Engineering Tripos Part IIB, 4M19: Advanced Building Physics, 2021-22

Module Leader

Professor Ruchi Choudhury [1]

Lecturer

Professor Gary Hunt [2]

Lecturer

Dr. Shaun Fitzgerald [3]

Timing and Structure

16 lectures (including integrated examples classes) + coursework; Assessment: 100% coursework

Aims

The aims of the course are to:

- To develop a deep understanding of principles of building physics at the system level to guide the design of zero-carbon buildings
- To understand methods and tools used for quantifying energy efficiency of buildings
- To understand the design of heating, cooling, and ventilation in buildings

Objectives

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

- evaluate alternative energy systems and buildings technologies against energy consumption for a given context.
- design and evaluate energy efficiency of buildings
- understand the factors that influence and control the movement of air and heat in naturally ventilated buildings.

Content

Designing sustainable buildings requires making choices among various building materials and components, and more efficient use of energy and natural resources. In order to do so, the building structure, the building fabric and the building services must be understood both in individual detail and as interacting systems. For example, the need for energy must be analysed in conjunction with energy production for heating and cooling, distribution, thermal storage and the end-use in buildings. The module first introduces students to energy-efficient building systems and other advanced building physics topics. It subsequently describes energy modelling techniques for analysing buildings as a system of interacting components and processes leading to low-energy buildings that satisfy occupant comfort systems and technologies. The module aims to develop a deep understanding of how fundamental principles of building physics are integrated at the system level to guide the design of zero-carbon built environments.

Energy Efficient Building Systems & Building Performance Modelling (6 hours, Choudhary/Fitzgerald)

- Introduction to energy demand in buildings
- Introduction to building performance simulation
- Introduction to data-driven performance assessment
- Integrated design of heating, cooling, and ventilation systems

Ventilation: creating air movements for the supply of fresh air and removal of stale air (10 hours, Hunt)

- Natural ventilation of modern buildings
- Displacement ventilation & thermally stratified flows
- Mixing ventilation
- Airflow through vents
- Transient flows through rooms & night purging
- Steady flows through rooms & heat source modelling
- Sizing ventilation openings
- Low-energy design

Further notes

Examples papers

Coursework

1. Assignment 1 consists of modelling the energy demand of building and identifying three strategies for optimizing energy demand. This part will be delivered in the form of an individual report in Week 4 of the term.

2. Assignment 2 consists of an in-class exercise to design the heating, cooling, and ventilation system of a building in relation to occupant comfort and health. This part will be in the form of an individual repo

3. Assignment 3, drawing directly from the ventilation lectures, consists of an in-class exercise to

map out (qualitatively and quantitatively) the preliminary design of a low-energy, naturally ventilated building. This exercise is assessed in class and is therefore not graded anonymously

4. Assignment 4 consists of using sensors to monitor a space in the department and analyze its

performance. These reports are due on day 1 of term 2.

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

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

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