האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University of Jerusalem

Syllabus

DYNAMICAL SYSTEMS AND THE NEURON - 76931

Last update 02-09-2018

HU Credits: 2

Degree/Cycle: 2nd degree (Master)

Responsible Department: Brain Science: Computation & Information Proc.

Academic year: 0

Semester: 1st Semester

Teaching Languages: English

Campus: E. Safra

Course/Module Coordinator: Prof. Yonatan Loewenstein

Coordinator Email: yonatan.loewenstein@mail.huji.ac.il

Coordinator Office Hours: by appointment

Teaching Staff:

Ms. Lotem Elber

Course/Module description:

An introduction to Neuronal Excitability and the field of Non-Linear Dynamics. The basic models used for describing the activity of a single neuron will be presented and studied, and through them several basic concepts of dynamical systems will be demonstrated.

Course/Module aims:

Introducing the principles governing neuronal excitability and the theoretical tools used to model this phenomenon.
Introducing and teaching methods of analyzing dynamical systems to extract properties such as the existence of fixed points, stability of fixed points, oscillations etc.

Learning outcomes - On successful completion of this module, students should be able to:

Analyze one-, two- and three-dimensional dynamical systems to find fixed points, assess their stability, determine the existence of oscillations,and infer or refute the existence of limit cycles. Perform numerical integration (simulations) to verify and expand on this analysis.

Attendance requirements(%):

Teaching arrangement and method of instruction: Frontal lectures and homework assignments for exercising the principles and methods taught in class

Course/Module Content:

Neuronal Excitability:
1. RC Circuits
2. The Action Potential
3. Integrate & Fire Neuron
4. Phase response curves
4. Fitzhugh-Nagumo Model
6. Cable Theory

Dynamical Systems:
1. 1D Dynamical Systems

2. 2D Linear Dynamical Systems
3. Phase Plane Analysis
4. Non-Linear Dynamical Systems: Fixed point classification, closed orbits and bifurcations

Additional topics:
•Numerical Integration: Euler's Method, Improved Euler, 4th-Order Runge-Kutta.
• Chaos Theory

Required Reading:
Nonlinear Dynamics and Chaos / Steven H. Strogatz

Additional Reading Material:
Dynamical Systems in Neuroscience / Eugene M. Izhikevich

Principles of Neural Science / Kandel, Schwartz & Jessell

Theoretical Neuroscience / Dayan & Abbott

Course/Module evaluation:
End of year written/oral examination 70 %
Presentation 0 %
Participation in Tutorials 0 %
Project work 0 %
Assignments 30 %
Reports 0 %
Research project 0 %
Quizzes 0 %
Other 0 %

Additional information:
The first class of this course will be held on November 5th.