Engineering Tripos Part IB, Sustainable Engineering, 2018-19

Lecturers

Dr Claire Barlow and others [1]

Timing and Structure

5 lectures in Michaelmas Term.

Objectives

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

- Appreciate the scale of the global challenges in energy production and control of climate change, and the importance of identifying, quantifying and pursuing the developments which will have significant impact.
- Understand a range of opportunities to reduce energy consumption and to implement lower carbon technologies, in different sectors of engineering, in both developed and developing economies.
- Complete a technical investigation into an aspect of Sustainable Engineering of their own choice.

Content

The need to move rapidly toward a lower carbon economy is widely accepted in the Engineering community, to mitigate against climate change, to improve future energy security, and to assist the developing economies of the world. This course will illustrate some of the current issues and applied developments relating to sustainability, in all areas of Engineering. Students follow up the lecture course with their own short research project over the Christmas vacation, submitted as a poster.

1. 25 October. Dr Teng Long. Edison Redux - Greening of electrical power systems using power electronics technologies

120 years ago, Edison and Westinghouse publicly battled over DC (Direct Current) versus AC (Alternating Current) in the War of Currents. Fixed frequency AC won the battle at that time, and became the dominant form of the electric power thanks to its ease and efficiency for high voltage electricity transmission with low losses. Since that time, however, DC technology has been improved significantly. Transformative semiconductor technologies in electric power applications, known as Power Electronics, enables efficient and controllable conversion between different forms of power: DC, AC, electromagnetic and electromechanical. The advantages offered by Power Electronics have been driving a revolution of greener and more sustainable transport and energy. In this Lecture, state-of-the-art Power Electronics technologies will be introduced, and illustrated with emerging applications of power conversion for intelligent and efficient generation, transfer, storage and consumption of electrical energy. Engineering challenges and future career opportunities in transport electrification and sustainable energy will be briefly discussed, in order to give an overview of the contribution Power Electronics Engineers can make to move and power the world by more sustainable means.

2. 1 November. Dr Michael Ramage. Natural structure: materials, form and force.

The relationship between structural form and natural force allowed medieval master builders to construct spaces that still inspire awe today, many of which would be difficult to recreate. But with an understanding of antique knowledge, traditional construction, and contemporary computation we can once again explore the form and structure of centuries ago in contemporary architecture and engineering. Combining historic wisdom with the latest natural material technology offers the promise of novel and sustainable building solutions. Michael Ramage will discus new developments from his research at Cambridge that draws on learning from ancient traditions for

contemporary sustainable architecture and engineering.

3. 8 November. Professor Julian Allwood. Use Less.

In this talk, we'll take a look at how humans are getting on in managing (or not) their impacts on the natural environment, and focus particularly on climate change. The sad reality is that while we talk more and more about global warming, the rate at which our emissions are increasing is itself increasing, and this comes down to the fact that rich countries want to keep continuing getting richer. As a result, while we're happy to talk about relative reductions in environmental impact, our absolute impacts are still rising. The solution is pretty straightforward - we have to use less; less energy, water, material and meat. Doing so wouldn't be that painful if we made the choice to do so, so we'll look at how it might happen, how engineers can contribute, and how we can be part of the very broad public debate that's required to imagine a future in which we aim to grow our well-being more than our incomes.

4. 15 November. Dr Claire Barlow. Critical materials and sustainability: are we running out of resources?

Are we in danger of running out of some materials? It is generally accepted that the way we currently use materials cannot be sustained indefinitely, but opinions vary on what the real 'crunch points' are. In this lecture we will explore some of the issues, concentrating on materials which are extracted from the ground. We will look at the basis on which decisions are made about the resources that should be regarded as critical. This is a difficult area: different assumptions and priorities lead to big discrepancies in the materials appearing on the resulting lists. We will then turn to ways in which the problems of materials scarcity can be mitigated. Solutions include substitution of other materials, minimisation of materials usage, and increasing the reclamation of materials and products at end-of-life.

5. 22 November. Dr Claire Barlow. Plastic packaging: challenges, problems and solutions.

Plastic packaging has hit the headlines as iconic of our wasteful throwaway society. But there are other sides to the story: packaging can save huge amounts of resources if used and disposed of wisely. In this lecture we will look at the big picture around the use of plastics for packaging, and examine the alternatives.

Coursework

Coursework, in the form of a small independent research project, will be conducted over the Christmas vacation, leading to preparation of a poster summarising the key findings. The expected time to be spent on the research project and poster is 12-15 hours.

You will present your poster to a small group of students in a timetabled lab session in the Lent Term.

Deadline for poster submission (in electronic format as PDF): Friday January 18th 2019, 4pm (via Moodle: details to follow).
Standard credit: 10 marks (from maximum of 14); penalty of 1 mark per day poster is late.

Booklists

Recommended books for the research project and for general interest are:

- David Mackay, *Sustainable Energy - without the hot air* (available online)
- Michael Ashby, *Materials and the Environment*
- Julian Allwood and Jonathan Cullen, *Sustainable Materials - with both eyes open* (available online)

See Part IB Booklist **[2]**

Examination Guidelines

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

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