Title of Course: **MATH 5600:0001 Nonlinear Dynamics with Numerical Methods**

Course meeting time and place:
Lecture: **MWF 1:30 PM – 2:20 PM, 113 MLH**

Department of Mathematics: [https://math.uiowa.edu/](https://math.uiowa.edu/)

Course ICON site: To access the course site, log into Iowa Courses Online (ICON) [https://icon.uiowa.edu/index.shtml](https://icon.uiowa.edu/index.shtml) using your Hawk ID and password.

Course Home
The College of Liberal Arts and Sciences (CLAS) is the home of this course, and CLAS governs the policies and procedures for its courses. Graduate students, however, must adhere to the **academic deadlines set by the Graduate College**.

Instructor: **Rodica Curtu**
Office location: **225F MLH**
Office hours: **MWF: 9:30 AM – 10:20 AM or by appointment.**

Phone: **(319) 335-0744**
E-mail: **rodica-curtu@uiowa.edu**

DEO: Associate Professor Ryan Kinser, **ryan-kinser@uiowa.edu**, 14 MLH, 335-0714

Description of Course
This is a course on ordinary differential equations and dynamical systems. Topics to be covered include fundamental solutions of linear systems of differential equations, flows and attractors of nonlinear differential equations, phase plane analysis, limit cycles, invariant manifolds, gradient and Hamiltonian systems, and introduction to chaos theory and to bifurcation theory. Although some mathematical sophistication (e.g., MATH:3600 & 3770 or MATH:3600 & 4210) is required to take the course, a review of the necessary background material will be provided.

Learning Objectives
This is an introductory graduate level course to the theory of dynamical systems, and it is assumed that the students can work independently. Some theorems and results will be proved but not all. Some long and more difficult proofs are to be discussed in MATH:6600 (ODE I) and MAH:6610 (ODE II). The students will acquire fundamental mathematical knowledge of the qualitative properties of dynamical systems depending on parameters and will develop skills for their numerical simulations. The basic plan for the course is as follows:
- Linear Systems: A review on fundamental solutions, matrix exponentials, Floquet theory;
- Nonlinear Systems: existence and uniqueness, flows, attractors;
- Local Nonlinear Theory: invariant manifolds, Hartman-Grobman, Poincaré maps;
- Global Nonlinear Theory: Poincaré-Bendixson, Lyapunov functionals, gradient flows;
- Bifurcations: saddle node, pitchfork, transcritical, Hopf, normal forms.

Textbook/Materials
Your course material is available on your ICON course site; this is called ICON DIRECT. Please read the additional files on ICON.
1. **Main textbooks (see ICON or links below):**
   - Differential Equations, Dynamical Systems & An Introduction to Chaos by Hirsch, Smale, and Devaney
   - Differential Dynamical Systems, SIAM 2007 by James D. Meiss

2. **More textbooks:**
   - Ordinary Differential Equations and Dynamical Systems by Gerald Teschl
   - Differential Equations and Dynamical Systems by Lawrence Perko

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**Grading policy**

With criterion-reference grading, students receive grades based on the quality of their work in relation to the criteria defined by the instructor and by the rubrics or models specifying the qualities of each grade. A tentative grade scheme for the class is given by the following ranges:

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<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A</td>
<td>90-100</td>
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<tr>
<td>B</td>
<td>80-89</td>
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<tr>
<td>C</td>
<td>65-79</td>
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<tr>
<td>D</td>
<td>50-64</td>
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<tr>
<td>F</td>
<td>&lt;50</td>
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</tbody>
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*Plus/minus* grading will be used.

20% Homework assigned weekly - usually due Wednesday at 1:30 pm (written hw, to be submitted in class). For each homework the score (20 points per hw) will be split into 10 points for overall homework completion (i.e., all problems are written / we will only check for completion) and 10 points for correctness of one problem (the students will learn which problem will be graded for correctness only after the homework was collected).

20% (Take-home) Midterm 1 – assigned Monday Oct 2 & due Friday Oct 6 at 1:30 pm in-class

20% (In-class) Midterm 2: 6:30PM - 8:30PM Monday Oct 16, 2023 SHAM LIB

20% (Take-home) Midterm 3 – assigned Monday Nov 27 & due Friday Dec 1 at 1:30 pm in-class

20% (In-class) Final exam -- date, time and place to be announced.

Attendance and class participation are strongly recommended.

**All exams are comprehensive** unless specified otherwise.

**Date and Time of the Final Exam**

The final examination date and time will be announced by the Registrar generally by the fifth week of classes and it will be announced on the course ICON site once it is known. Do not plan your end of the semester travel plans until the final exam schedule is made public. It is your responsibility to know the date, time, and place of the final exam. According to Registrar's final exam policy, students have a maximum of two weeks after the announced final exam schedule to request a change if an exam conflict exists or if a student has more than two exams in one day (see the policy here).

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**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 course instructor (not the TA). A reduced maximal score may be a direct consequence of any late submission of the assignment, and it will be decided by the instructor at the time the permission for the delay is obtained.
3) Attendance is expected. You are responsible for material covered in class and announcements made during class (these may include changes in the syllabus).
4) Absences from exams will require a compelling reason and must be arranged with your course instructor in advance.
5) All cell phones must be turned off during lecture and exams.

Student Collaboration: In this class, students are not allowed to collaborate with others on the take-home exams. Do not share your work with others or ask others to see their completed assignments since both are considered academic misconduct. If you need help, please meet with the TA during the course’s review sessions or stop by during my office hours.

Academic Honesty and Misconduct
All students in CLAS courses are expected to abide by the CLAS Code of Academic Honesty. Undergraduate academic misconduct must be reported by instructors to CLAS according to these procedures. Graduate academic misconduct must be reported to the Graduate College according to Section F of the Graduate College Manual.

Student Complaints
Students with a complaint about a grade or a related matter should first discuss the situation with the instructor and/or the course supervisor (if applicable), and finally with the Director or Chair of the school, department, or program offering the course.

Undergraduate students should contact CLAS Undergraduate Programs for support when the matter is not resolved at the previous level. Graduate students should contact the CLAS Associate Dean for Graduate Education and Outreach and Engagement when additional support is needed.

Drop Deadline for this Course
You may drop an individual course before the deadline; after this deadline you will need collegiate approval. You can look up the drop deadline for this course here. When you drop a course, a “W” will appear on your transcript. The mark of “W” is a neutral mark that does not affect your GPA. Directions for adding or dropping a course and other registration changes can be found on the Registrar’s website. Undergraduate students can find policies on dropping CLAS courses here. Graduate students should adhere to the academic deadlines and policies set by the Graduate College.

College of Liberal Arts and Sciences (CLAS) Course Policies

Attendance and Absences
University regulations require that students be allowed to make up examinations that have been missed due to illness, religious holy days, military service obligations (including service-related medical appointments), or other unavoidable circumstances or University-sponsored activities. Students with UI-authorized activities must discuss their absences with the instructor as soon as possible. Religious obligations must be communicated within the first three weeks of classes.

Communication: UI Email
Students are responsible for all official correspondences sent to their UI email address (uiowa.edu) and must use this address for any communication with instructors or staff in the UI community. For the privacy and the protection of student records, UI faculty and staff can only correspond with UI email addresses.

Student Collaboration: Student collaboration is NOT permitted on the midterms and final exam. Any attempt to collaborate during these exams will result in a score of 0 on that test.

Late Homework will not be accepted.
Mental Health Resources and Student Support
Students are encouraged to be mindful of their mental health and seek help as a preventive measure or if feeling overwhelmed and/or struggling to meet course expectations. Students are encouraged to talk to their instructor for assistance with specific class-related concerns. For additional support and counseling, students are encouraged to contact University Counseling Service (UCS). Information about UCS, including resources and how to schedule an appointment, can be found at counseling.uiowa.edu. Find out more about UI mental health services at mentalhealth.uiowa.edu.

Student Care and Assistance provides assistance to University of Iowa students who are experiencing a variety of crisis and emergency situations, including but not limited to medical issues, family emergencies, unexpected challenges, and sourcing basic needs such as food and shelter. More information on the resources related to basic needs can be found at basicneeds.uiowa.edu/resources/. Students are encouraged to contact Student Care & Assistance in the Office of the Dean of Students (Room 135 IMU, dos-assistance@uiowa.edu, or 319-335-1162) for support and assistance with resources.

University Policies
Accommodations for Students with Disabilities
The University is committed to providing an educational experience that is accessible to all. If a student has a diagnosed disability or other disabling condition that may impact the student’s ability to complete the course requirements as stated in the syllabus, the student may seek accommodations through Student Disability Services (SDS). SDS is responsible for making Letters of Accommodation (LOA) available. The student must provide an LOA to the instructor as early in the semester as possible, but requests not made at least two weeks prior to the scheduled activity for which an accommodation is sought may not be accommodated. The LOA will specify what reasonable course accommodations the student is eligible for and those the instructor should provide. Additional information can be found on the SDS website.

Free Speech and Expression
Absences for Religious Holy Days
Classroom Expectations
Non-discrimination
Sexual Harassment/Misconduct and Supportive Measures
Sharing of Class Recordings (if appropriate)