Course guide
240EQ321 - 240EQ321 - Biophysics

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Unit in charge: Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Optional subject).

Academic year: 2022 **ECTS Credits:** 4.5 **Languages:** Spanish

LECTURER

Coordinating lecturer: LUIS JAVIER DEL VALLE MENDOZA

Others: Primer quadrimestre:
JUAN AYMAMI BOFARULL - T10
JOSEFA DE LOURDES CAMPOS LOPEZ - T10
LUIS JAVIER DEL VALLE MENDOZA - T10
DOMINGO MARTINEZ DE ILARDUYA SAEZ DE ASTEASU - T10
DAVID ZANUY GOMARA - T10

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

2. Designing products, processes, systems and services for the chemical industry as well as the optimization of other already developed technology based on various areas of chemical engineering, understanding of processes and transport phenomena, separation operations and engineering chemical reactions, nuclear, electrochemical and biochemical.
3. Easily integrate technical team and creative interdisciplinary any chemical company or research center.

Generical:
4. Ability to apply the scientific method and the principles of engineering and economics, to formulate and solve complex problems in processes, equipment, facilities and services, in which the material changes its composition, state or energy content, characteristic of chemical industry and other related sectors which include the pharmaceutical, biotechnology, materials, energy, food or environmental.
5. Communicate and discuss proposals and conclusions in forums multilingual, skilled and unskilled, in a clear and unambiguous.
6. Integrate knowledge and handle complexity, making judgments and decisions, from incomplete or limited information, including reflections on the social and ethical responsibilities of professional practice.
7. Possess independent learning skills to maintain and enhance the competencies of chemical engineering to enable the continued development of their profession.
8. Ability to analyze and synthesize to the continued progress of products, processes, systems and services using criteria of safety, affordability, quality and environmental management.

TEACHING METHODOLOGY

MD.1. Apprenticeship contract.
MD.2. Lectures.
MD.3. Scheduled independent learning.
MD.4. Cooperative learning.
MD.5. Project-based learning, problems and cases.

LEARNING OBJECTIVES OF THE SUBJECT

The subject of Biophysics aims to provide students a basic knowledge in physics and physic-chemistry which govern the biological systems. In regard to this, the first content of the subject discusses various concepts of physical chemistry that are relevant to understand the physiological and structural biological systems. The following contents of the subject are relative to various techniques of physics and physical chemistry (e. g, hydrodynamics, spectroscopy, scattering and diffraction, etc.). introduced in the biology field, and are now indispensable tools for the study of biological systems and their macromolecular components. Finally, the last content of the subject is dedicated to structural and functional simulation of macromolecules by applying calculations based on molecular dynamics.

STUDY LOAD

Type	Hours	Percentage
Hours small group	40,5	36.00
Self study	72,0	64.00

Total learning time: 112.5 h

CONTENTS

Introduction to biophysics

Description:
1.1) Introduction to Biomechanics. Kinematics. Dynamics. Work and Energy.
1.2) Physical basis of circulation and respiration. Hydrostatic. Hydrodynamics. Viscosity. Gases. Diffusion and Osmosis. Transport across biological membranes and nerve conduction. Physical properties of the membranes. Basic characteristics of ion channels. Action potential. Axons with myelin.
1.3) The thermodynamics of living organisms. Heat and temperature. First law of thermodynamics. Second law of thermodynamics.
1.4) Physical basis of bioelectric phenomena. Electrostatics. Electrodynamics.
1.5) Wave Motion. Dimensional harmonic waves. Sound waves. Electromagnetic waves. Reflection. Refraction. Interference, diffraction, polarization. X-ray Laser. Optics.

Specific objectives:
Consolidate different knowledge of physical chemistry iregarding to biological systems which will be basic for the development of the subject.

Related activities:
Recommended reading. Exercises and Problems.

Full-or-part-time: 34h
Theory classes: 7h
Practical classes: 2h
Theory classes: 7h
Practical classes: 2h
Self study : 16h

Absorption spectoscopy, fluorescence and circular dischroism.

Description:
2.1) Spectroscopy. UV-Visible spectroscopy: identification, quantification, and melting curves of biomacromolecules. Turbidimetry. Colorimetry.
2.2) Circular dichroism: secondary structure analysis of biomacromolecules.
2.3) Infrared spectroscopy (FTIR): identification and analysis of secondary structure of biomacromolecules.
2.4) Optical microscopy: perfilometry. Fluorescence Microscopy: epifluorescence and confocal
2.5) Flow Cytometry.

Specific objectives:
Students will analyze and discuss with biophysical foundations results obtained by spectroscopic methods on the structure and function of biomolecules.

Related activities:
Exercises. Selected readings.
Activity 1. Analysis of macromolecules by spectroscopic methods.

Full-or-part-time: 14h
Theory classes: 3h
Practical classes: 1h
Theory classes: 3h
Practical classes: 1h
Self study : 6h

Nuclear magnetic resonance

Description:
3.1) Radioactivity. Nuclear structure, properties of the nucleus. Radioactivity, half-life, dosimetry
3.2) Use of radioactive and non-radioactive isotopes in the human body. Harmful effects
3.3) Nuclear magnetic resonance

Specific objectives:
By the end of this chapter, the students will have to be able to analyse a nuclear magnetic resonance spectrum

Related activities:
Selected readings.
Exercises and problems

Full-or-part-time: 10h
Theory classes: 2h
Practical classes: 1h
Theory classes: 2h
Practical classes: 1h
Self study : 4h

Crystallography and X-ray diffraction

Description:
4.1) Crystallization.
4.2) Data Collection X-ray diffraction
4.3) Treatment of diffraction data: space group determination, indexing and scaling of the data.
4.4) Methods of solving structures. Refining structures. Electron density maps. Validation of the structure. Structural databases.

Specific objectives:
The student must know the methodology to determine the structure of a biomacromolecula using X-ray diffraction of a single crystal.

Related activities:
Selected readings.
Activity 2. Determine the structure of a biomacromolecula.

Full-or-part-time: 21h
Theory classes: 4h
Practical classes: 2h
Theory classes: 4h
Practical classes: 2h
Self study : 9h

Molecular modeling and structure determination based on molecular dynamics

Description:
5.1) Molecular modeling and applications in bioengineering.
5.2) Potential energy. Force Field. Minimization (technical).
5.3) Molecular dynamics (MD). Definition. Classical dynamics. Calculating gradients. Numerical integration. MD trajectory. Practical aspects. Protocol. Properties which can be calculated from an MD. Limitations. Examples.
5.4) Molecular recognition. Electrostatic properties of biomolecules. Docking: How to know where a connection will be made (search algorithms, scoring functions, clustering results, limitations, examples). Calculation of binding constants.

Specific objectives:
Ability to analyze and compare different experimental and computational data for the determination of the structure and function of macromolecules.

Related activities:
Activity 3: Introduction to structural simulation of biomolecules using molecular dynamics.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 1h
Theory classes: 4h
Practical classes: 1h
Self study : 8h

GRADING SYSTEM

The final mark for the course will be calculated according to different evaluation systems, as follows:
Final Mark = 55% (IE.3) +40% (IE.4) + 5% (IE.7)
Where: IE.3) Test after each course content; IE.4) formal reports of activities; and IE.7) Mark teachers discretion.

EXAMINATION RULES.

By the end of each lesson of the subject, a test (IE.3) will take place using the virtual portal ATENEA based on Moodle, or otherwise it will correspond to a written exam.
The students will be obliged to present the formal reports of the activities (IE.4).
The qualification of the discretionary valuation (IE.7) will be established by all the Professors taking part in the subject.

BIBLIOGRAPHY

Basic:

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- Frenkel, Daan; Smit, Berend. Understanding molecular simulation : from algorithms to applications. [2nd ed.]. San Diego [etc.]: Academic Press, cop. 2002. ISBN 0122673514.
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- Laurendeau, Normand M. Statistical thermodynamics : fundamentals and applications [on line]. Cambridge: Cambridge University Press, 2005 [Consultation: 21/05/2020]. Available on: http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10129076. ISBN 9780511139086.
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