Engineering Tripos Part IIB, 4I14: Biosensors and Bioelectronics, 2019-20

Module Leader

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Lecturer

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Timing and Structure

Lent term. Lectures and coursework. Assessment: 100% coursework.

Aims

The aims of the course are to:

- Link engineering principles to understanding of biosystems in sensors and bioelectronics.

Objectives

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

- Extend principles of engineering to the development of biosensors and bioelectronic devices.
- Understand the principles of signal transduction between biology and electronics. • appreciate the basic configuration and distinction among biosensors and bioelectronic systems.
- Appreciate the basic configuration and distinction among biosensors and bioelectronic systems.
- Demonstrate appreciation for the technical limits of performance.
- Make design and selection decisions in response to measurement and actuation problems amenable to the use of biosensors and bioelectronic devices.
- Be able to evaluate novel trends in the field.

Content

This course covers the principles, technologies, methods and applications of biosensors and bioelectronics. The objective of this course is to link engineering principles to understanding these biosystems. It will provide the student with detail of methods and procedures used in the design, fabrication and application of biosensors and bioelectronic devices. The fundamentals of measurement science are applied to electrochemical and optical signal transduction. The fundamentals of electrophysiology are applied to implantable and cutaneous bioelectronic devices. Upon successful completion of this course, students are expected to be able to explain biosensing and transduction techniques, design and construct biosensor instrumentation, and explain the techniques of recording and stimulation of electrically active cells and tissues.

Introduction to Biosensors

- Overview of Biosensors
- Fundamental elements of biosensor devices
- Engineering sensor proteins

Electrochemical Biosensors

- Electrochemical principles
- Amperometric biosensors and charge transfer pathways in enzymes
- Glucose biosensors
- Engineering electrochemical biosensors

Optical Biosensors

- Optics for biosensors
- Attenuated total reflection systems

Diagnostics for the real world

- Communication and tracking in health monitoring
- Detection in resource limited settings

Introduction to Bioelectronics

- Neurons and other electrically active cells
- Recording and stimulation of electrically active cells
- Foreign body response

Implantable electronic medical devices

- Cardiac pacemaker
- Cochlear implants
- Deep brain and spinal cord stimulators
- Brain-Computer Interfaces
- Ethical and regulatory issues

Wearable devices

- Wearable electrophysiology devices
- Wearable biosensors
- Power, processing and communication
- Emerging trends

Coursework

The coursework will be assessed on two marked assignments. The first assignment will involve a laboratory session illustrating the functional demonstration of glucose sensor technology. The second assignment will involve a laboratory session illustrating the principles of electrophysiology applied to bioelectronic devices.

Coursework	Format	Due date & marks
[Coursework activity #1 : Glucose biosensors] <u>Learning objectives:</u> • To introduce students to electrochemical sensors employed for the measurement of glucose. • To quantitatively analyse measurements conducted using test strip glucose biosensors on a range of samples. • To explore the principles of accuracy and precision and their application to clinical measurements and their impact on clinical decision making.	Individual Report anonymously marked	21 February 2 [30/60]

Coursework	Format	Due date & marks
• To extend the principles to the design of a biosensor for the measurement of lactate.		
[Coursework activity #2 : Cutaneous electrophysiology] Learning objectives: • To introduce students to sensors employed for the measurement of electrophysiology. • To explore different recording configurations. • To quantitatively analyse measurements conducted using cutaneous electrodes. • To extend the principles to the design of a sensor for the measurement of biopotentials.	Individual Report anonymously marked	20 March 20 [30/60]

Booklists

Please see the Booklist for Group I Courses [3] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [4].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [5] standard:

Toggle display of UK-SPEC areas.

General Learning Outcomes

Graduates with the exemplifying qualifications, irrespective of registration category or qualification level, must satisfy the following criteria:

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