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
[Group Presentation] Comparison of natural vs engineering solutions to a specific problem <u>Learning objective:</u> • Quantitative evaluation of nature vs current engineering practice	Group Presentation non-anonymously marked	Week 8 Lent [12/60]
[Preliminary Report] Comparison of natural vs engineering solutions to a specific problem <u>Learning objective:</u> • Quantitative evaluation of nature vs current engineering practice • Emphasis on your own individual focus within the group	Individual Report non-anonymously marked	Friday week [18/60]
[Final Report] Biomimetic design dossier, written report plus additional drawings, calculations, computer simulations, and prototypes <u>Learning objective:</u> • Use creativity to present a bio-inspired solution to the problem from current engineering practice	Individual Report non-anonymously marked	Tuesday we 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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