Approval: 2nd Adhoc Meeting

MA460 Nonlinear Dynamics and Chaos

Credit: 3-0-0-3

Prerequisites: MA 101 and MA 102

Students intended for: B Tech 3rd year

Elective or Core: Elective Semester: Even

Course objective:

It is an applied mathematics course designed to provide an introduction to the theory and basic concepts of Nonlinear Dynamics and Chaos. The course concentrates on simple models of dynamical systems, their relevance to natural phenomena. The main goal of the course is to introduce and describe nonlinear phenomena in physical systems by only using a minimum background in physics and mathematics. The emphasis is on nonlinear phenomena that may be described by few variables that evolve with time. There will be problem sets that will require use of computer. The computer exercises is mainly based on the use of MATLAB, but students will be free to use different software tools as desired.

Course content:

- Introduction to Nonlinear Dynamics and Chaos, Recent applications of Chaos, Computer and Chaos, Dynamical view of the world [3 hours]
- Basics of nonlinear science: Dynamics, Dynamical Systems, Types of Dynamical Systems, Nonlinearity, Dissipative Systems, Deterministic versus Stochastic Systems, Degree of Freedom, State Space, Phase Space, Attractor [5 hours]
- Stability of solutions to Ordinary Differential Equations [4 hours]
- Flows on line, Fixed Points and its Stability, Analytical Approach, Graphical approach, Simulation of Equations [5 hours]
- Elementary Bifurcation Theory: Saddle Node, Transcritical, Pitchfork, Imperfect, Hopf bifurcation [5 hours]
- Two dimensional Flows, Simple Harmonic Mass-Spring Oscillator [4 hours]
- Limit Cycle, Ruling out closed orbits, Poincare Benedixson theorem [4 hours]
- Butterfly Effect, Chaos, Lorenz Equations, Application of Chaos in sending secret messages, Introduction to Fractals, Dimensions of fractals, Cantor Set and Koch curve [6 hours]
- One dimensional map, Logistic Map, Period doubling Route to chaos, Feigenbaum constants [5 hours]

Text Book

Chaos: An Introduction to Dynamical systems, K.Allgood, T.Sauer, J.A.Yorke, Springer Verlag

Nonlinear Dynamics: a two way trip from Physics to Maths, H.G. Solari, M.A. Natiello and G.B. Mindlin, Overseas publication

Reference Books

Does God Play a Dice? The Mathematics of Chaos, Ian Stewart, Blackwell, NewYork.

Nonlinear Dynamics Integrability Chaos and Pattern, Laksmanan M Rajsekhar, Springer.

Chaotic and Fractal Dynamics, F.C. Moon, Wiley