Department of Mathematics
Faculty of Mathematics & Computer Science
M.Sc. (Applied Mathematics), 3rd Semester

Course Code	AM 304(d)
Course Title	Dynamical Systems
Course Credits	04

Course objectives:

Learn and use various tools for the analysis and control of nonlinear systems. Know and play with a wide variety of interesting, inherently nonlinear examples. Learn how to study complexity of nonlinear systems.

Minimum pre-requisites:

AM 102: Numerical Analysis & Methods
AM 103: Ordinary Differential Equations & Applications
AM 202: Numerics of Ordinary Differential Equations

Course structure:

Linear dynamical systems: Introduction and preparatory material, linear versus nonlinear systems, equilibria, diagonalization, Jordan canonical form, stability, stable, unstable, and center subspaces, non- homogeneous systems; **Solutions of nonlinear dynamical systems**: Preliminary concepts, solutions of initial value problems, existence and uniqueness of solutions, continuous dependence on initial conditions and parameters, flows, classical examples. **Linearization methods for nonlinear dynamical systems**: Linearization, invariant manifolds, stable, unstable and center manifolds, Hartman-Grobman theorem; **Lyapunov stability theory for nonlinear dynamical systems**: Lyapunov functions, Lie derivative, stability and instability theorems, LaSalle Invariance Principle, exponential stability; **Global theory of nonlinear dynamical systems**: Periodic orbits, limit cycles, attractors, Poincar'e-Bendixon theorem, Poincar'e maps, index theory, examples: harmonic oscillator, Duffing's equation, and Lotka-Volterra predator-prey model; **Bifurcation theory for nonlinear dynamical systems**: Bifurcations of vector fields, saddle-node,

transcritical, pitchfork and Hopf bifurcations, codimension of a bifurcation, stability under perturbations, structural stability, Euler's buckling beam and van der Pol oscillator.

Reading Suggestions:

- Differential Equations and Dynamical Systems, 3rd Edition, 2006, L Perko.
- Differential Dynamical Systems, 2007, James Meiss, SIAM.
- Dynamical Systems with Applications using Maple 2nd Ed, 2010, Stephen Lynch, Springer.
- Introduction to Applied Nonlinear Dynamical Systems and Chaos, 2003, Stephen Wiggins, Texts in Applied Mathematics, Springer.

Evaluation and weightage:

- Computer Assignment 1 :10%
- Computer Assignment 2 :10%
- Lab :10%
- Mid Term Exam :30%
- End Term Exam :40%