Course Type	Course Code	Name of Course	L	T	P	Credit
DE	**NMCD528**	Nonlinear Dynamics and Chaos	3	0	0	3

Prerequisite

- One should have idea about first order ODEs, Difference Equations and Matlab. Basics of Matrix theory.

Course Objective

- The objective of the course is to foster the knowledge of dynamical system Theory and its wide range of Applications to the students. It will help the students to visualize the various interesting dynamics in real world scenario.

Learning Outcomes

Upon successful completion of this course, students will:

- have a broad understanding of the concepts Dynamical System Theory and their real world applications.
- It also provides idea of analyzing the bifurcation scenario of different continuous and discrete dynamical systems.
- It helps students in understanding the concept of chaotic dynamics and its visualization. Also the concept of fractal dynamics in real life situations.
- Different approaches to solve nonlinear dynamical systems either by reducing the dimensionality or removing the nonlinearity.

Unit No.	Topics to be Covered	Contact Hours	Learning Outcome
1.	1D map, Logistic map, Circle map, Henon map, generalized Baker's map, Horseshoe map,	5	Broad understand of the concepts of maps and their real world Applications
2.	Dynamical systems and its mathematical models, Hamiltonian Systems. Construction of Lyapunov function and testing of stability. Phase plane analysis, Limit cycles,	8	Broad understand of the concepts of Dynamical System Theory and their real world applications
3.	Bifurcations - Saddle-node bifurcation, Transcritical bifurcation, Pitchfork bifurcation, PD bifurcation, Hopf-bifurcation, Global bifurcations of cycles.	8	It provides idea of analyzing the bifurcation scenario of different continuous and discrete dynamical systems. How to handle the extreme situation when dynamics changes?
4.	Introduction to Chaotic dynamic, Primary root to chaos, Transients and Attractors. Lyapunov exponent, Strange attractors, Lorenz system, Rossler system, Chaos in Mass-Spring system.	8	It helps students in understanding the concept of chaotic dynamics and its visualization. Also the chaotic dynamics in mechanical systems.
5.	Central manifold theory and Normal form theory and its Applications.	8	Different approaches to solve nonlinear dynamical systems either by reducing the dimensionality or removing the nonlinearity.
6.	Fractals dimentions, Box-counting, point wise and correlation, Hausdorff dimensions.	5	Also the concept of fractal dynamics in real life situations.
Total		**42**	

Text Books:

1. S. Wiggins, Introduction to applied nonlinear dynamical systems and chaos (Vol. 2). Springer Science & Business Media, 2003.
2. S.H. Strogatz, Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry, and Engineering, 1994.

Reference Books:

1. R.K. Upadhyay, S.R. K. Iyengar, Introduction to mathematical modeling and chaotic dynamics. Chapman and Hall/CRC, 2013.
2. L. Perko, Differential equations and dynamical systems, Springer Science & Business Media, 1991.