# Mathematical Biology

## prof. Marco Squassina

### **cOURSE AIMS and EXPECTED ACQUIRED KNOWLEDGES**

The aim of the course is to provide the basic knowledge about some important reaction-diffusion PDE arising from Biology and about some related shape optimization problems.

At the end of the course, students will be able to model simple biological situations from population dynamics with partial differential equations of reaction-diffusion type. Moreover, they will be able to deal with large classes of PDEs with methods from mathematical analysis and related eigenvalue problems.

Finally, students will be able to make numerical simulations with the finite elements method to solve parabolic PDE.

### **COURSE CONTENTS**

Elements of Biology: diffusion, transport and biological applications.

Elements of population dynamics.

Transport equation in some easy settings.

Diffusion equation and parabolic PDEs of second order: mean value theorem, maximum principle.

Reaction-diffusion equations (mainly of Lotka-Volterra type), stability and traveling waves. Elements about systems of reaction-diffusion equations.

Shape optimization problems for eigenvalues of the Dirichlet Laplacian with weight, arising from reaction diffusion PDEs in population dynamics.

### **READING LIST**

J.D. Murray*, Mathematical biology I. An introduction,*

J.D. Murray, *Mathematical biology II. Spatial models and biomedical applications,*

S. Salsa, *Equazioni a derivate parziali. Metodi, modelli applicazioni.*

R.S. Cantrell, C. Cosner, *Spatial Ecology via Reaction-Diffusion Equations,* Wiley 2003.

Some informal notes about parts of the program will be given to the students by the lecturers, moreover students will be referred to some research papers dealing with some of the topics of the course.

***TEACHING METHOD***

Lectures at the blackboard or video lectures.

***ASSESSMENT METHOD AND CRITERIA***

Oral exam. The interview is designed to ascertain the extent to which the students have assimilated the concepts, results and procedures illustrated during the course, through explaining and discussing some of the points of the course program, not excluding references to prerequisites or relationships between the parts of the program.

The grading of the interview will take into account the accuracy of the concepts illustrated, their logical and methodological rigor, and the effectiveness and accuracy in explanation, with a value assigned to the assimilation of concepts and the reworking thereof by the student.

***NOTES AND PREREQUISITES***

Students are expected to possess the knowledge from the Mathematical Analysis courses from the Bachelor.

The course will be delivered in English. For more information the students can contact the lecturers with an email.

Covid-19

In case the current Covid-19 health emergency does not allow frontal teaching, remote teaching will be carried out following procedures that will be promptly notified to students.

***TIME AND PLACE OF OFFICE HOURS***

The lecturers have office hours in their offices on request, which can be done with an email.