MATH 371: Math Modeling in Physiology & Medicine
Fall 2023 Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Any form of plagiarism such as copying of homework or projects, or any form of cheating in quizzes and exams, is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to report suspected instances of cheating to your instructor, and protect your educational investment by knowing and following the Academic Code of Integrity policy that is found at: *http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf*

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online resources inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

COURSE INFORMATION

Course Description: Mathematical models of diverse physiological and biological processes such as SIR epidemic model, action potential generation in neurons, enzyme kinetics, oxygen-hemoglobin binding, and genetic regulatory networks. The biology is introduced with each topic. Emphasis is on quantitative problem solving, model building, and numerical simulation.

Number of Credits: 3

Prerequisites: MATH 222 with a grade of C or better

Course-Section and Instructors:

Course-Section	Instructor
Math 371-001	Professor V. Matveev

Office Hours for All Math Instructors: Fall 2023 Office Hours and Emails

Required Textbook:

Title	*Mathematical Models in Systems Biology: An Introduction*
Author	B. P. Ingalls

Edition	1st (2013)
Publisher	MIT Press
ISBN #	978-0262018883

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, November 13, 2023**. It will be strictly enforced.

COURSE GOALS

Course Objectives

- Extend previously acquired knowledge of calculus and differential equation to the study of dynamical models of biological and physiological processes
- Learn new mathematical modeling techniques to analyze dynamical biological models in several variables
- Learn modeling principles and tools broadly applicable to many fields of biology and physiology
- Learn basic models in the study of neurophysiology, biochemical reaction pathways and genetic networks
- Learn to use MATLAB to solve and visualize complex problems describing biological processes

Course Outcomes

- Students will become skilled at analyzing and solving dynamic mathematical models arising in physiology
- Students will become familiar with the fundamental modeling principles in the study of biological processes
- Students will be able to use both numerical and analytical solution methods to tackle biological models
- Students will demonstrate mastery of the learned material through testing in quizzes and exams

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Class Participation	3%
Homework & Quizzes	20%
MATLAB Assignments	17%
Midterm Exam	25%
Final Exam	35%

Your final letter grade will be based on the following tentative curve.

A	90 - 100	**C**	60 - 66
B+	81 - 89	**D**	55 - 59
B	74 - 80	**F**	0 - 54
C+	67 - 73		

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced.

Homework and Quiz Policy: Homework is assigned each week, to be uploaded into the Canvas learning platform. Late submissions will not be accepted unless explicit permission of the instructor in obtained. In-class short quizzes will be given on occasion, announced in advance.

MATLAB: Use of MATLAB (or another high-level coding language like python) is mandatory, and students should install MATLAB on their personal laptop or desktops. MATLAB is free to all NJIT students:

https://ist.njit.edu/matlab

Exams: There will be one exam during the semester and a cumulative final exam during the final exam week:

Midterm Exam	November 2, 2023
Final Exam Period	December 17 - December 23, 2023

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

Makeup Exam Policy: There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Math Tutoring Center: Located in the Central King Building, Lower Level, Rm. G11 (See: Fall 2023 Hours)

Further Assistance: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you need an accommodation due to a disability, please contact the Office of Accessibility Resources and Services at oars@njit.edu, or visit Kupfrian Hall 201 to discuss your specific needs. A Letter of Accommodation Eligibility from the office authorizing student accommodations is required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at:

https://www.njit.edu/accessibility/

Important Dates (See: Fall 2023 Academic Calendar, Registrar)

Date	Day	Event
September 4, 2023	Monday	Labor Day
September 5, 2023	Tuesday	First Day of Classes
September 11, 2023	Monday	Last Day to Add/Drop Classes
November 13, 2023	Monday	Last Day to Withdraw
November 21, 2023	Tuesday	Thursday Classes Meet
November 22, 2023	Wednesday	Friday Classes Meet
November 23 to November 26, 2023	Thursday and Saturday	Thanksgiving Recess - Closed
December 13, 2023	Wednesday	Last Day of Classes
December 14, 2023	Thursday	Reading Day 1
December 15, 2023	Friday	Reading Day 2
December 17 to December 23, 2023	Sunday to Saturday	Final Exam Period

Course Outline

#	Date	Section	Topic
1	Sep 7	Review	Introduction: ODE review; cell population growth models
2	Sep 11	Review	Linear stability analysis and geometric analysis of 1D ODE models
3	Sep 14	2.1.4	Solving a nonlinear ODE using MATLAB: the Euler and the Midpoint methods
4	Sep 18	N/A	Models with discontinuities: simple pharmacokinetics
5	Sep 21	N/A	Models with discontinuities: “Leaky” integrate-and-fire neuron
6	Sep 25	2.1	Chemical reaction networks and the law of mass action
7	Sep 28	2.1	Second-order reactions; the buffering reaction
8	Oct 2	2.2	Separation of time scales and model reduction
9	Oct 5	3.1	Enzymatic reactions: Michaelis-Menten kinetics
10	Oct 9	3.2	Competitive inhibition; the Excess Reactant Approximation
11	Oct 12	3.3	Cooperative binding
12	Oct 16	3.3	Cooperative binding (continued)
13	Oct 19	4.1-4.2	ODE model in many dimensions: numerical solution using MATLAB
14	Oct 23	4.1-4.2	ODE model in 2D: phase-plane analysis
15	Oct 26	4.1-4.2	ODE model in 2D: phase-plane analysis
16	**Oct 30**		**Review for the Midterm Exam**

17	Nov 2	**MIDTERM EXAM: Thursday, November 2, 2023**	
18	Nov 6	N/A	Intro to epidemiology: SIR model and the basic reproductive ratio
19	Nov 9	N/A	Intro to epidemiology: SIR model and the basic reproductive ratio
20	Nov 13	4.4	Bifurcation analysis: Saddle-Node bifurcation
21	Nov 16	N/A	Bifurcation analysis: Andronov-Hopf bifurcation
22	Nov 20	6.1-6.2	Amplification: “zero-order” ultrasensitivity
23	Nov 21	7.6	Stochastic continuous-time Markov models
24	Nov 27	7.6	Stochastic continuous-time Markov models
25	Nov 30	7.2-7.3	Genetic switches and oscillators
26	Dec 4	8.1-8.2	Electrophysiology: excitable membranes and the Morris-Lecar model
27	**Dec 7**	8.3	Electrophysiology: Synaptic Transmission
28	**Dec 11**	**Review for the Final Exam**	
FINAL EXAM PERIOD: December 17 - December 23, 2023			

Updated by Professor V. Matveev - 8/29/2023
Department of Mathematical Sciences Course Syllabus, Fall 2023