Course Specifications

Valid as from the academic year 2020-2021

Introductory Biophysics (C004229)

Due to Covid 19, the education and evaluation methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

Course size (nominal values; actual values may depend on programme)

Credits	6.0	Study time	180 h	Contact hrs	52.5 h

Course offerings and teaching methods in academic year 2020-2021

A (semester 1)	English	Gent	group work	0.0 h
			seminar	30.0 h
			lecture	30.0 h

Lecturers in academic year 2020-2021

Vandersickel, Nele	WE05	lecturer-in-charge
Panfilov, Alexander	WE05	co-lecturer

Offered in the following programmes in 2020-2021	crdts	offering
Bachelor of Science in Physics and Astronomy	6	A
Exchange programme Faculty of Sciences (bachelor's level)	6	A

Teaching languages

English

Keywords

dynamical systems, Euler integration, equilibria, bifurcation diagrams, non-linear dynamics and chaos, oscillations, limit cycles, neurological model, Python

Position of the course

The aim of this course is to learn to model and analyze biological systems. For this we will base ourselves on the book "Modeling of life" by Alan Garfinkel, Jane Shevtsov and Yiba Guo.
Positive and negative feedback are a crucial part of learning to set up the model. For example, we will learn to model an ecosystem of prey (such as tuna) and predators (such as sharks), a typical negative feedback system. Most of the systems we will set up will be non-linear and cannot be solved with pen and paper. Therefore, these must be simulated with the computer to understand the behavior of the system. We will analyse these systems by learning to write scripts in Python.

Contents

- Learning to understand feedback: what is positive and what is negative feedback.
- Converting a system into a differential equation: learning to convert words into mathematics.
- In this course we will model the following systems: population models, feather and friction systems, prey hunter systems, chemical reactions, epidemiology (such as learning to model the Corona virus), neurons, pest outbreak, respiration, food chains, and many others.
- Calculate trajectories of the evolution of the state of a system, via Euler integration.
- Recognize types of equilibria: stable knots, unstable knots, saddle points, stable and unstable coils.
- Method of the nullclines.
- Recognize bifurcations of equilibria: transcritical bifurcation, saddle-node bifurcation, pitch fork bifurcation.
- Recognizing oscillations in systems: in chemistry, biology and physiology.
- Hopf bifurcation: the creation of limit cycles.
- Chaos: in continuous models and in discrete models. Learning to recognize the properties of choas, understanding the routes to a chaotic system.

Initial competences

Basic knowledge of: linear algebra, mathematical analysis, differential equations

Final competences

1 To be able to convert a biological system of words to a differential equation.
2 To be able compute the equilibria in a dynamical system.
3 To be able to compute the trajectory of a system via Euler's method.
4 To be able to analyse the types of bifurcations in a system.
5 To be able to analyse oscillations and limitcycles in a system.
6 To be able to recognize and analyse chaos in a continuous system as well as in a discrete system.
7 To be able to build and analyse a neurological model.
8 To be able to write sripts in Python to analyse a system.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Group work, lecture, seminar

Extra information on the teaching methods

The classes will be a continuous variation of theory and exercises mainly on the computer. Each week a group of students has to complete a report of the exercises which will be evaluated for 15% of the total evaluation. Each student will therefore participate in 1 report in any case, but it is free for other students to help the chosen group. The report must always include the corresponding Python code of the exercise.

Learning materials and price

The PDF of Alan Garfinkel's book "Modeling of life" will be shared with the students free of charge via UFORA. If desired, students can also purchase this book online.

References

"Modeling of life" Alan Garfinkel, Jane Shevtsov en Yiba Guo.

Course content-related study coaching

Students can always contact the teacher and the assisting staff with questions about the course (theory and exercises).

Evaluation methods

end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period

Open book examination, oral examination

Examination methods in case of periodic evaluation during the second examination period

Open book examination, oral examination

Examination methods in case of permanent evaluation

Assignment

Possibilities of retake in case of permanent evaluation

not applicable

Extra information on the examination methods

1. group work
The group work will be evaluated for 3 credits (out of 20) after peer assessment. The teacher retains ultimate responsibility for deviating from or deciding not to take the peer assessment scores into account when determining the grades per student for the group work. If there is clearly different input from the different group members, the final grade per student belonging to the same group may differ.
2. The exam is responsible for the other 17/20 credits. During this exam, the student will have to solve a similar exercise as during the exercise classes by programming a script in Python. The script and an oral explanation of the solution serve as an evaluation form for this exam.

Calculation of the examination mark

- group work 3/20
- exam: 17/20