

Mathematical Modeling of Biological and Physiological Systems

BME 6705

Class Periods: 4 (Monday, Wednesday, Friday)

Location: Weimer 1094

Academic Term: Spring 2020

Instructor

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Office Location: BMS J285

Office Hours: 1 to 1:50pm (Monday, Wednesday, Friday)

Teaching Assistant

N/A

Course Description

This 3-credit course deals with the mathematical concepts and methods for modeling biological and physiological phenomena from the perspective of dynamical systems theory. Building on the basic theory of linear systems we focus on the qualitative analysis of nonlinear ordinary differential equations and difference equations (maps). Examples from biomedical applications will be used to demonstrate the concepts and methods.

Course Pre-Requisites / Co-Requisites

Calculus, differential equations, and some knowledge of linear algebra.

Course Objectives

This course will acquaint the student with all the major concepts and analysis methods in dynamical systems theory. Biological and physiological examples will be used to illustrate the concepts and methods.

Materials and Supply Fees

None.

Required Textbooks and Software

Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering, Second Edition, by Steven H. Strogatz.

Recommended Reading

Mathematical Biology by James Murray; *Mathematical Physiology* by Keener and Sneyd

Course Content

Part I. One-dimensional flows

1. Nonlinear differential equations on the line: fixed point, population dynamics, linear stability analysis.
2. Bifurcations: saddle-node bifurcation, transcritical bifurcation, pitchfork bifurcation.
3. Flows on the circle: uniform oscillators, nonuniform oscillators.

Part II. Two-dimensional flows

4. Linear differential equations on the plane: classification of linear systems.
5. Nonlinear differential equations on the plane: phase portraits, limit cycles, nonlinear oscillators, Poincare-Bendixson theorem.

6. Advanced bifurcation theory: Saddle node, transcritical and pitchfork bifurcations on the plane, Hopf bifurcations, coupled oscillators.

Part III. Higher dimensional flows and nonlinear difference equations

7. Lorenz equations: fixed points, limit cycles, chaos.
8. Logistic maps and Henon maps: bifurcation diagrams, strange attractors.

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance is strongly encouraged. Students are expected to take careful class notes.

Evaluation of Grades

50% homework, 25% midterm exam and 25% final exam.

Grading Policy

A: 95-100, A-: 90-94.99, B+: 85-89.99, B: 80-84.99, B-: 75-79.99, C+: 70-74.99, C: 65-69.99, C-: 60-64.99.

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.