Course No	Course Name	L-T-P-Credits
MA 541	**Applied Dynamical Systems**	**3-0-0: 3**

Prerequisite: Ordinary Differential Equations

Course Objectives: The objective of this course is to understand the qualitative nature of autonomous system and discrete maps. One of the important purposes is to establish stability of the system dynamics and discuss about different bifurcation theories which are useful to apply in control theory and mathematical modelling.

Course Outcomes: After successful completion of the course, students will be able to:

1. Define flow and its properties in dynamical system.
2. Find equilibrium and linearize a nonlinear system around equilibrium.
3. Establish global stability of an equilibrium using Lyapunov method.
4. Apply appropriate techniques to rule out the existence of closed orbit in a system.
5. Know the normal form for transcritical bifurcation, saddle-node bifurcation, pitch-fork and Hopf-bifurcations.
6. Understand period doubling bifurcation and chaos in dynamical system.
7. Compute Lyapunov exponent and Fiegenbaum constant, and realize the idea of renormalization and its application

SYLLABUS

Module	Contents	Hours
I	Autonomous and non-autonomous systems, flow in dynamical system, fundamental difference in solutions between autonomous and non-autonomous systems.	3
II	Linearized system, classification of stationary points, attracting and Lyapunov Stability, Hartman-Grobman theorem, phase space analysis, local and global stability in non-linear systems, Lyapunov function and stability analysis, stable and unstable manifolds of an equilibrium, Limit cycles, index theory, Poincare-Bendixson theorem.	15
III	Transcritical bifurcation, saddle-node bifurcation, pitch-fork and Hopf-bifurcations, hmomoclinic and heteroclinic orbits, non-linear centers.	8
IV	Period doubling, strange attractor, Lyapunov exponent, Ruelle-Takens embedding theorem, reconstructing an attractor, Smale horseshoe, Fiegenbaum constant and the renormalization idea.	10

Essential Readings:

1. S. H. Strogatz, “Nonlinear Dynamics and Chaos”, Westview Press, 2nd edition, 2014
2. M. W. Hirsch, S. Smale and R. L. Devaney, “Differential Equations, Dynamical Systems, and an Introduction to Chaos”, Academic Press, 3rd edition,2012

Supplementary Readings:

1. L. Perko, “Differential Equations and Dynamical Systems”, Springer, 3rd edition, 2008.