

COURSE CODE	COURSE TITLE	L	T	P	C
1152AE142	Non Linear Control System	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

This course aims to explore and develop a deep knowledge in nonlinear control systems.

b. Prerequisite Courses:

Linear systems and control

c. Related Courses:

Nil

d. Course Educational Objectives :

- To understand the concepts of nonlinear systems.

e. Course Outcomes :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain mathematical modelling	K2
CO2	Classify systems	K3
CO3	Derive second order systems	K3
CO4	Solve second order systems	K3
CO5	Analyze second order systems	K3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	H			H	H		H	H
CO2	H		H	H	H			H	H		H	H
CO3	H		H	H	H			H	H		H	H
CO4	H	H	H	H	H			H	H		H	H
CO5	H	H	H	H	H			H	H		H	H

H- High; M-Medium; L-Low

UNIT I MATHEMATICAL PRELIMINARIES

9

Modeling of simple mechanical systems, degree-of-freedom, configuration spaces and state-space representation, equilibrium points/operating points, Jacobian linearization.

Review of mathematical preliminaries on point-set topology, normed spaces, Lipschitz continuity, existence and uniqueness of solution of ODE's.

UNIT II INTRODUCTION TO SIMPLE MECHANICAL SYSTEMS 9

Notion of vector field, trajectories, vector field plot, phase-plane portrait, positively invariant sets and classification of equilibrium points.

UNIT III SECOND-ORDER NONLINEAR SYSTEMS 9

Second-order systems, Periodic solution, Bendixson's theorem and Poincare-Bendixson criteria.

UNIT IV PERIODIC SOLUTIONS 9

Various notions of stability such as Lyapunov stability, Asymptotic stability, Exponential stability.

UNIT V STABILITY ANALYSIS 9

Stability analysis using Lyapunov's direct and indirect method, La Salles's invariance principle and singular perturbation.

TOTAL: 45

REFERENCES:

1. [Khalil](#), "Nonlinear Systems", Pearson Education India
2. [Smarajit Ghosh](#), "Control Systems: Theory and Applications", Pearson Education India
3. [Laura Menini](#), "Current Trends in Nonlinear Systems and Control", Springer