

## **Engineering Tripos Part IIB, 4G4: Biomimetics, 2017-18**

### **Module Leader**

[Dr M Oyen](#) [1]

### **Lecturers**

Dr M Oyen, Dr F Iida, and Dr W Federle

### **Timing and Structure**

Lent term. 12 lectures + Group project work. Assessment: 100% coursework

### **Aims**

The aims of the course are to:

- Develop an understanding the ways engineers adopt and adapt ideas from nature and make new engineering entities.

### **Objectives**

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

- Understand how scientists are borrowing from nature across many different fields of engineering, with in-depth understanding on one topic (project)
- Identify new possibilities for biomimesis in design.
- Learn how to read the current biomimetics literature.

### **Content**

#### **Introduction and Project assignment ( M. Oyen, CUED) (2L)**

#### **Bioinspired Robotics (F. Iida, CUED) (2L)**

- Legged robot locomotion and underactuated motion control
- Soft robotics and bio-inspired actuation

#### **Biomimetic adhesion and adhesives (W. Federle, Zoology) (4L)**

- Attachment devices and mechanisms in nature
- Approaches to develop biomimetic adhesives

#### **Biomimetic materials (M. Oyen, CUED) (4L)**

- Protein-based structural materials
- Protein folding, weak bonding, hydration
- Biomineralisation
- Biosilification, calcium carbonates, calcium phosphates
- Composite mechanics applied to natural materials

- Polymer amphiphiles
- Self-healing materials

**Project Presentations (2L)****Coursework**

Students will work in groups of 2-3 on a biomimetics design portfolio for one specific case from any of the following: biomimetic materials (e.g. bone, shell); natural structures (e.g. photonic crystals, lotus paint, adhesives); robots that swim, fly, or crawl like creatures; or any other biomimetics topic identified as acceptable via discussion with the module leader.

Coursework	Format	Due date & marks
<b>[Group Presentation]</b>  Comparison of natural vs engineering solutions to a specific problem  <u>Learning objective:</u> <ul style="list-style-type: none"> <li>• Quantitative evaluation of nature vs current engineering practice</li> </ul>	Group Presentation  non-anonymously marked	Week 8 Lent  [12/60]
<b>[Preliminary Report]</b>  Comparison of natural vs engineering solutions to a specific problem  <u>Learning objective:</u> <ul style="list-style-type: none"> <li>• Quantitative evaluation of nature vs current engineering practice</li> <li>• Emphasis on your own individual focus within the group</li> </ul>	Individual Report  non-anonymously marked	Friday week  [18/60]
<b>[Final Report]</b>  Biomimetic design dossier, written report plus additional drawings, calculations, computer simulations, and prototypes  <u>Learning objective:</u> <ul style="list-style-type: none"> <li>• Use creativity to present a bio-inspired solution to the problem from current engineering practice</li> </ul>	Individual Report  non-anonymously marked	Tuesday week Term [30/60]

**Booklists**

Please see the [Booklist for Group G Courses](#) [2] for references for this module.

**Examination Guidelines**

Please refer to [Form & conduct of the examinations](#) [3].

**UK-SPEC**

This syllabus contributes to the following areas of the [UK-SPEC](#) [4] standard:

[Toggle display of UK-SPEC areas.](#)

## **GT1**

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

## **IA1**

Apply appropriate quantitative science and engineering tools to the analysis of problems.

## **IA2**

Demonstrate creative and innovative ability in the synthesis of solutions and in formulating designs.

## **KU1**

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

## **KU2**

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

## **E1**

Ability to use fundamental knowledge to investigate new and emerging technologies.

## **E2**

Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate.

## **P1**

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

## **P3**

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

## **US1**

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

## **US3**

An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.

## **US4**

An awareness of developing technologies related to own specialisation.

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**Links**

[1] <mailto:mlo29@cam.ac.uk>

[2] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364101&chapterid=56091>

[3] <https://teaching23-24.eng.cam.ac.uk/content/form-conduct-examinations>

[4] <https://teaching23-24.eng.cam.ac.uk/content/uk-spec>