Course Syllabus

1. Course Title:

Mathematical Models in Biology

2. Academic Level:

Master

3. ECTS Credits:

5 ECTS

4. Semester:

2 year, autumn semester

5. School/Department:

Institute of Mathematics, Mechanics, and Computer Science named after I.I. Vorovich

6. Location:

8-A Milchakova St., Rostov-on-Don

7. Instructor:

Prof. Vyacheslav Tsybulin, email: vgcibulin@sfedu.ru

8. Language of Instruction:

English

9. Course Description:

Course deals with mathematical modeling in biology, which is based on difference equations and differential equations (ODEs and PDEs). Dynamical system technique is applied to analyze the behavior of systems under investigation. The subject of the course is focused on the basic models of population dynamics and qualitative and numerical methods to the analysis of these models. Also, this course includes discussions about applications and extensions.

10. Course Aims:

The major emphasis is on the study of basic models and methods of the qualitative and numerical analysis. The principal aims are: mastering the basics of dynamical system analysis (difference and differential equations), mastering the basic mathematical models of biological and population dynamics, mastering the technique for studying models.

11. Specific entry requirements (if any):

BSc. courses of analysis, linear algebra, ODE, PDE, calculus, scientific computing (Maple, MATLAB)

12. Course Content:

Mathematical modeling and computational experiment in biology. Mathematical models of growth, competitive dynamics, predator-prey interaction, taxis. The basic mechanisms, concepts and results,Difference equations, ODEs and PDEs as mathematical models. Introduction to dynamical system theory. Bifurcations, chaos. Fundamental PDEs, its classification and basic initial and boundary-value problems. Essential and natural boundary conditions. Basic formulas for differential operators, their characteristics, and transformations. Operator representation for problems of mathematical physics.

13. Intended Learning Outcomes:

On successful completion of the course, students are expected to be able to:

• describe and compare different approaches to the discretization procedure for the typical initial and boundary-value problems for ODE and PDE;

• choose and implement a suitable numerical method for given regular initial and boundary-value problems for ODE and PDE;

• ascertain basic properties of regular differential and discrete problems and analyze their correlations;

• define and analyze the influence of calculations errors (both absolute and relative).

14. Learning and Teaching Methods:

Lectures, laboratory and pre-laboratory work, self-study with writing a report

15. Methods of Assessment/Final assessment information:

Exam

16. Reading List:

- Murray, James D. Mathematical Biology. 1. Introduction. Springer-Verlag Berlin Heidelberg. 2002.
- Murray, James D. Mathematical Biology. II: Spatial models and their applications in biomedicine = Spatial Models and Biomedical Applications. Springer-Verlag Berlin Heidelberg. 2003.
- Chasnov, Jeffrey R. Mathematical Biology. Hong Kong. 2016.
- Turchin, Philip. Complex Population Dynamics: a Theoretical/Empirical Synthesis. Princeton, NJ: Princeton University Press. 2003.
- Gillman, M. and Hails, R. 1997 An Introduction to Ecological Modelling Blackwell Science.