University of the Balearic Islands

Teaching guide

Academic year	2014-15
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 de presencials (19.25 hours) 2.23 de no presencials (55.75 hours) 3 de totals (75 hours).
Group Group 1, 2S (Campus Extens)
Teaching period 2nd semester
Teaching language English

Professors

Lecturers	Horari d'atenció als alumnes					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Claudio Rubén Mirasso Santos claudio.mirasso@uib.es	14:30h	15:30h	Thursday	09/02/2015	30/06/2015	IFISC Despacho 202

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 synapsis, 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 Mathlab programing.

Skills

Specific

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

Date of publication: 13/06/2014

Generic

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

Basic

* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

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
- Mutual entropy.
- Populations of neurons.

Date of publication: 13/06/2014

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. Grp.	Description	Hours
Theory classes	Theoretical Lectures	Large group (G)	Explanation of thoretical concepts by the professor.	15
Seminars and workshops	Oral presentation	Medium group 2 (X)	Oral presentation to the whole class of an assigned paper.	2.5
Practical classes	Hands-on sessions	Large group (G)	Introduction to the use of the computational infrastructure and basic software	1.75

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.

Distance education work activities

Modality	Name	Description	Hours
Individual self-study	Preparation on the oral presentation	The student must read some papers and organize a presentation	20
Individual self-study	Program development	The student has to prepare a software program to solve an specific problem.	35.75

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Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

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

Preparation on the oral presentation

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

Final grade percentage: 25%

Program development

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

Final grade percentage: 75%

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. Boccalettia; J. Kurthsc, G. Osipovd, D.L. Valladaresb; C.S. Zhouc, Physics Reports 366 (2002) 1–101.

Other resources

Date of publication: 13/06/2014

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.

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