Dynamical Systems (MATH11027) 2010/2011

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Introduction. This course provides an introduction to the qualitative theory of dynamical systems, their long-term behaviour and the concept of 'chaos'. The emphasis is on discrete systems (i.e., iterated maps), but the connection between discrete systems and continuous systems (i.e., systems of ODEs) is explored. Examples of dynamical systems (both discrete and continuous) which arise from problems in various sciences will be studied to illustrate the theory.

Aims.

1. To establish the concepts of discrete and continuous dynamical systems
2. To explore the stability of dynamical systems
3. To introduce bifurcation theory and the notion of chaotic systems

Prerequisite. 3rd year course in Differential Equations or equivalent.

Course outline. Concepts of continuous and discrete dynamical systems. Orbits, fixed points and periodic orbits. Poincare maps. Classification of fixed points for linear discrete systems. Fixed points in nonlinear systems: stable and unstable manifolds. Bifurcation theory for one and two dimensional systems: saddle-node, flip and Hopf bifurcations. Logistic map: period-doubling cascade and chaos. Chaotic attractors and fractals.

Texts. The course does not follow any one particular text, but the following books may be useful: (*=recommended, **=strongly recommended)

1. R.L. Devaney, *An Introduction to Chaotic Dynamical Systems*, Benjamin/Cummings (**)
2. Alligood, Sauer and York, *Chaos: An Introduction to Dynamical Systems*, Springer (*)
3. S.H. Strogatz, *Nonlinear Dynamics and Chaos*, Westview Press (*)
4. J. Guckenheimer and P. Holmes, *Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields*, Springer
5. P.G. Drazin, *Nonlinear Systems*, Cambridge University Press
6. Arrowsmith and Place, *Dynamical Systems: Differential Equations, Maps and Chaotic Behaviour*, Chapman & Hall
7. J.T.Sandefur, *Discrete Dynamical Systems: Theory and Applications*, Claredon Press

Assessment. The May exam will count for 100% of the course mark.

Assignments. There will be 4 assignments distributed in weeks 3,5,7 and 9 which are due in weeks 5,7,9 and 10 respectively. These assignments will be marked by the lecturer but they will not be recorded in the final mark. Every student is *strongly* encouraged to submit written solutions to these assigned problems.