shifting theorem, convolution integral, impulse response, unit step response of first and second order system, time response specifications, steady state errors and error constants.		
UNIT - III	**STABILITY ANALYSIS AND CONTROLLERS**	**Classes: 09**
Concept of stability: Necessary and sufficient conditions for stability, Routh‘s and Routh Hurwitz stability criterions. Root locus technique: Introduction, root locus concept, construction of root loci, graphical determination of k for specified damping ratio, relative stability, effect of adding zeros and poles on stability. Controllers: Proportional, derivative and proportional derivative, proportional integral and PID controllers.		
UNIT - IV	**FREQUENCY DOMAIN ANALYSIS**	**Classes: 10**
Frequency domain analysis: Introduction, frequency domain specifications, stability analysis from Bode plot, polar plot, Nyquist plot, calculation of gain margin and phase margin, determination of transfer function, correlation between time and frequency response.		
UNIT - V	**STATE SPACE ANALYSIS AND COMPENSATORS**	**Classes: 08**
State Space Analysis**:** Concept 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 properties, concept of controllability and observability; Compensators: Lag, lead, lag lead networks.		
Text Books:		
1. I. J. Nagrath, M. Gopal, ―Control Systems Engineering‖, New Age International Publications, 3rd Edition, 2007. 2. K. Ogata, ―Modern Control Engineering‖, Prentice Hall, 4th Edition, 2003. 3. N. C. Jagan, ―Control Systems‖, BS Publications, 1st Edition, 2007.		
Reference Books:		
1. A. Anand Kumar, ―Control Systems‖, PHI Learning, 1st Edition, 2007. 2. S Palani, ―Control Systems Engineering‖, Tata McGraw Hill Publications, 1st Edition, 2001. 3. N. K. Sinha, ―Control Systems‖, New Age International Publishers, 1st Edition, 2002.		

Web References:

1. https://www.researchgate.net
2. https:// www.aar.faculty.asu.edu/classes
3. https://www.facstaff.bucknell.edu/
4. https://www.electrical4u.com
5. https://www.iare.ac.in

E-Text Books:

1. https://www.jntubook.com/
2. https://www.freeengineeringbooks.com