GENERIC ELECTIVE (GE – 9): APPLIED DYNAMICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
APPLIED DYNAMICS GE – 9	4	3	1	0	Passed 12th Class	NIL

LEARNING OBJECTIVES

This course introduces the main topics of low-dimensional nonlinear systems, with applications to a wide variety of disciplines, including physics, engineering, mathematics, chemistry, and biology. This course begins with the first order dynamical system and the idea of phase space, flows and trajectories and ends with the elementary fluid dynamics. The nature of the subject demands that the tutorials should include only computational problems.

LEARNING OUTCOMES

Upon successful course completion, a student will be able to:

- Demonstrate understanding of the concepts that underlay the study of dynamical systems.
- Learn various forms of dynamics and different routes to chaos.
- Understand basic Physics of fluids and its dynamics

SYLLABUS OF GE 9

THEORY COMPONENT

Unit – I **(22 Hours)**

Introduction to Dynamical systems: Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Concept of stability and un-stability. Simple mechanical systems as first order dynamical systems: simple and damped harmonic oscillator. Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems. Examples of dynamical systems – Population models e.g. exponential growth and decay, logistic growth, predator-prey dynamics.

Unit – II **(16 Hours)**

Introduction to Chaos: Bifurcations: Saddle-Node bifurcation, Transcritical bifurcation, Pitchfork bifurcation and Hopf bifurcation. Chaos in nonlinear equations: Logistic map and Lorenz equations. Sensitivity to initial states. Parameter dependence: steady, periodic and chaotic states. Cobweb iteration. Simple examples from physics, chemistry, engineering and lifesciences.

Unit – III **(7 Hours)**

Elementary Fluid Dynamics: Basic physics of fluids: The continuum hypothesis-concept of

fluid element or fluid parcel; Definition of a fluid- shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity and equation of state.

References:

Essential Readings:

1) Nonlinear Dynamics and Chaos, S. H. Strogatz, Westview Press, 2nd Edition, 2014
2) Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer New York, 1995
3) Nonlinear Dynamics: Integrability, Chaos and Patterns, M. Lakshmanan and S. Rajasekar, Springer, 2003
4) An Introduction to Fluid Dynamics, G. K. Batchelor, Cambridge University Press, 2002
5) Fluid Mechanics, 2nd Edition, L. D. Landau and E. M. Lifshitz, Pergamon Press, Oxford, 1987

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