



Academic year	2016-17
Subject	11012 - Modeling and Dynamics of Neural Systems
Group	Group 1, 2S
Teaching guide	B
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	Second 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	14:00	15:00	Monday	12/09/2016	15/02/2017	IFISC, Campus UIB, 202

Contextualisation

Professor: Claudio Mirasso received the Ph.D. degree in physics from the Universidad Nacional de La Plata, Buenos Aires, Argentina, in 1989. He has held Postdoctoral positions in Spain and The Netherlands. He is a Full Professor at the Physics Department, Universitat de les Illes Balears, Palma de Mallorca, Spain, and Researcher of the Institute for Cross-Disciplinary Physics and Complex Systems.

His current research interests include synchronization and control of dynamical systems, information processing, neuronal dynamics, dynamics and applications of delayed coupled systems and applications of nonlinear dynamics in general.

He has five years of teaching periods and four years of research periods recognized.

Subject

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 synchronization aspects and methods to measure characteristics of physiological signals.

Requirements





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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

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..

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.





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- 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.
 - 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 (M)	Oral presentation to the whole class of an assigned paper.	2.5
Practical classes	Hands-on sessions	Large group (G)	Development ofcomputational programs to study neuronal dynamics	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.



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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

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 assigned work

Oral presentation

Modality	Seminars and workshops
Technique	Oral tests (retrievable)
Description	Oral presentation to the whole class of an assigned paper.
Assessment criteria	
Final grade percentage:	25%

Hands-on sessions

Modality	Practical classes
Technique	Student internship dissertation (retrievable)
Description	Development of computational programs to study neuronal dynamics
Assessment criteria	
Final grade percentage:	35%



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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: 40%

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

Other resources

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

