EEU33C01 Signals and Systems [5 credits]

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Module organisation
Semester 1: 3 lectures and 1 tutorial per week. 1 associated laboratory

Module description, aims and contribution to programme
The Signals and Systems module is taken by Junior Sophister B, C, CD, D stream and Bioengineering students. It provides a foundation for the Signal Processing, Control, and Communications Engineering modules covered later in the undergraduate curriculum.

The module presents the mathematical techniques used for continuous-time signal and system analysis. The analytical framework for discrete-time signals and systems is then developed. The final part of this module is an introduction to control systems.

Learning outcomes
On completion of this module the student should be able to:

1. Represent both continuous-time and discrete-time periodic signals as a Fourier series.
2. Use the Fourier transform and the Laplace transform to analyse continuous-time signals and systems
3. Use the discrete-time Fourier transform and the z-transform to analyse discrete-time signals and systems
4. Determine the impulse response, step response and frequency response of both continuous-time and discrete-time systems
5. Determine the response of the LTI system to any input signal
6. Determine the stability of a feedback system

Module content
Continuous-Time Signals and Systems

- Linearity, time-invariance, impulse response of a linear time-invariant (LTI) system; the convolution integral; properties of LTI systems; unit step response
- Periodic functions; Fourier series; properties of the Fourier series
- Laplace Transform; properties of the Laplace transform; transfer function of LTI system; poles, zeros and stability of an LTI system
- The Fourier transform and its properties
- Frequency response; steady state response; low-pass and high-pass filtering
- Representation of a continuous-time signal by its samples; the sampling theorem; reconstruction of a continuous-time signal from its samples

Discrete-Time Signals and Systems

- The unit-impulse response of an LTI discrete-time system; the convolution sum; properties of discrete-time LTI systems; unit step response
- Fourier series representation of discrete-time periodic signals; properties of discrete-time Fourier series
- The discrete-time Fourier transform (DTFT); properties of the DTFT
- The z-transform; region of convergence for the z-transform; inverse z-transform; properties of the z-transform
- Causality; Stability; LTI systems characterized by linear constant-coefficient difference equations
- FIR and IIR filters

Introduction to Control Systems

- Linear Feedback Systems, closed-loop system function

Teaching strategies

The module is taught using a combination of lectures and tutorials.
There is one associated Matlab-based laboratory.

Assessment

85% of the assessment of the 3C1 module is derived from the annual two-hour written examination, 10% from an in-class test, and the remaining 5% from the Matlab-based laboratory .

The overall module mark at the Supplemental examinations will be determined solely on the basis of the written examination.

Recommended textbook

A. V. Oppenheim, A. S. Willsky with S. H. Nawab, *Signals and Systems,* 2nd Ed., Pearson, 2013

Further information

https://www.tcd.ie/Engineering/undergraduate/baiyear3/