REQUIREMENTS

Semmelweis University Faculty, Department:

Faculty of Medicine, Department of Anatomy, Histology and Embryology

Name of the course: Systems Neuroscience III. Neurodynamics: from single neurons to motifs

Type of course: optional course-unit

code: AOSANT560_3A

credit: 2

Name of the responsible person: Dr. Gábor Gerber (prof. John Milton, PhD)

Academic year: 2018/2019., second semester

Role of the course in the training of the Department:

Can the behavior of large ensembles of neurons can be understood, at least in part, from the properties of smaller ensembles containing 2-5 neurons, currently referred to as motifs? Typically as we move up from the level of single neurons to the level of populations new phenomena emerge, for example, organized waves of neural activity. The goal of this week of lectures is to provide a foundation in neurodynamics of neurons and small neuronal motifs for neuroscientists who have only an introductory background in calculus.

The program of the course:

1. Lecture: Basic Concepts of Dynamical systems I
2. Lecture: Basic Concepts of Dynamical systems II
3. Lecture: Basic Concepts. Bifurcations and Oscillations I
4. Lecture: Basic Concepts. Bifurcations and Oscillations II
5. Lecture: Basic Concepts. The Hodgkin-Huxley equation
6. Lecture: Neurodinamics. Conductance-based models of neural motifs: Childhood absence epilepsy I
7. Lecture: Neurodinamics. Conductance-based models of neural motifs: Childhood absence epilepsy II
8. Lecture: Neurodinamics. Generic properties of oscillations: Synchronization, phase resetting and phase locking I
9. Lecture: Neurodinamics. Generic properties of oscillations: Synchronization, phase resetting and phase locking II
10. Lecture: Neurodinamics. Excitability
11. Lecture: Feedback control. Feedback control and time delays I
12. Lecture: Feedback control. Feedback control and time delays II
13. Lecture: Feedback control. Linear feedback control I
14. Lecture: Feedback control. Linear feedback control II
15. Lecture: Feedback control. Nonlinear feedback control
16. Lecture: Applications. Pendulum models of gait dynamics I
17. Lecture: Applications. Pendulum models of gait dynamics II
18. Lecture: Applications. The edge of stability: Stick balancing and falling in the elderly I
19. Lecture: Applications. The edge of stability: Stick balancing and falling in the elderly II
20. Lecture: Applications. The future: Neuro-prosthetic devices and mHealth
21. Lecture: Students' presentations, discussion I
22. Lecture: Students' presentations, discussion II
23. Lecture: Students' presentations, discussion III
24. Lecture: Written test

25. Lecture: Written test

Practical courses:
1. course: Introduction into the XPPAUT computer program for exploring neurodynamics. I
2. Course: Introduction into the XPPAUT computer program for exploring neurodynamics. II
3. Course: Introduction into the XPPAUT computer program for exploring neurodynamics. III
Consultations: personally with the actual course leader

Requirements of course participation and options to recover missed hours:

1. **Total absence allowed: 10% of the course hours**
2. **Recovering missing hours: studying the material provided by the course leaders, consultation**

Eligibility: US grade point average (GPA) of 3.0. Students with a GPA lower than 3.0 should inquire with the Directors on the possibility of a waiver.

Justification of absence from course hours or exams:
Hungarian medical certificate

Number and schedule of the examinations:

1 on the last day of the course

Requirements of the successful completion of the program:

written or oral test in each course material

Marks:

In case of a written test grades are given after obtaining points as follows: 0-50% fail, 51-60% pass, 61-75% fair, 76-90% good, above 90% excellent.

Types of exam: test, essay, verbal

Requirements of the examinations:

Verbal and electronic etc. material provided by the lecturers. Syllabus is available upon opening the program on the web page.

Registration for exams: NEPTUN

Rescheduling the tests:

N/A
Each student has to take an examination in each block of the course.

Justification of absence from the exam:

Hungarian medical certificate (see above).

List of useful literature (books, papers etc):

B. Ermentrout (2002). Stimulating, analyzing, and animating dynamical systems: A guide to XPPAUT for researchers and students. SIAM, Philadelphia.
G. B. Ermentrout and D. H. Terman (2010). Mathematical foundations of neuroscience. Springer, New York.

J. Milton (1996). Dynamics of small neural populations. CRM Monograph Series, American Mathematical Society, Providence, Rhode Island

J. Milton (2010). Epilepsy as a dynamic disease: A tutorial of the past with an eye to the future. Epilepsy and Behavior 18: 33-44.

J. Milton and T. Ohira (2014). Mathematics as a laboratory tool: Dynamics, delays and noise. Springer, New York.