

Engineering Tripos Part IIA, 3G3: Introduction to Neuroscience, 2021-22

Module Leader

[Dr G Hennequin](#) [1]

Lecturers

Dr G Hennequin, Dr Y Ahmadian

Lab Leader

Dr G Hennequin

Timing and Structure

Lent term. 16 lectures.

Aims

The aims of the course are to:

- Introduce students to how the brain processes sensory information, controls our actions, learns through experience and lays down memories.
- Elucidate the computational and engineering principles of brain function.

Objectives

As specific objectives, by the end of the course students should be able to:

- Have a basic grasp of neuroscience that can act as foundation for further study.
- Understand the basic principles of sensory processing, decision making, learning and memory and how engineering concepts can be applied to them.

Content

Perception and action (6L) (Dr G Hennequin)

- Neurons and synapses
- Perception as Bayesian inference
- Decision making

Dynamics of single neurons (2L) (Dr G Hennequin)

- Introduction to basic cell physiology and ion channels
- How do neurons communicate? The action potential and the Hodgkin-Huxley model

Learning and memory (8L) (Dr Y Ahmadian)

- The cellular basis of learning and memory

- Animal learning
- Memory

Coursework

Simulation of different types of neural coding of natural images. Laboratory report and/or Full Technical Report.

Efficient coding in visual cortex

Learning objectives:

- To apply basic techniques from linear algebra, optimization and statistics to understand how the primary visual cortex might efficiently encode natural scenes
- To learn (or consolidate) how to implement simple algorithms in Python
- To consolidate critical analysis and report-writing skills

Practical information:

- Sessions normally take place in the DPO, but could be done online if required by Covid19-related restrictions.
- This activity involves preliminary homework (estimated 30 min duration), consisting of mathematical derivations (including some basic vector calculus) to be performed before coming to the lab.

Full Technical Report:

Students will have the option to submit a Full Technical Report. This will take the form of a unifying review of 2 papers addressing efficient coding of sensory information in the brain.

Booklists

Please refer to the Booklist for Part IIA Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [2].

UK-SPEC

The [UK Standard for Professional Engineering Competence \(UK-SPEC\)](#) [3] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the '[Accreditation of Higher Education Programmes](#)' (AHEP) document [4] which sets out the standard for degree accreditation.

The [Output Standards Matrices](#) [5] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links

[1] <mailto:gjeh2@cam.ac.uk>

[2] <http://teaching.eng.cam.ac.uk/content/form-conduct-examinations>

[3] <http://www.engc.org.uk/ukspec.aspx>

[4] <http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/>

[5] <http://teaching.eng.cam.ac.uk/content/output-standards-matrices>