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

Module Leader
Dr M Oyen

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.

<table>
<thead>
<tr>
<th>Coursework</th>
<th>Format</th>
<th>Due date &amp; marks</th>
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</thead>
<tbody>
<tr>
<td><strong>[Group Presentation]</strong></td>
<td>Group Presentation</td>
<td>Week 8 Lent</td>
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<tr>
<td>Comparison of natural vs engineering solutions to a specific problem</td>
<td>non-anonymously marked</td>
<td>12/60</td>
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<tr>
<td><strong>Learning objective:</strong></td>
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<tr>
<td>• Quantitative evaluation of nature vs current engineering practice</td>
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<td><strong>[Preliminary Report]</strong></td>
<td>Individual Report</td>
<td>Friday week 10 Lent</td>
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<tr>
<td>Comparison of natural vs engineering solutions to a specific problem</td>
<td>non-anonymously marked</td>
<td>18/60</td>
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<td><strong>Learning objective:</strong></td>
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<td>• Quantitative evaluation of nature vs current engineering practice</td>
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<td>• Emphasis on your own individual focus within the group</td>
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<tr>
<td><strong>[Final Report]</strong></td>
<td>Individual Report</td>
<td>Tuesday week 1 of Easter Term</td>
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<tr>
<td>Biomimetic design dossier, written report plus additional drawings, calculations, computer simulations, and prototypes</td>
<td>non-anonymously marked</td>
<td>30/60</td>
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<tr>
<td><strong>Learning objective:</strong></td>
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<tr>
<td>• Use creativity to present a bio-inspired solution to the problem from current engineering practice</td>
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**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**

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] 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 [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] 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:mlo29@cam.ac.uk