Biological Systems

Academic Year: (2023 / 2024) **Review date: 19-12-2023**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: LEON CANSECO, CARLOS

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is strongly advised to have completed Mathematics, Programming, Physics, Fundamentals of Biology and Biochemistry.

SKILLS AND LEARNING OUTCOMES

RA1: Acquire knowledge and understanding of the basic general fundamentals of engineering and biomedical sciences.
RA2: Be able to solve basic engineering and biomedical science problems through a process of analysis, identifying the problem, establishing different methods of resolution, selecting the most appropriate one and its correct implementation.
CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG1: Adequate knowledge and skills to analyse and synthesise basic problems related to engineering and biomedical sciences, solve them and communicate them efficiently.
CG3: Knowledge of basic scientific and technical subjects that enables them to learn new methods and technologies, as well as providing them with great versatility to adapt to new situations.
CG4: Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the biomedical engineer's activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG8: Ability to solve mathematical, physical, chemical and biochemical problems that may arise in biomedical engineering.
CG12: Ability to solve mathematically formulated problems applied to biology, physics and chemistry, using numerical algorithms and computational techniques.
CG13: Knowledge of the fundamental principles of molecular, cellular, structural and biochemical biology applied to human beings.
CG14: Acquire a global vision of the basic functioning of biological systems. Ability to model such systems using mathematical and computational tools.
ECRT14: Ability to model common biological systems (proteins, nucleic acids, cellular and subcellular compartments) using mathematical and computational tools. Acquire the critical ability to judge the hypotheses under which the proposed models represent the corresponding biological system.
CT1: Ability to communicate knowledge orally and in writing to both specialised and non-specialised audiences.

OBJECTIVES

The main goal of the course is to acquire capabilities for modeling common biological systems using mathematical physical and computational tools. The student will be able to apply these tools for extracting quantitative information in order to understand different type of systems. Finally the student will acquire capabilities for evaluating and be objective with the results obtained from those analyses and models.

DESCRIPTION OF CONTENTS: PROGRAMME

Biological Systems: The course consists of (1) enumeration of the biological components that participate in biological processes, statistical representation, interpretation and prediction of biological data, (2) reconstruction of the interactions necessary to form a network (3) mathematical representation for analysis, interpretation and prediction, especially modeling and application related to

biological components involved in cellular processes (4) model validation and use of prospective design, in particular tree modeling and biological networks at the molecular level. Students will be taught quantitative modeling of biological systems: reactions between molecules, including receptor-ligand and antigen-antibody specificity, protein structure, genetic and biochemical pathways and networks, enzyme catalysis, genetic information processing and secretion of proteins, study of data related to biological systems, description and modeling of the structure and dynamics of biological components, study of interactions between molecular systems involved in biological processes, study of networks of biological and biochemical interactions contained in databases freely accessible. Advanced quantitative analysis techniques including multi-state kinetics and Monte Carlo simulations of biochemical reactors. Fundamentals of systems biology Synthetic biology.

LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will include:

- Lectures, where the concepts that students must acquire will be shown. To facilitate its development students receive class notes and have basic reference texts that will facilitate following the lessons and developing further work. These classes are designed by way of seminars.
- Resolution of exercises, problems and laboratory practice to serve as self-assessment to acquire the necessary skills to perform the works corresponding to the continuous assessment, experimentally verifying the results presented in class.

ASSESSMENT SYSTEM

The evaluation system includes continuous assessment of student work (papers, class participation and tests assessing practical skills and theoretical knowledge), and final evaluation through a final written exam that will assess knowledge globally the skills and abilities acquired throughout the course. Continuous assessment will consist of three works, totaling 50% of grade divided into three evaluations of 16.6% each. The other 50% of the mark will be obtained through a written exam. It is necessary to obtain a mark higher than 4 over 10 in this exam to add to this mark the continuous evaluation mark.

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

BASIC BIBLIOGRAPHY

- Allman, Elizabeth Spencer Mathematical models in biology : an introduction , Cambridge University Press, 2004

- Helms, Volkhard Principles of computational cell biology : from protein complexes to cellular networks, Wiley-VCH,, 2008
- Shonkwiler, Ronald W Mathematical biology : an introduction with Maple and Matlab , Springer, 2009

ADDITIONAL BIBLIOGRAPHY

- Klett J, León C, Di Geronimo B Biological Systems. Data Modelling and simulations at molecular level, UC3M. ISBN: 978-84-16829-65-1, 2021