Universitat de les Illes Balears

Academic year	2017-18
Subject	11198 - Neuronal networks
Group	Group 1, 2S
Syllabus	A
Language	English

Syllabus

Subject

Name 11198 - Neuronal networks
Credits 0.77 in-class (19.25 hours) 2.23 distance (55.75 hours) 3 total (75 hours).
Group Group 1, 2S (Campus Extens)
Period Second semester
Language English

Lecturers

Lecturers	Office hours for students					
	Starting time	Finishing time	Day	Start date	End date	Office
Claudio Rubén Mirasso Santos claudio.mirasso@uib.es	You need to book a date with the professor in order to attend a tutorial.					

Context

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 fiveyears o fresearch 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 and neural networks,noise effects as well as sincronization aspects and metods to measure characteristics of physiological signals.

Requirements

Date of publication: 07/07/2017

Recommended

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..

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..

Transversal

* 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/.

Basic

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Content

Theme content

1-. Introduction

Membrane potential and electrical currents.

Neuronal activity: generalities

Nerve impulse

Voltage dependent channels

2-. Models of individual neurons

Hudgkin-Huxley experiment

Hudgkin-Huxley model; pulses and bursts

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

3-. Synapses

Chemical and electrical synapses

Date of publication: 07/07/2017

Neurotransmitters and receptors.

Synaptic and postsynaptic conductance.

Short-range plasticity

Dynamic of coupled neurons.

4-. Synchronization

Introduction

Synchronization of identical systems

Synchronization of nonidentical systems

5-. Interacting systems

Characterization of time series

Calculations of autocorrelation and cross-correlation

Mutual entropy.

Populations of neurons.

Neural networks

6-. Information Encoding

Temporal coding

Rate Coding

7-. Effects of noise

Gaussian white noise, color noise and Poisson noise

Effect of background activity of neuronal systems.

8-. Examples

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.	13
Seminars and workshops	Oral Presentations	Medium group (M)	Oral presentation of scientific papers	2.5
Practical classes	Numerical Excersies	Medium group (M)	Development of computational programs to study neuronal dynamics	1.75
Assessment	Questionnarie	Large group (G)	Toevaluate every 2 weeks the progress of the students	2

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

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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 developments	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

Oral Presentations

Modality	Seminars and workshops
Technique	Oral tests **(non-retrievable)**
Description	Oral presentation of scientific papers
Assessment criteria	15 minutes presentation of a scientific paper

Final grade percentage: 20% with minimum grade 5

Numerical Excersies

Modality	Practical classes
Technique	Papers and projects **(retrievable)**
Description	Development of computational programs to study neuronal dynamics
Assessment criteria	Developement of numerical codes to sudy neuroal circuits

Final grade percentage: 35% with minimum grade 5

Questionnarie

Modality	Assessment
Technique	Short-answer tests **(retrievable)**
Description	Toevaluate every 2 weeks the progress of the students
Assessment criteria	Evaluation of the progress of the student

Final grade percentage: 35% with minimum grade 5

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Program developments

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	Preparation of numerical codes

Final grade percentage: 10% with minimum grade 5

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.

Complementary bibliography

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.

Other resources

NEURAL NETWORKS AND BIOLOGICAL MODELING- LECTURER: PROF. WULFRAM GERSTNER (Youtube)

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