2025 Winter OxCam Programme

Systems Design and Engineering Thinking+

Course Outline

Energy-Saving Hardware Design

I. Course Information

Course Dates	3rd February - 16th February 2025
Course Duration	2 Weeks
Course Hours	45 hours in total It includes a total of 4 hours of Pre-programme online sessions, 22 hours of Core Module sessions delivered by Cambridge faculty members, 8.5 hours of Seminars and 10.5 hours of British cultural activities.
Pre-requisites	A background in project mamangement is preferred for the course. Programming experience is helpful but not necessary.
Assessment	Assessed in groups through group academic projects
Skills Trained	Problem solving, design thinking, project planning, teamwork, presentation, communication
Materials Required	Internet connection and devices for writing, interacting with online templates such as Google Docs, researching a project and preparing for a final group presentation

II. Course Description

'Systems that work do not just happen – they have to be planned, designed and built.' So said the Royal Academy of Engineering in 2007. To maximise success in an increasingly complex world, employing design thinking and systems thinking is even more important now than it was then. We often hear calls for 'systems thinking' and a 'systems approach', but how can this be done? This course will teach students to follow a method for systems thinking that has been employed successfully in many domains, including in the world of healthcare systems design and at government and policy level.

Embark on an enthralling exploration of system design, presented through a nuanced, application-driven lens. Delve into the foundational tenets that govern this vast domain, setting the stage for deeper engagement. As we transition from elemental constructs to sophisticated methodologies, participants will be invited to immerse themselves in carefully curated Project-Based Learning (PBL) scenarios. These hands-on experiences aim to cultivate and crystallise the design ideologies inherent to the field.

To culminate this transformative learning experience, students will channel their newfound knowledge and insights into a capstone project— an opportunity to showcase, reflect, and innovate on the principles imbibed throughout this enlightening journey.

III. Goals & Objectives

The course aims to provide students with a solid understanding of systems design and engineering thinking, focusing on advancing hardware design for energy-efficient and low-carbon technologies. By integrating concepts from electronics, computer science, and materials science, students will learn to apply systems design principles to develop innovative sustainability solutions. Through this project-based learning (PBL) experience, participants will engage in design activities that transform their ideas into tangible innovations enhancing hardware efficiency. By the end of the course, students will create cutting-edge hardware solutions and gain the expertise to push the boundaries of hardware design, contributing transformative solutions to energy-efficient technologies and supporting sustainable development for a low-carbon future.

Key Components & Milestones:

1. Technological Landscape Analysis & Industry Gap Identification
2. Hardware Conceptualization & Innovative Design Strategies
3. Integration of Innovative Technologies & Optimisation Framework
4. Regulatory Adherence & Risk Mitigation
5. Prototyping & Rigorous Performance Testing
6. Collaboration with Industry Stakeholders & Market Entry Strategy
7. Continuous Innovation & Scalability Plans

IV. Course Syllabus

Module 1 Fundamentals of Systems Design and Engineering Thinking

Introduction:

This course introduces students to design thinking and a systems approach through four key perspectives: systems, design, risk, and people. By understanding these interconnected elements, students will develop a holistic approach to problem-solving, equipping them with timeless principles applicable across diverse fields. The course focuses not only on creating individual products but also on designing comprehensive systems. By the end of the course, students will have developed a systems mindset for tackling complex challenges, empowering them to create solutions that are both innovative and adaptable.

Aims

- Develop a strong understanding of systems thinking and its applications across various domains.
- Explore a systems approach that emphasises comprehensive design rather than focusing solely on individual products.
- Apply systems engineering methods to real-world case studies to enhance problem-solving and solution design skills.
- Identify and mitigate risks using structured tools and models to ensure design robustness.

Topics

- Introduction: Understanding Stakeholders and the System
- Systems: Visualising Interconnectivity and Relationships
- Risk: Managing Uncertainty and Preparing for Failures
- Design: Crafting Solutions with Purpose and Clarity

Module 2 New Energy Materials and Devices

Introduction:

This module introduces the fundamental principles of semiconductor physics with a focus on their application in renewable energy technologies, such as solar cells and energy-efficient devices. Students will explore the behavior of semiconductors and learn how they are utilised in modern energy materials and devices. Topics will cover the design, operation, and performance of semiconductors in photovoltaic cells and other energy-related technologies.

Aims

- Gain a foundational understanding of semiconductor physics, with an emphasis on their importance in new energy technologies.
- Familiarise with renewable energy materials, particularly semiconductors used in solar cells and other energy-efficient devices.
- Explore the principles behind the design and operation of key devices such as solar cells, MOSFETs, and energy conversion technologies.
- Develop the analytical skills needed to evaluate and conceptualise semiconductor-based solutions for energy-related technologies.

Topics

- Fundamentals of Semiconductor Physics
- p-n Junctions and Charge Transport
- Semiconductors in Energy Devices
- MOSFETs and Renewable Energy Applications
- Semiconductor Materials for Solar Cells and Energy-Efficient Devices

V. More Information

Assessment

Learning will be assessed through small group presentations at the end of the course. Each individual will be expected to present within their group presentation time. The quality of the presentation will be assessed by the instructor. Teams will need to demonstrate how they have used a systems approach to plan or design an improvement. The emphasis will be on the process they have followed rather than the quality of the finished product.

Format

The course will take place in a face-to-face format, interspersed by self-directed group work, to prepare for the assessed presentation.

Reading List

Readings will be provided to students in due course.