COURSE OUTLINE

(1) GENERAL

SCHOOL			
ACADEMIC UNIT	**Interdisciplinary Graduate Programme in the BRAIN and MIND sciences**		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	CS-588	SEMESTER	1o -2o
COURSE TITLE	Brain Network Analysis and Modeling		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	WEEKLY TEACHING HOURS	CREDITS
	4	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background
PREREQUISITE COURSES:	CS-217, CS-215, CS-240
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	http://www.csd.uoc.gr/CSD/index.jsp?content=pg_courses_catalog&openmenu=demoAcc4&lang=gr&course=235

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

1. Knowledge: Having attended and succeeded in the course, the student is able to understand aspects related to the neuronal activity under different conditions, neuronal models, and the characterization of the neuronal network architecture.

2. Understanding: Having attended and succeeded in the course, the student will have an understanding of the main principles of neuronal functional connectivity, physiology, and network neuroscience.

3. Application: Having attended and succeeded in the course, the student is able to apply algorithms and techniques from graph theory, network science, and machine learning to characterize the behavior of the functional networks and neuronal activity.

4. Analysis: Having attended and succeeded in the course, the student is able to analyze biological data (e.g., two-photon imaging data), to characterize the connectivity and the neuronal activity of various populations under different conditions.

5. Synthesis: Having attended and succeeded in the course, the student is able to combine ideas and techniques from graph theory, network science, and machine learning, as well as data from different imaging tools, in order to characterize the neuronal activity and connectivity under different conditions (e.g., stimulus presentation, in the context of neurological diseases);
6. Evaluation: Having attended and succeeded in the course, the student is able to assess the changes of the functional connectivity and activity of various neuronal populations, in the presence of various conditions.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology *Adapting to new situations* *Decision-making* *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Project planning and management* *Respect for difference and multiculturalism* *Respect for the natural environment* *Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking* *……* *Others…* *…….*

- Search, analysis and synthesis of data and information
- Decision making
- Autonomous work and team work
- Generating new research ideas
- Working in a research project; project planning and management
- Criticism and self-criticism
- Working in an international environment
- Working in an interdisciplinary environment

(3) SYLLABUS

The course includes the following parts:
1. Fundamental Concepts in Neuroscience, neurophysiology; neurons; neuronal anatomy; synaptic transmission; the role of neurotransmitters; basics in cognitive neuroscience
2. Neuronal models (e.g., leaky integrate and fire model); Neural Computations, Communications and Ensembles
3. Concepts and techniques from graph theory and network science (small worldness, network robustness)
4. Applying techniques from statistical analysis and machine learning (e.g., statistical tests, clustering algorithms, classification, correlations, dimensionality reduction)
5. Imaging tools, experimental methods, monitoring, and data collection (e.g., two-photon imaging, optogenetics MRI, patch clamping)
6. Advanced topics in network neuroscience, including neuroscience-driven AI, e.g., continual learning, neuromorphic computing

During the class, the students work in data analysis projects, focusing on the visual cortex and how it encodes the various stimuli, propagates the activity between layers and areas, and represents the behavior. Furthermore, it analyzes functional connectivity under various conditions and in the context of neurological diseases.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• email • course website http://www.csd.uoc.gr/~hy539 • electronic submission of exercises • e-learn platform
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	The student is evaluated according to: ● Class attendance/participation ● Exercises and research projects (programming project, literature review and presentation) ● Final written exams The final grade is a weighted mean: 50% (final exam) + 40% (project) + 10% report/meetings/ class participation)

Activity	*Semester workload*
Lectures	52
Tutorials	0
Study	52
Exercises/labs	52
Final project	8
Exams	4
Course total	168

(5) ATTACHED BIBLIOGRAPHY

Suggested bibliography:
Principles of neural science. Eric Kandel, James Schwartz, and Thomas Jessell
Networks of the Brain by Olaf Sporns, The MIT Press ISBN 978-0-262-01469-4
Network Science by Albert-László Barabási

Scientific Journals:
Science
Nature Neuroscience https://www.nature.com/neuro/
Nature Communications https://www.nature.com/ncomms/
eLife https://elifesciences.org/
Brain https://academic.oup.com/brain
Neuron
Journal of Neuroscience https://www.jneurosci.org/
Conferences: Cosyne, NeurIPS, and AREADNE
Lectures and seminars from the Department of Brain and Cognitive Sciences at MIT

The professors of the course recommend papers from the aforementioned journals and conferences in the context of literature review/presentation and research projects.