Engineering Tripos Part IIA, 3F1: Signals & Systems, 2020-21

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 refer to the Booklist for Part IIA 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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