

MA3K9-15 Mathematics of Digital Signal Processing

26/27

Department

Warwick Mathematics Institute

Level

Undergraduate Level 3

Module leader

Randa Herzallah

Credit value

15

Module duration

10 weeks

Assessment

Multiple

Study location

University of Warwick main campus, Coventry

Description

Introductory description

Digital signal processing is based on many, core disciplines covering many theoretical and application fields. In the field of Mathematics, calculus, probability statistics, deterministic and stochastic processes, and numerical analysis are all core disciplines for digital signal processing. It also lies at the core of many new and emerging areas of science and technology, including network theory and interconnected systems, signals and systems, cybernetics, communication theory, control theory, and fault diagnosis. In addition, digital signal processing forms the basic foundation for the exciting fields of artificial intelligence, pattern processing and analysis, and neural networks. This module comprehensively introduces the main topics in digital signal processing design and analysis including interpolation, convolution, correlation, discrete Fourier transform, z transform, and filter designs. It will also be supported by examples and other modelling techniques using programming languages such as Matlab and Python.

Module aims

The module aims at developing an in-depth knowledge of discrete-time signal processing algorithms and approaches to measure, analyse and understand and improve the performance of digital systems and their applications. It will then be structured around the following topics:

1- Data acquisition and sampling

- Discrete sequences and systems
- Sampling and sampling theorem
- Aliasing,
- Quantisation
- Signal reconstruction

2- Time domain Methods

- Correlation
- Linear convolution
- Circular convolution

2- Frequency domain methods

- Forward and inverse z-transform
- Forward and inverse discrete Fourier transform

3- Digital filter design

- Finite and infinite impulse response filters
- Realisation of digital filters

4- Introduction to multirate signal processing

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.

Digital signal processing lies at the core of many new and emerging areas of science and technology including telecommunication, biomedical applications, image processing and recognition, and digital media. This module is an introduction to the basic mathematical tools that are required to present, analyse, understand and design digital signal processing systems. This includes the basics of sampling of continuous time signals, digital filters, digital spectral analysis and digital multirate signal processing.

Learning outcomes

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

- 1. Describe the terminology and concepts of core methods and techniques of digital signal processing.
- 2. Design and develop digital signal processing systems and applications.
- 3. Formulate and code DSP algorithms to simulate and implement digital signal processing algorithms.
- 4. Analyse and explain the behaviour of digital systems.
- 5. Design and implement various digital filters including FIR and IIR filters.

Indicative reading list

[Reading lists can be found in Talis](#)

Interdisciplinary

DSP is a highly interdisciplinary field. It is dependent on technical studies in many adjacent fields including Communication Theory, Numerical Analysis, Probability and Statistics, and Digital Electronics, etc.

Subject specific skills

Students taking the module will be able to analyse discrete signals and systems, apply introduced methods in the design of basic signal processing applications, work independently on Matlab/Python signal and analysis tools, design and apply digital filters to separate required/desired signal from signals with noise, and critically assess digital signal processing systems in terms of performance.

Transferable skills

Specialist knowledge and application. Critical thinking and problem solving. Critical analysis. Numeracy. Effective Information retrieval and research skills. Computer literacy. Creativity, innovation & independent thinking.

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Tutorials	9 sessions of 1 hour (6%)
Online learning (independent)	(0%)
Private study	56 hours (37%)
Assessment	55 hours (37%)
Total	150 hours

Private study description

Review lectured material and work on set exercises.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time	Eligible for self-certification
Assignments	15%	25 hours	No
4 homeworks assignments. This will ensure that the students keep up with the module during the term. The students' understanding of the basic concepts and theory and their application to real world problems will be assessed through continuous coursework assignments that are lined up with the lecture topics and learning outcomes.			
Centrally-timetabled examination (On-campus)	85%	30 hours	No
A standard 3 hour exam			

- Answerbook Gold (24 page)

Assessment group R1

	Weighting	Study time	Eligible for self-certification
Resit exam	100%		No
The same as above.			

- Answerbook Gold (24 page)

Feedback on assessment

Marked assignments

[Past exam papers for MA3K9](#)

Availability

Courses

This module is Optional for:

- Year 1 of TMAA-G1P0 Postgraduate Taught Mathematics
- TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
 - Year 1 of G1PC Mathematics (Diploma plus MSc)
 - Year 2 of G1PC Mathematics (Diploma plus MSc)
- Year 3 of UCSA-G4G1 Undergraduate Discrete Mathematics
- UCSA-G4G3 Undergraduate Discrete Mathematics
 - Year 3 of G4G1 Discrete Mathematics
 - Year 3 of G4G3 Discrete Mathematics
- Year 4 of UCSA-G4G4 Undergraduate Discrete Mathematics (with Intercalated Year)
- Year 4 of UCSA-G4G2 Undergraduate Discrete Mathematics with Intercalated Year

This module is Core option list A for:

- Year 4 of UMAA-GV18 Undergraduate Mathematics and Philosophy with Intercalated Year

This module is Core option list B for:

- Year 3 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Core option list C for:

- Year 3 of UMAA-GV17 Undergraduate Mathematics and Philosophy
- Year 3 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Core option list F for:

- Year 4 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Option list A for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
 - Year 4 of G105 Mathematics (MMath) with Intercalated Year
 - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- Year 3 of UMAA-G100 Undergraduate Mathematics (BSc)
- UMAA-G103 Undergraduate Mathematics (MMath)
 - Year 3 of G100 Mathematics
 - Year 3 of G103 Mathematics (MMath)
 - Year 4 of G103 Mathematics (MMath)
- Year 4 of UMAA-G107 Undergraduate Mathematics (MMath) with Study Abroad
- Year 4 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- Year 3 of UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)

- Year 3 of GF13 Mathematics and Physics
 - Year 3 of FG31 Mathematics and Physics (MMathPhys)
- Year 4 of UPXA-GF14 Undergraduate Mathematics and Physics (with Intercalated Year)
- Year 4 of UMAA-G101 Undergraduate Mathematics with Intercalated Year