# Engineering Tripos Part IB, 2P6: Fourier Transforms & Signal and Data Analysis, 2021-22

## Course Leader

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## Lecturer

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## Timing and Structure

Lent Term: 7 lectures Weeks 1-3, 2 lectures, week 4, 1 lecture

## Aims

The aims of the course are to:

- Introduce the Fourier Transform as an extension of Fourier techniques on periodic functions and to see how the Fourier Transform is applied to real problems
- Introduce discrete Fourier methods and to develop skills in analysing discrete data.

## Objectives

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

- develop the ability to discuss and manipulate signals in terms of their frequency content.
- relate properties of signals in the time domain to those in the frequency domain.
- be familiar with the difference in behaviour/properties of continuous signals compared to sampled signals, and the basic rules that apply to the latter.

## Content

**Introduction and preliminaries**

- Motivation for signal analysis. Examples of typical datasets.
- Power and energy
- Revision and extension of delta functions
- Revision of Fourier series

**The Fourier Transform (FT)**

- Mathematical formulation of the FT
- Interpretation of the FT
- The inverse Fourier transform (IFT)
- Some important Fourier transforms

**Properties of the Fourier Transform**

- Linearity and scaling
- Time and frequency shifts (modulation)
- Duality, Parseval's Theorem, convolution
- Relationship to Laplace transforms

**Sampling Theory**

- The sampling theorem and aliasing
- The discrete time Fourier transform
- Signal reconstruction and the Nyquist frequency

**The Discrete Fourier Transform**

- Derivation of DFT and inverse DFT
- Examples of using the DFT
- The spectrogram

## Booklists

Please refer to the Booklist for Part IB 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

The UK Standard for Professional Engineering Competence (UK-SPEC) [3] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [4] which sets out the standard for degree accreditation.

The Output Standards Matrices [5] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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**Links**
[1] mailto:sjg30@cam.ac.uk
[2] http://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[3] http://www.engc.org.uk/ukspec.aspx
[4] http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/
[5] http://teaching.eng.cam.ac.uk/content/output-standards-matrices