22M:142 Nonlinear Dynamics with Numerical Methods

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22M:142:A01, T 1:30 – 2:20 PM, 214 MH

(Library reference: Mathematical Sciences/ MacLean Hall; Course Reserve QA614.8 .H3355 1991)

Additional resources:
1) We will also follow some chapters and examples from
Steven Strogatz – Nonlinear dynamics and chaos: with applications to physics, biology, chemistry and engineering, Addison-Wesley Pub., 1994 (Library reference: Mathematical Sciences/ MacLean Hall; Course Reserve Q172.5.C45 S767 1994)

2) For numerical simulations of dynamical systems we will use the software XPPAUT (called simply: xpp) by Bard Ermentrout (University of Pittsburgh; http://www.math.pitt.edu/~bard/xpp/xpp.html). Computer programming skills are useful but not necessary at this stage. Instructions for how to use xpp will be provided in class.

   The source code is free and can be downloaded from http://www.math.pitt.edu/~bard/bardware/binary/ and installed on your own computer. Moreover the software is already installed on the Linux network in MLH (computer lab rooms B5 and 301). Linux computer accounts will be made available on this Linux network in MLH (Beware: accounts for students who are not majoring in Computer Science, Mathematics or Statistics and Actuarial Science will be deleted after the term has ended!).

3) An excellent tutorial for XPPAUT is the book:
Bard Ermentrout – Simulating, analyzing, and animating dynamical systems : a guide to XPPAUT for researchers and students, Society for Industrial and Applied Mathematics, 2002
(Library reference: Mathematical Sciences/ MacLean Hall; Course Reserve QA371.5.D37 E76 2002)


Course Description/ Goals and objectives:
This course covers nonlinear differential equations, one- and two-dimensional flows, stability, phase plane analysis, limit cycles, bifurcations, chaos, fractals; Euler's, multistep, and Runge-Kutta numerical methods. Applications to physics, chemistry, biology and engineering will be emphasized. The course is at a graduate level and it is assumed that you can work independently. Some theorems and results will be proved but not all (some long and more difficult proofs are discussed in 22M:213, 22M:214).

Grading policy:
- Plus/minus grades will be used in the course grading system
- Homework will be assigned weekly and collected one week from the assignment date
- Your grade will be based on:

  Homework 30%
  Midterm exam 30% (in class, Monday Nov 9th)
  Final exam 40% (in class, Tuesday Dec 15th at 9:45 AM)

The tests are open books and open notes examinations. Considerable improvement of work during the semester will be taken into account.
Schedule of topics:
From the book of Hale & Koçak we will cover: chapters 1-3, 7-11, 14 and part of 12 and 17.
From the book of Strogatz we will cover: chapters 9, 11 and 12.

A tentative schedule is to start with scalar autonomous equations and elementary bifurcations (chapters 1, 2), then continue with the linear systems (ch 8), planar autonomous systems and linearization about equilibria (chapters 7, 9), bifurcations in the presence of a zero eigenvalue and a pair of purely imaginary eigenvalues (chapters 10, 11), periodic orbits (sections 12.1, 12.2), conservative and gradient systems (ch 14), scalar maps (ch 3), fractals (ch 11/Strogatz), Lorentz equations and chaos (section 17.4/H&K and ch 9/Strogatz), strange attractors (ch 12/Strogatz).

This course plan may be modified during semester. Such modifications will be announced in advance during class periods; the student is responsible for keeping abreast of such changes. You should read all sections/handouts corresponding to covered material and/or assignments.

Course policies:
1) Information about the material covered in class, assignments and grades will be posted in ICON. You are urged to use ICON for this course.
2) Late homework will be accepted only by special permission of the instructor.
3) If you feel that your homework score is incorrect, you should first contact the grader. Only when you are not satisfied by his/her resolution, you would come to see me for further discussion.
4) Attendance is expected. You are responsible for material covered in class and announcements made during class (these may include changes in the syllabus).
5) Absences from exams will require a compelling reason and must be arranged with your instructor in advance.
6) All cell phones must be turned off during lecture and exams.

Note:
I would like to hear from anyone who has a disability which may require seating modifications or testing accommodations or other class requirements so that appropriate arrangements may be made. Please contact me during my office hours.

Some of the policies relating to this course (such as the drop deadline) are governed by its administrative home, the College of Liberal Arts and Sciences, 120 SH

The College of Liberal Arts and Sciences Policies and Procedures

Administrative Home: The College of Liberal Arts and Sciences is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall or see the CLAS Academic Handbook [www.clas.uiowa.edu/students/academic_handbook/index.shtml]

Electronic Communication: University policy specifies that students are responsible for all official communications sent to their standard University of Iowa e-mail address (@uiowa.edu). Students should check their account frequently. (Operations Manual, III.II.15.2 k.11.)

Academic Fraud: Plagiarism and any other activities when students present work that is not their own are academic fraud and are considered by the College to be a very serious matter. Academic fraud is reported by the instructor to the departmental DEO who enforces the departmental consequences. The Associate Dean for Undergraduate Programs and Curriculum is also informed. The Associate Dean enforces collegiate consequences which may include suspension or expulsion. See the CLAS Academic Handbook.

Making a Suggestion or Complaint: Students with a suggestion or complaint should first visit the instructor, then the course supervisor and the departmental DEO. Complaints must be made within six months of the incident. See the CLAS Academic Handbook.

Accommodations for Disabilities:
A student seeking academic accommodations should register with Student Disability Services and meet privately with the course instructor to make particular arrangements. For more information, visit www.uiowa.edu/~sds/

Understanding Sexual Harassment: Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Comprehensive Guide on Sexual Harassment at www.uiowa.edu/~cod/policies/sexual-harassment-guide/index.html for assistance, definitions, and the full University policy.

Reacting Safely to Severe Weather: In severe weather, the class members should seek shelter in the innermost part of the building, if possible at the lowest level, staying clear of windows and free-standing expanses. The class will continue if possible when the event is over. (Operations Manual, IV. 16.14. Scroll down to sections e and i for severe weather information.)

Resources for Students: Writing Center: http://www.uiowa.edu/~writingc/
Speaking Center: http://www.uiowa.edu/~rhetoric/centers/speaking.html

*The CLAS policy statements have been summarized from the web pages of the College of Liberal Arts and Sciences