UPPSALA UNIVERSITY
DEPARTMENT OF MATHEMATICS
Jörgen Östensson

Ordinary Differential Equations I, 5 credits
Fall 2012

Ordinary Differential Equations I

Course literature

Main book: George F. Simmons, Steven G. Krantz, *Differential Equation - Theory, Technique, and Practice*, McGraw-Hill.
Additional reading: Morris W. Hirsch, Stephen Smale, Robert L. Devaney, *Differential Equations, Dynamical Systems & An Introduction to Chaos*, Third Edition, Elsevier.

Teaching

The course Ordinary Differential Equations I consists of 25 lectures. Five of these will be entirely devoted to problem solving. Nevertheless, you are strongly advised to solve additional problems on your own. A preliminary lecture plan, which can also seen as an outline of the course itself, can be found below. I will certainly not have time to cover everything in class, during which I can only hope to explain the basic ideas. You are expected to study the rest on your own.

Preliminary lecture plan [(SK) means Simmons-Krantz and (HSD) Hirsch-Smale-Devaney.]

Lecture	Contents	Sections in book
1	Introduction to ordinary differential equations (ODE:s). First order equations: Separable, linear, exact and homogeneous.	SK: 1.1–1.8
2–3	Reduction of order. Second order linear equations.	SK: 1.9, 2.1–2.5
4	Some theory: Independence, existence and uniqueness.	SK: 3.2
5	Problem solving.	
6–7	Oscillations and the Sturm separation theorem. The Sturm comparison theorem.	SK: 3.4–3.5
8–9	Power series solutions of ODE:s. Second order linear equations with ordinary and regular singular points.	SK: 4.1–4.5
10–11	Numerical methods for solving ordinary differential equations: Euler's methods and the Runge-Kutta method.	SK: 9.1–9.5
12	Problem solving.	
13–14	Systems of first order equations. Autonomous systems. Trajectories and phase portraits. Planar linear systems. The trace-determinant plane.	SK: 10.1–10.3 SK: 11.3–11.4 HSD: 2.1–2.7 HSD: 3.1–3.4, 4.1
15	Higher-dimensional linear systems.	HSD: 6.1, 6.3
16	The exponential of a matrix. Nonautonomous linear systems.	HSD: 6.4–6.5
17	Problem solving.	
18–19	Nonlinear systems. Picard's existence and uniqueness theorem. Continuous dependence of solutions.	SK: 3.3 HSD: 7.1–7.3
20–21	Equilibria in nonlinear systems. Linearization and stability. Bifurcations.	SK: 11.6 HSD: 8.1–8.5
22	Problem solving.	
23	Nullclines. Liapunov's stability theorem. Conservative systems.	SK: 11.5, 11.7 HSD: 9.1–9.2
24	Periodic solutions: The Poincaré-Bendixson theorem.	SK: 11.8
25	Problem solving.	

A comment on the literature

We will mainly use the book by Simmons and Krantz. The book by Hirsch, Smale and Devaney is for particularly interested students. The material from this book which is part of the course overlaps to a large extent with that in chapters 10–11 in the first book. Provided you read the lecture notes carefully, the book by Simmons and Krantz should be sufficient to pass the course with a good grade. On the other hand, the book by Hirsch, Smale and Devaney is also used in the course Ordinary Differential Equations II, so if you plan to attend this course you might as well buy this book already.

Course web page: http://www2.math.uu.se/∼ostensson/

Here you can find information about the course, e.g. materials handed out in class.

Examination

The course finishes on the 24th of October with a written exam. Maximum score: 40 points. A total score of 18 is needed for the grade 3, 25 for the grade 4, and 32 for the grade 5.

Uppsala, 30th of August 2012.

Jörgen Östensson