Universitat de les Illes Balears

Teaching guide

Academic year	2012-13
Subject	11011 - Statistical physics in biological systems
Group	Group 1, 2S
Teaching guide	A
Language	English

Subject identification

Subject	11011 - Statistical physics in biological systems
Credits	0.72 in-class (18 hours) 2.28 distance (57 hours) 3 totals (75 hours).
Group	Group 1, 2S
Teaching period	2nd semester
Teaching language	English

Lecturers

Lecturers	**Timetable for student attention**					
	Starting time	**Finishing time**	**Day**	**Start date**	**Finish date**	**Office**
Tomás Miguel Sintes Olives tomas.sintes@uib.es	12:00h	13:00h	Monday	24/09/2012	21/09/2013	207 Edifici Instituts Universitaris

Degrees where the subject is taught

Degree	**Character**	**Academic year**	**Studies**
Master's Degree in Physics of Complex Systems	Optional		Postgraduate degree

Contextualisation

The aim of this subject is to train potential researchers in the study the properties of biological molecules. structures and function from a statistical mechanics point of view. It will range from the basic molecular interactions between particles to biological membranes, including the modelization of their basic constituents: lipids and proteins. Specific computer simulation techniques to biological systems will be also presented.

Requirements

Recommendable

It is recommended that students have taken statistical physics courses during their undergraduate studies.

Skills

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Specific

1. Development and optimal application of numerical algorithms for the simulation of complex systems (E2).
2. To understand the critical and cooperative phenomena from the perspective of cross-disciplinary physics and complex systems (E4).
3. To understand and to model processes subject to fluctuations (E6).

Generic

1. To acquire the capacity to develop a complete research plan covering from the bibliographic research and strategy to the conclusions (TG2)..
2. To write and describe rigoroulsy the research process and present the conclusions to an expert audience (TG3)..
3. To acquire high power computation skills and advanced numerical methods capabilities in applications to problems in the contex of complex systems (TG6)..

Content

Theme content

Chapter 1. Molecular forces.
- The covalent and Coulomb interaction
- Interactions involving polar molecules
- Polarized molecules
- Van der Waals forces
- Repulsive forces and the liquid structure
- Hydrogen bond and hydrophobic and hydrophilic interactions
- Interactions between particles and surfaces. Adhesion

Chapter 2. An introduction to polymer physics
- Static conformation of a single chain and in polymer melts
- Dynamics of flexible polymers in dilute solutions

Chapter 3. Fluid-like structures: Micelles, bilayers and biological membranes

Chapter 4. Membrane structure and function
- Modeling lipids and proteins
- Lipid-protein interaction
- Protein segregation

Chapter 5. Molecular motors

Chapter 6. Microscopic theory of chemical reaction rates
- Ion Channels

Chapter 7. Computer simulation techniques
- Metropolis Monte-Carlo

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Molecular dynamics

Calculating free energies

Simulating a biological molecule in solution

Long range forces and the Ewald summation

Teaching methodology

In-class work activities

Modality	Name	Typ.Gr.	Description
Theory classes	Theoretical Lectures	Large group (G)	The students will acquire the knowledge and methodologies to study and understand the properties of biological molecules.

Distance education work activities

Modality	Name	Description
Group or individual self-study	Autonomous work	The students will apply the concepts and techniques learned during the lectures to solve specific problems. The students will present the results obtained in a rigorous way and will be evaluated.

Riscs especifics i mesures de protecció

Les activitats d'aprenentatge d'aquesta assignatura no comporten riscs específics per a la seguretat i salut de l'alumnat i, per tant, no cal adoptar mesures de protecció especials.

Workload estimate

Modality	Name	Hours	ECTS	%
In-class work activities		**18**	**0.72**	**24**
Theory classes	Theoretical Lectures	18	0.72	24
Distance education work activities		**57**	**2.28**	**76**
Group or individual self-study	Autonomous work	57	2.28	76
	Total	**75**	**3**	**100**

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will

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be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

Student learning assessment

Theoretical Lectures

Modality	Theory classes
Technique	Short-answer tests **(Non-recoverable)**
Description	The students will acquire the knowledge and methodologies to study and understand the properties of biological molecules.
Assessment criteria	The participation of the students along the lecturing period will be evaluated, as well as solved proposed short problems.

Percentage of final qualification: 50% following path A

Autonomous work

Modality	Group or individual self-study
Technique	Extended-response, discursive examinations **(Recoverable)**
Description	The students will apply the concepts and techniques learned during the lectures to solve specific problems. The students will present the results obtained in a rigorous way and will be evaluated.
Assessment criteria	Public presentation of the results of a selected problems proposed by the professor.

Percentage of final qualification: 50% following path A

Resources, bibliography and additional documentation

Basic bibliography

J. Israelachvili, Intermolecular and Surface Forces. Academic Press 2011
P.G. de Gennes, Scaling Concepts in Polymer Physics. Cornell Uni. Press. 1979

M. Doi and S. F. Edwards, The theory of polymer dynamics. Oxford Sci. Pub.1988

R. Gennis, Biomembranes, molecular structure and function. Springer 1988

B. Hille, Ionic Channels of excitable membranes. Sinauer Assoc.2001

D. C. Rapaport, The art of molecular dynamics simulation, Cambridge Uni. Press. 2004

Complementary bibliography

Other resources

Date of publication: 05/07/2012

Research papers will be provided by the professor along the lecturing period.

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