Mathematical Modeling of Biological and Physiological Systems

BME 6705
Class Periods: 3 (Monday, Wednesday, Friday)
Location: HPNP 1101
Academic Term: Fall 2025

Instructor:
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Office Hours: 1pm to 2pm W and F or by appointment

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
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 Materials
Mathematical Biology by James Murray; *Mathematical Physiology* by Keener and Sneyd

Required Computer
Recommended Computer Specifications: https://it.ufl.edu/get-help/student-computer-recommendations/
HWCOE Computer Requirements: https://www.eng.ufl.edu/students/advising/fall-semester-checklist/computer-requirements/

Course Schedule
Part I. One-dimensional flows (~10-15 lectures)

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 (~15-20 lectures)

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 (~5-10 lectures)

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

Evaluation of Grades
100% homework

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.

Academic Policies & Resources
To support consistent and accessible communication of university-wide student resources, instructors must include this link to academic policies and campus resources: https://go.ufl.edu/syllabuspolicies. Instructor-specific guidelines for courses must accommodate these policies.

Commitment to a Positive Learning Environment
The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Coordinator
• HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
• Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu