Module Layout
COS514 / Computational Neuroscience

<table>
<tr><td>Faculty</td><td>ΣΘΕΕ</td><td colspan="3">Faculty of Pure and Applied Science</td></tr>
<tr><td>Programme of Study</td><td>COS</td><td colspan="3">M.Sc. in Cognitive Systems</td></tr>
<tr><td>Module</td><td>COS514</td><td colspan="3">Computational Neuroscience</td></tr>
<tr><td rowspan="3">Level of Study</td><td colspan="2" rowspan="2">Undergraduate</td><td colspan="2">Graduate</td></tr>
<tr><td>Master</td><td>Doctoral</td></tr>
<tr><td colspan="2"></td><td>x</td><td></td></tr>
<tr><td>Language of Instruction</td><td colspan="4">English</td></tr>
<tr><td>Mode of Delivery</td><td colspan="4">Distance</td></tr>
<tr><td rowspan="2">Module Type</td><td colspan="2">Required</td><td colspan="2">Electives</td></tr>
<tr><td colspan="2"></td><td colspan="2">x</td></tr>
<tr><td rowspan="2">Number of Group Consulting Meetings</td><td>Total</td><td colspan="2">Physical Presence</td><td>Online</td></tr>
<tr><td>12 + 1 revision</td><td colspan="2">-</td><td>12 + 1 revision</td></tr>
<tr><td>Number of Assignments</td><td colspan="4">1 Assignment / Project and 12 Interactive Activities</td></tr>
<tr><td rowspan="2">Final Grade Calculation</td><td>Interactive Activities</td><td colspan="2">Assignment / Project</td><td>Final Exam</td></tr>
<tr><td>24 %</td><td colspan="2">26 %</td><td>50 %</td></tr>
<tr><td>Number of European Credit Transfer System (ECTS)</td><td colspan="4">10</td></tr>
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Module Description

The thematic unit COS514 will provide tools and methods for characterizing what nervous systems do, determine how they function, and understand why they operate in particular ways. In the introduction, the main biophysical aspects of neurons will be covered and the mechanism behind the creation of the action potential will be described. Also, the biophysics of excitatory and inhibitory synapses will be covered. In the next part of the course two simple mathematical models for neurons will be covered: the passive membrane model and the leaky integrate-and-fire model. The equivalent electrical circuits for these models are presented, the corresponding equations are derived, and their solutions are found analytically. Subsequently, the Hodgkin-Huxley neuron model is addressed, along with the equivalent electrical circuit and the full model equations for the membrane potential and the gating variables are derived. Taking into consideration the spatial extension of neurons, we will study the topic of dendritic function and how dendrites can be modeled as cables. The cable equation for the passive dendrite is derived and corresponding stationary solutions are calculated analytically. Dendritic theory is completed by presenting the famous Rall cable theory and compartmental models. The topic of neuron plasticity will be addressed next, and the differences between structural and functional plasticity, in particular. The Hebb's postulate will be formulated and the biophysical mechanism behind plasticity is explained. Spike Timing-Dependent Plasticity is described mathematically. Three rules and their corresponding models are presented: Hebb's rule, covariance rule and Oja's rule. Comparisons between these rules are made. Finally, the course will deal with the subject of neural encoding, that is, how stimuli are reflected on the neural responses. Various techniques for neural recordings are presented and the neural code is explained through an example experiment. Concepts such as neural response function, firing rate, tuning curves, reverse correlation function, and spike-train statistics are addressed.

Pre-requisite Modules

Co-requisite Modules

Grading Scheme

<table>
<tr><td rowspan="2">Assessment Method</td><td rowspan="2">Percentage on Final Grade</td><td colspan="2">Workload</td></tr>
<tr><td>Hours</td><td>ECTS</td></tr>
<tr><td>Interactive Activities</td><td>24 %</td><td>25-30</td><td>1</td></tr>
<tr><td>Assignment / Project</td><td>26 %</td><td>50-50</td><td>2</td></tr>
<tr><td>Final/Repeat Examination</td><td>50 %</td><td>3</td><td>-</td></tr>
<tr><td>Total</td><td>100%</td><td>Total</td><td>Total</td></tr>
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Grading Rules and Assessment methods

- Passing rate
  - 50% of the Interactive Activities
  - 50% of the Assignment / Project
  - Students are allowed to participate in the final exam of a Module if they have overall earned the minimum grade (≥ 50 %) in both their Assignment / Project and Interactive Activities
  - 50% of the Final Exam

If a student earns a grade with decimal points, then it is rounded to the nearest half unit.