



Academic year	2012-13
Subject	11012 - Modeling and dynamics of neural systems
Group	Group 1, 2S
Teaching guide	A
Language	English

Subject identification

Subject	11012 - Modeling and dynamics of neural systems
Credits	0.77 in-class (19.25 hours) 2.23 distance (55.75 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
Claudio Rubén Mirasso Santos claudio.mirasso@uib.es	There are no defined sessions				

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 introduce the students into the computational neuroscience. The subject covers an introduction to the brain, a modeling part for individual neurons, the synopsis, the model of neuronal populations, noise effects as well as sincronization aspects and metods to measure characteristics of physiological signals.

Requirements

Recommendable

It is recommended that the student has basic concepts on numerical integration of differential equations as well as fortran, C or Matlab programing.

Skills





Academic year	2012-13
Subject	11012 - Modeling and dynamics of neural systems
Group	Group 1, 2S
Teaching guide	A
Language	English

Specific

1. E2: Development and optimal application of numerical algorithms for the simulation of complex systems..
2. E6: To understand and to model processes subject to fluctuations..
3. E8: To know to characterize generic behavior of dynamical systems and their instabilities..

Generic

1. TG2: To acquire the capacity to develop a complete research plan covering from the bibliographic research and strategy to the conclusions..
2. TG4: To acquire the ability to ask questions, read and listen critically and participate actively in seminars and discussions..
3. TG5: To knowing to disseminate and present the concepts acquired at a non-expert..

Content

Theme content

Introduction. Introduction

Membrane potential and electrical currents.

Neuronal activity: generalities

Nerve impulse

Voltage dependent channels

Models of individual neurons. Models of individual neurons

Hudgkin-Huxley experiment

Hudgkin-Huxley model; pulses and bursts

Reduced models; Integrated & Fire, Morris Leccar, Fitzhugh Nagumo, Izhickevich, etc.

Synapsis. Synapsis

Chemical and electrical synapses

Neurotransmitters and receptors.

Synaptic and postsynaptic conductance.

Short-range plasticity

Dynamic of coupled neurons.

Synchronization. Synchronization

Introduction

Synchronization of identical systems

Synchronization of nonidentical systems

Interacting systems. Interacting systems

Characterization of time series

Calculations of autocorrelation and cross-correlation





Academic year	2012-13
Subject	11012 - Modeling and dynamics of neural systems
Group	Group 1, 2S
Teaching guide	A
Language	English

Mutual entropy.
 Populations of neurons.
 Neural networks
 Information Encoding. Information Encoding
 Temporal coding
 Rate Coding
 Effects of noise. Effects of noise
 Gaussian white noise, color noise and Poisson noise
 Effect of background activity of neuronal systems.
 Exampes. Exampes

Teaching methodology

In-class work activities

Modality	Name	Typ.Gr.	Description
Theory classes	Theoretical Lectures	Large group (G)	Explanation of thoretical concepts by the professor.
Seminars and workshops	Oral presentation	Medium group 2 (X)	Oral presentation to the whole class of an assigned paper.
Practical classes	Hands-on sessions	Large group (G)	Introduction to the use of the computational infrastructure and basic software

Distance education work activities

Modality	Name	Description
Individual self-study	Preparation on the oral presentation	The student must read some papers and organize a presentation
Individual self-study	Program development	The student has to prepare a software program to solve an specific problem.





Academic year	2012-13
Subject	11012 - Modeling and dynamics of neural systems
Group	Group 1, 2S
Teaching guide	A
Language	English

Riscs específics i mesures de protecció

Les activitats d'aprenentatge d'aquesta assignatura no comporten riscos 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		19.25	0.77	25.67
Theory classes	Theoretical Lectures	15	0.6	20
Seminars and workshops	Oral presentation	2.5	0.1	3.33
Practical classes	Hands-on sessions	1.75	0.07	2.33
Distance education work activities		55.75	2.23	74.33
Individual self-study	Preparation on the oral presentation	20	0.8	26.67
Individual self-study	Program development	35.75	1.43	47.67
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 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

The subject will be evaluated by both the oral presentation of a certain paper and the numerically assigned work

Preparation on the oral presentation

Modality	Individual self-study
Technique	Oral tests (Non-recoverable)
Description	The student must read some papers and organize a presentation
Assessment criteria	Oral presentation of a given paper

Percentage of final qualification: 25% following path A





Academic year	2012-13
Subject	11012 - Modeling and dynamics of neural systems
Group	Group 1, 2S
Teaching guide	A
Language	English

Program development

Modality	Individual self-study
Technique	Papers and projects (Recoverable)
Description	The student has to prepare a software program to solve an specific problem.
Assessment criteria	Report on the numerical results

Percentage of final qualification: 75% following path A

Resources, bibliography and additional documentation

Basic bibliography

1. Neurophysiology, D. Stratton, LIMUSA, 1981.
2. Theoretical Neuroscience, P. Dayan and L. F. Abbott, MIT Press, 2001.
3. Spiking Neuron Models, W. Gerstner and W. Kistler, Cambridge University Press, 2002.
4. Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting, E. Izhikevich, The MIT press, 2007.
5. The synchronization of chaotic Systems, S. Boccaletti; J. Kurths; G. Osipov; D.L. Valladares; C.S. Zhou, Physics Reports 366 (2002) 1–101.

Complementary bibliography

Other resources

6. Characterizing synaptic conductance fluctuations in cortical neurons and their influence on spike generation, Z Piwkowska, M. Pospischil, R Brette, Julia Sliwa, M. Rudolph-Lilith, T. Bal, A. Destexhe, Journal of Neuroscience Methods 169 (2008) 302–322.

