Engineering Tripos Part IIB, 4B11: Photonic Systems, 2024-25

Module Leader

Prof T Wilkinson [1]

Lecturer

Prof T Wilkinson

Timing and Structure

Michaelmas term. 14 lectures. Assessment: 100% exam

Prerequisites

3B6 useful

Aims

The aims of the course are to:

- understand how Fourier optics can be used to manipulate light in many applications
- examine the advance of optical techniques into electronic systems for computation and communications.
- investigage the technology behind such potential applications

Objectives

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

- a simple introduction to optical diffraction and Fourier optics.
- apply Fourier techniques to simple optical spatial patterns.
- understand the principles of optical correlation and holography.
- understand the basic principles of liquid crystal phase modulation.
- explain the principles and construction of spatial light modulators (SLMs).
- understand the basic principles of free space optical systems and how to build them
- know the basic function of adaptive optical systems.
- understand the properties of optical aberrations and how to correct them.

Content

The aim of this module is to examine the advance of optical techniques into electronic systems for computation and communications. Two dimensional and three dimensional transmission, storage and processing of information using free space optics are discussed. Applications such as computer generated holography, optical correlation, optical switching and adaptive optics are highlighted through the use of liquid crystal technology.

Fourier Holograms and Correlation (5L)

- Basic diffraction theory, Huygens principle

- Fourier Transforms and Holography introduction and motivation;
- Fourier transforms: theoretical and with lenses: resolution of optical systems;
- Correlation and convolution of 2-dimensional signal patterns;
- Dynamic and fixed phase computer generated holograms.

Electro-Optic Systems (5L)

- Free space optical components; wave plates and Jones matrices
- Fundamentals of liquid crystal phase modulation
- Spatial light modulation and optical systems;
- Holographic interconnects and fibre to fibre switching
- Wavelength filters and routing systems
- The BPOMF and 1/f JTC correlators.

Adaptive optical Systems (4L)

- Adaptive systems in free space optics;
- The power of phase conjugation;
- Adaptive optical interconnects;
- Optical aberrations and optical correction techniques;

Demonstrations in the lectures will include:

1. 2D Fourier transform and diffraction patterns.
2. Computer generated hologram for optical fan-out.
3. Optical beam steering with dynamic holograms on SLMs.
4. The JTC

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 [2].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [3] 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.

E3

Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.

E4

Understanding of and ability to apply a systems approach to engineering problems.

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.

US2

A comprehensive knowledge and understanding of mathematical and computer models relevant to the engineering discipline, and an appreciation of their limitations.

US4

An awareness of developing technologies related to own specialisation.

Last modified: 31/05/2024 10:01

iib-4b11-photonic-systems-2024-25

Links
[1] mailto:tdw13@cam.ac.uk
[2] https://teaching26-27.eng.cam.ac.uk/content/form-conduct-examinations
[3] https://teaching26-27.eng.cam.ac.uk/content/uk-spec