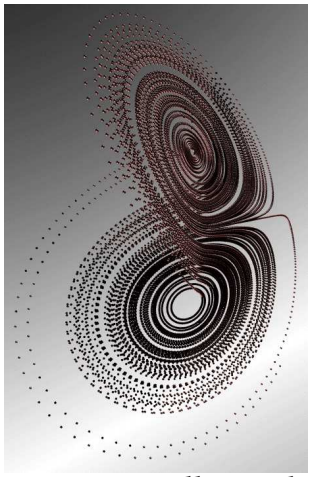

With this letter, we wish to welcome you to the Ph.D.course *Nonlinear Differential Equations and Dynamical Systems*, that takes place in the period March 2 - March 12 at AAU.

Aims and Goals. A rough overview of the aims and goals for this course has previously been given in the course catalogue of the doctoral school of technology and science.

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 with *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 directly calculate or depict 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).

Litterature. We ask you to purchase the textbook
Differential Equations, Dynamical Systems and An Introduction to Chaos by Hirsch, Smale & Devaney. 2004, (2nd ed.). Elsevier, ISBN 0-12-349703-5.

The university bookstore at Fredrik Bajersvej 7B2-221[1] has some copies at a relatively modest prize. We plan to go through substantial parts of the book, although with several omissions. At some instances, we will have to 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 this web-page. Please have a look at this web-page for suggestions for supplementary reading.

Software. Dynamical systems, at least in dimension 2, can feel much more alive if one uses mathematical software. First of all, there is dedicated Java software showing phase planes for 2-dimensional systems, e.g.,

- dfield and pplane
- ODE phase portraits

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Among computer algebra systems, we are mainly familiar with MAPLE and will advertise it. 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. In dimenstion two, 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 `Tour of Maple` in the `Help` Menu (in the right on the top bar), in particular on Matrix Computations and on Differential Equations. Also `Tools`→`Tutors`→`Differential Equations` – `Linear Algebra` may be helpful.

Overall plan for a session. The course consists of five work days starting at 9am and ending at 3:15pm. Our lecture rooms vary from day to day; please check the web page.

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.

The overall plan for one course day is as follows:

09:00 – 09:55	Lecture 1
09:55 – 10:50	Exercise session 1
10:50 – 11:45	Lecture 2
11:45 – 12:30	Lunch break
12:30 – 13:25	Lecture 3
13:25 – 14:20	Exercise session 2
14:20 – 15:15	Lecture 4

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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. 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.

A few exercises will be given as homework. We ask you to hand in your homework (in groups of 1 – 3 people) at a date to be fixed yet. Satisfactory answers to these homework sets are a prerequisite for passing this course.

Please have a look at the course web page at regular intervals. We will post the plans for the sessions at this page soon. The course starts on Tuesday, March 2.

Looking forward to meeting you,

Lisbeth Fajstrup Martin Raussen Rafal Wisniewski

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