MODELLI MATEMATICI IN BIOMEDICINA E FISICA MATEMATICA

"Mathematical models in medicine and the life sciences"

Instructor: Prof. Cyrill Muratov 42 contact hours
Semester: Spring 2026

1. INTRODUCTION

This course serves as an introduction to the principles of mathematical modeling in medicine and the life sciences. The student that successfully completes this course will be in a position to use the basic methodologies of mathematical modeling to formulate quantitative descriptions of the biophysical and biochemical processes governing the behavior of biological systems in the biomedical context, which involves identifying the state variables, establishing the relationships between the state variables, solving the governing equations, analyzing and interpreting the obtained solutions. Questions and discussions in the classroom will be encouraged, with suggestions for exercises to be done outside the classroom, including numerical simulations.

2. COURSE OUTLINE

In view of the vastness of the subject matter, the course will cover several select topics to illustrate the basic modeling approaches to biomedical systems, time permitting. The topics discussed will include:

0. Introduction to mathematical modeling of living systems
1. Heart and circulation
2. Control of cell volume
3. Electrical properties of cell membranes
4. Biochemical reactions and gene regulation
5. Cell communication and population dynamics

3. BIBLIOGRAPHY

The course will partly follow the textbook:

F.C. Hoppensteadt and C.S. Peskin, "Modeling and Simulation in Medicine and the Life Sciences" (Springer-Verlag, 2002), ISBN 978-0387950723

Other useful books include:

J. Keener and J. Sneyd, "Mathematical Physiology I: Cellular Physiology" (Springer-Verlag, 2008), ISBN 978-0387758466

J. Keener and J. Sneyd, "Mathematical Physiology II: Systems Physiology" (Springer-Verlag, 2009), ISBN 978-0387793887

A somewhat complementary text to this course is:

P. Nelson, "Physical Models of Living Systems: Probability, Simulation, Dynamics" (Chiliagon Science, 2021), ISBN 978-1737540243

4. PREREQUISITES

Basic mathematics.

5. LANGUAGE OF INSTRUCTION

This course will be taught in English.

6. EVALUATION

A final project on a relevant topic of student's choice is to be presented orally at the end of the course.