

PG7914 NEURAL ENGINEERING [5 credits]

Lecturers: Professor Richard Reilly,
School of Medicine, School of Engineering

Semester: 1

Module Organisation

The module runs over two weeks and comprises ten lectures per week for a total contact time of 20 hours.

Module Description

This module aims to introduce students to the field of neural engineering from a neuroscience perspective. Students will apply engineering principles to understand the excitation of nerves and muscles, the generation of bioelectric signals, and the stimulation of biological tissue. Common methods of stimulating, recording, and analysing neural systems will be examined. The basic principles and methods studied will then be applied to examine specific neuroscience applications of neural engineering, such as biomarkers for neurological and neurodegeneration and neuromodulation for neurological and psychiatric disorders.

Prerequisites: **PG7901** Form and Function of the Nervous System

Learning Outcomes

On successful completion of this module, students should have developed:

1. Understanding of monitoring of neural activity
2. Ability to understand neural processes and their applications to neural engineering
3. Insight on biomaterial properties and integration of biomaterials as implanted systems
4. Ability to integrate the knowledge of central nervous system and the development of neural engineering applications
5. Ability to design and conduct experiments and measure, analyse and interpret data from living systems.
6. Ability to identify, formulate and adapt engineering solutions to unmet biological needs
7. Ability to model and analyze biological systems as engineering systems
8. Knowledge of the commercial market and understanding of the regulatory hurdles in neural engineering
9. Ethical issues and considerations for neural engineering

Module Content

Section 1 Monitoring, Analyzing and Interpreting Neural Activity

- Monitoring neural activity: Bioelectric potentials and currents
- Implantable microelectrodes
- Neural spike trains and their analysis
- Electroencephalography EEG
- Non-invasive Brain Machine Interfaces
- Invasive Brain Machine Interfaces
- Magnetic stimulation of biological tissues
- Speech and Gait as a window into Cognitive Function

Section 2 Replacing/Restoring Neural Function

- Electric stimulation of biological tissues
- Deep brain stimulation
- Retinal and Visual Prostheses
- Cochlear Implants and Auditory Prostheses

Module Reading material

Provided via Blackboard

Teaching Strategies

The module is delivered as a combination of lectures and discussions.

Assessment Modes

Written Exam (100%)

Recommended Texts

Neural Engineering

Handbook on Neural Engineering

Neural Engineering

He (ed), Springer

Akay (ed), Wiley-IEEE Press

Eliasmith, Anderson, MIT Press