

With this letter, we wish to welcome you to the Ph.D.course *Nonlinear Differential Equations and Dynamical Systems*

Aims and Goals

A rough overview of the aims and goals for this course has previously been given in the course catalogue at

http://auaw2.aua.auc.dk/fak-tekn/phd/kurser/s1_4.htm

We have given a similar course before - in 2003; this years course is shorter and it had to be slightly modified to take this into account.

Many problems in science and engineering disciplines can be quite naturally modelled by systems of ordinary (ODEs) or partial differential equations (PDEs). In this course, we will stick to ODEs that usually describe processes developping in *time*. There are ways to calculate solutions for the simplest of such systems, but in most cases, it is not possible to get formulae for solutions at all. In many cases, one can get grasp of the solutions by computerised numerical solutions. But often, one cannot say very much about the nature of solutions, in particular, if some of the coefficients in the system of departure are not precisely determined. In that case, an analysis based on geometrical methods will often help. This course will provide you with the basic geometric ideas and methods and conclude with glimpses into bifurcation theory (how do solutions vary qualitatively along changes in the parameters) and chaos theory (sensitive dependance on initial conditions).

Literature

We ask you to purchase the textbook

Differential Equations, Dynamical Systems and An Introduction to Chaos, Hirsch, Smale & Devaney. 2002, (2nd ed.). Elsevier, ISBN 0-12-349703-5. The book has been ordered by the university bookstore at Fredrik Bajersvej 7B2-221, phone: 9635 8072, e-mail: 8712baj@bogpost.dk . They got it at a very good price, which makes it cheaper than at the internet bookstores. We plan to go through most of the book, although with several omissions. At some instances, we may supplement with handouts. The book is quite easy to follow, there are many examples and exercises.

All course schedules and plans for the sessions will be made available from the web-page

<http://www.math.auc.dk/~fajstrup/UNDERVISNING/PHD/05-1/index.html>.

Software

Dynamical systems, at least in dimension 2, can feel much more alive if one uses mathematical software. We are mainly familiar with MAPLE and will advertise this computer algebra system. But you can certainly also make use of MATLAB, if you prefer and have it available. There are packages that solve systems of differential equations, sometimes algebraically, most often numerically, and you can obtain plots of phase spaces, vector fields and flow lines to get a feeling of what is going on. Moreover, we are going to use linear algebra and need a lot of matrix calculations, and these systems are the right tools to handle all the calculations with. If you do not know MAPLE yet – the university has a site license – we advise you to try the *Quick New User's Tour* in the *Help* Menu (in the right on the top bar), in particular topics (9) and (10).

A nice Java-based graphical solver is available at

www.prenhall.com/divisions/esm/app/ode

Overall plan for a session

The course consists of two blocks of two day sessions and a concluding one day session in the period 9am – 3:00 pm. Our lecture room is G5-109 at the Department of Mathematical Sciences, Fredrik Bajersvej 7G

(<http://www.math.aau.dk/GB/practical/DeptSitu.htm>).

Every session will consist of a mixture of lectures and exercise sessions; sometimes supplemented by counselling on an individual basis and by computer laboratory excursions, that will allow us to give visual/graphical explanations for some of the concepts.

What we expect from the participants

In order to make you benefit from the course as much as possible, we ask you to prepare for every session. We will clearly indicate, which parts of the textbook and/or of handouts we would like you to have looked at beforehand. Having your comments before or at the beginning of a session will make it easier for us to focus on the really interesting or really difficult parts.

Usually, the best spinoff from a course comes from your own activities. It is very hard to grasp theoretical concepts without “getting your hands dirty”. This is why we will ask you to work on a range of exercises – some of them quite dull with the only purpose to train the use of concepts or results, others more advanced needing active reasoning.

What we would like to know about you asap

1. Please describe the mathematical disciplines that you have met after the first year at your university.
2. Are you interested in specific topics covered in the course, or does it mainly serve your “general education” aims?
3. What are your main expectations, what sort of results would you appreciate most?

Please consider these questions and answer them as soon as possible. You may email us at the addresses below.

The plan for the first session will be up at the web-page
<http://www.math.auc.dk/-fajstrup/UNDERVISNING/PHD/05-1/index.html>
 late August. We start on Thursday, Sep. 8 at 9 am, at Fredrik Bajersvej G5-109
 (just walk straight from the entrance).

Looking forward to meeting you,

Lisbeth Fajstrup Martin Raussen Rafal Wisniewski