# ES2H5-15 Signal Processing

## 25/26

**Department**
School of Engineering
**Level**
Undergraduate Level 2
**Module leader**
Adam Noel
**Credit value**
15
**Module duration**
10 weeks
**Assessment**
30% coursework, 70% exam
**Study location**
University of Warwick main campus, Coventry

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## Description

## Introductory description

Module web page

## Module aims

The module aims to introduce signal processing to 2nd year students. It aims to develop the student's ability to: Select and apply appropriate mathematical methods for modelling and analysing signals and systems; Understand the scientific principles underlying the generation and classification of signals; Use practical skills to measure and analyse real-world signals; Select and apply appropriate computer based methods for modelling signals and systems; Design signal processing systems to meet a target specification.

## Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Analogue Signals and Systems: Time domain and s-domain representation of continuous-time signals; Linear time-invariant systems; Laplace transform; Analogue system transfer functions; Analogue system stability; Fourier transform and analogue frequency response; Analogue filter

design and specification; Fourier series for periodic analogue signals; Computational modelling of analogue signals and systems

Digital Signals and Systems: Time-domain and z-domain representation of discrete-time signals; Signal conversion between analogue and digital representations; Sampling and aliasing; Linear shift-invariant systems; Z-transform; Digital system transfer functions; Digital system stability; Discrete-time Fourier transform and digital frequency response; Finite impulse response and infinite impulse response filters; Digital filter design and specification; Discrete Fourier Transform and evaluation with the Fast Fourier Transform; Computational modelling of digital signals and systems

Random Signal Processing: Random variable properties and variable distributions; Random signals; Signal estimation; Correlation; Power spectral density

Image Processing: Multi-dimensional signals; Representing images as signals; Multi-dimensional convolution; Image filtering

## Learning outcomes

By the end of the module, students should be able to:

- 1. Apply mathematics to analyse deterministic and random signals and to analyse processing systems [C1, M1]
- 2. Apply signal processing systems to classify signals and extract information [C1, M1]
- 3. Critique practical issues behind signal processing and information retrieval [C12, M12]
- 4. Design signal processing systems to meet a specification [C1, M1]
- 5. Model signals, filters and processes using computer packages [C3, M3, C3, M3]
- 6. Measure and analyse real-world signals [C12, M12]
- 7. Demonstrate, plan and record self-learning and development as the foundation for lifelong learning/CPD (at least 5 points) [C18, M18]

## Indicative reading list

“Essentials of Digital Signal Processing”, B.P. Lathi and R.A. Green, Cambridge University Press, 2014
“Essential MATLAB”, B. Hahn and D. Valentine, Academic Press, 6th Edition, 2017
“Discrete-Time Signal Processing”, Oppenheim and Schafer, Pearson, 3rd Edition, 2013

## Subject specific skills

- Ability to conceive, make and realise a component, product, system or process
- Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality

## Transferable skills

- Numeracy: apply mathematical and computational methods to communicate parameters,

model and optimize solutions
- Apply problem solving skills, information retrieval, and the effective use of general IT facilities
- Plan self-learning and improve performance, as the foundation for lifelong learning/CPD

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## Study

## Study time

| Type | Required |
|---|---|
| Lectures | 24 sessions of 1 hour (16%) |
| Practical classes | 3 sessions of 2 hours (4%) |
| Other activity | 4 hours (3%) |
| Private study | 116 hours (77%) |
| Total | 150 hours |

## Private study description

46 hours Guided independent learning
30 hours coursework submission
40 hours final exam study

### Other activity description

2 x 1hr examples class
2 x 1hr revision class

## Costs

No further costs have been identified for this module.

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## Assessment

You must pass all assessment components to pass the module.

### Assessment group D

| | Weighting | Study time | Eligible for self-certification |
|---|---|---|---|
| Lab Assignment | 30% | | Yes (extension) |

Assignment submission supported by laboratory activities and using both hardware and software.

| | Weighting | Study time | Eligible for self-certification |
|---|---|---|---|
| Submission consists of a written report (maximum length of 5 pages) in addition to written code files and code output. | | | |
| Online Examination | 70% | | No |
| QMP Online Examination 2 x 1hr | | | |
| ~Platforms - QMP | | | |

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- Online examination: No Answerbook required
- Students may use a calculator
- Engineering Data Book 8th Edition
- Graph paper

### Feedback on assessment

- Model solutions to past papers.
- Individual and cohort-level feedback on assignments.
- Support through advice and feedback hours.
- Cohort-level feedback on final exam.

Past exam papers for ES2H5

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## Availability

## Courses

This module is Core for:

- Year 2 of UESA-H161 BEng Biomedical Systems Engineering
- Year 2 of UESA-H63W BEng Electronic Engineering
- Year 2 of UESA-H113 BEng Engineering
- Year 2 of UESA-HH35 BEng Systems Engineering
- Year 2 of UESA-H163 MEng Biomedical Systems Engineering
- Year 2 of UESA-H63X MEng Electronic Engineering
- Year 2 of UESA-H114 MEng Engineering
- UESA-HH31 MEng Systems Engineering
    - Year 2 of HH31 Systems Engineering
    - Year 2 of HH35 Systems Engineering
- Year 2 of UESA-H605 Undergraduate Electrical and Electronic Engineering
- Year 2 of UESA-H606 Undergraduate Electrical and Electronic Engineering MEng