King Fahd University of Petroleum & Minerals

Department of Mathematics

Math 336: Mathematical Models in Biology

Semester 221

Prof. Jawad Abuihlail

Description: Growth models, Single species and interacting population dynamics. Dynamics of infectious diseases. Modelling enzyme dynamics. Some fatal diseases' models. Programming software for numerical simulations.

Prerequisite: MATH 202 *or* MATH 208

Textbook: Ching-Shan Chou and Avner Friedman, Introduction to Mathematical Biology: Modeling, Analysis, and Simulations, Springer Undergraduate Texts in Mathematics and Technology, Springer (2016). http://link.springer.com/book/10.1007/978-3-319-29638-8

Further Reading:

- J. D. Murray, Mathematical Biology I; An Introduction, Interdisciplinary, 3rd edition, Applied Mathematics book series (IAM, volume 17), Springer (2007).
- Johannes Müller and Christina Kuttler, Methods and Models in Mathematical Biology: Deterministic and Stochastic Approaches, Lecture Notes on Mathematical Modelling in the Life Sciences, Springer (2015).

Grading Policy:

We will follow the **Inquiry-Based Learning** (project-based):

Midterm Exam	Projects	Quizzes	Homework	Final Exam
25%	25%	10%	5%	35%
23.10.2022	Week 15			TBA

Objectives:

1. Master the logic and the procedure of mathematical modeling in Biology.
2. Learn numerical methods to solve systems of ODEs resulting from modeling.

Learning Outcomes:

Upon completion of this course, students should be able to:

- Describe standard modelling procedures: observation, collecting data, building a model, testing the model.
- Distinguish between analytic and numerical models
- Use MATLAB to quantitatively test hypotheses with data
- Build and evaluate mathematical and simulation models of biological systems.

Syllabus

Week(s)	Chapter	Topic
1-2	1 & 2	Bacterial Growth in Chemostat (CSTR)
		What Is a Chemostat?
		Numerical Simulations – Introduction to MATLAB
		Differential Equations (Revision)
		Equilibrium and Stability
		Growth Models
		Modeling the Chemostat
3	3	System of Two Linear Differential Equations (Revision)
		Second Order Linear Differential Equations
		Linear Systems
		Equilibrium Points
		Numerical Simulations
4	4	Predator–Prey Models
		Numerical Simulation
		Revisiting Euler Method for Solving ODE – Consistency and Convergence
5	5	Systems of Two Differential Equations
		Numerical Simulations
6	6	Two Competing Populations
		Numerical Simulations
		Revisiting Euler Method for Solving ODE – Backward Euler Method
7	7	General Systems of Differential Equations
		Numerical Simulations
		Solving for the Steady States
		Bisection Method
		Newton's Method
8	9	Spread of Disease
		HIV
		Numerical Simulations
10	10	Enzyme Dynamics
		Numerical Simulations
11	11	Bifurcation Theory
		Hopf Bifurcation
		Neuronal Oscillations
		Endangered Species
		Numerical Simulations
12	13	Cancer-Immune Interaction
		Numerical Simulations
13 & 14	14	Cancer Therapy
		VEGF Receptor Inhibitor
		Virotherapy
		Numerical Simulations
15	Presentations of projects	

Sunday 18th December 2022: Normal Thursday Class & Last day of classes.

Cheating in Exams: Cheating or any attempt of cheating by use of illegal activities, techniques and forms of fraud will be reported to the higher university administration.

Cheating in exams includes (but is not limited to):

➢ looking at the papers of other students

➢ talking to other students

➢ using mobiles or any other electronic devices.

Exam Issues:

- No student will be allowed to take the exam if not having his/her KFUPM ID or National/Iqama ID .
- Students are not allowed to carry mobiles, smart watches, or electronic devices to the exam halls/rooms
- Missing an Exam: In case a student misses an exam (midterm or the Final Exam) for a legitimate reason (such as medical emergencies), he/she must bring an official excuse from Students Affairs. Otherwise, he/she will get zero in the missed exam.

Attendance: Students are expected to attend all lecture classes.

➢ If a student misses a class, he/she is responsible for any announcement made in that class.

➢ A DN grade will be awarded to any student who accumulates more than 20% (09) unexcused absences or 33% (15) excused and unexcused absences.

Note: The student will be warned twice by his instructor before he/she is assigned a DN grade

The Usage of Mobiles in Class: Students are not allowed to use mobiles for any purpose during class time. Students who want to use electronic devices to take notes must take permission from their instructor. Violations of these rules will result in a penalty decided by the instructor.

Academic Integrity: All KFUPM policies regarding ethics apply to this course. See the Undergraduate Bulletin.