

## **Engineering Tripos Part IIA, 3F1: Signals & Systems, 2019-20**

### **Module Leader**

[Dr T O'Leary](#) [1]

### **Lecturers**

[Dr T. O'Leary and Dr F. Forni](#) [2]

### **Lab Leader**

[Prof M Smith](#) [3]

### **Timing and Structure**

Michaelmas term. 16 lectures.

### **Aims**

The aims of the course are to:

- Cover three basic topics in signals and systems which provide the basis for further topics in signal processing, communications, control and related subjects.
- Introduce the z-transform, which is the generalisation of the Laplace transform to discrete time systems.
- Introduce digital filtering.
- Introduce stochastic processes.

### **Objectives**

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

- Be familiar with the theory and application of the z-transform.
- Analyse the stability of discrete-time systems
- Understand the use of correlation and spectral density functions.
- Analyse the behaviour of linear systems with random inputs.

### **Content**

**Enabling theory, application and design, Dr T. O'Leary and Dr F. Forni**

Introduction to signals and systems, discrete time signals and systems, Z-transform (5L – O'Leary)

- Discrete signals and systems, LTI systems, convolution.
- z-transform and solution of linear difference equations
- System analysis in the z-domain.
- Impulse and frequency responses.

Applications & digital filtering (8L – Forni)

- Design and properties of digital feedback systems. Nyquist stability criterion.
- Design and properties of Digital Filters, FIR and IIR
- Analysis of systems with discrete/continuous interfaces.
- DTFT/DFT and links to z-transforms
- The Fast Fourier Transform (FFT)
- Windowed spectral analysis of data
- Introduction to 2D filtering, image analysis

Introduction to random processes and linear systems (3L – O’Leary)

- Continuous time random processes, correlation functions, spectral density.
- Response of continuous time linear systems to random excitation.

## Coursework

### Flight control

Learning objectives:

- Simulation of various aircraft models on the computer.
- Study real-time (manual) control and the limitations imposed by time delays.
- Design of a simple autopilot.
- Illustrate frequency response concepts in analogue and digital control systems, conditions for oscillation in feedback systems and stability.
- Gain familiarity with MATLAB.

Practical information:

- Sessions will take place in the EIETL laboratory on Wednesdays and Fridays of full term from 11am-1pm.
- Students will find it helpful to read through the lab sheet in advance of carrying out the experiment.
- Students will have the option to submit a Full Technical Report.

Full Technical Report:

Students will have the option to submit a Full Technical Report.

## Booklists

Please see the [Booklist for Part IIA Courses](#) [4] for references for this module.

## Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [5].

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**Links**

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[4] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364091&chapterid=48921>

[5] <https://teaching.eng.cam.ac.uk/content/form-conduct-examinations>