CS249-15 Digital Communications and Signal Processing

24/25

Department
Computer Science
Level
Undergraduate Level 2
Module leader
Jianfeng Feng
Credit value
15
Module duration
10 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The aim of the module is to acquaint students with the principles and practice of digital communications - from the fundamental basis of communication to how signals are represented and processed.
This module is only available to students in the second year of their degree and is not available as an unusual option to students in other years of study.

Module aims

The aim of the module is to acquaint students with the principles and practice of digital communications - from the fundamental basis of communication to how signals are represented and processed.
The module develops an analytical approach to problems in communication design and operation, grounded in elements of communication theory sufficient to give students an understanding of the problems that affect its reliability and efficiency.
It introduces the theory and implementation of digital signal processing approaches, including the representation of signals in communication systems, filtering techniques and the applications of digital 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.

Information Sources and Coding: Information theory, coding of information for efficiency and error protection;
Data transmission: Channel characteristics, signalling methods, interference and noise, synchronisation, data compression and encryption;
Signal Representation: Representation of discrete time signals in time and frequency; z transform and Fourier representations; discrete approximation of continuous signals; sampling and quantisation; stochastic signals and noise processes;
Filtering: Analysis and synthesis of discrete time filters; finite impulse response and infinite impulse response filters; frequency response of digital filters; poles and zeros; filters for correlation and detection; matched filters;
Digital Signal Processing applications: Processing of speech signals using digital techniques.

Learning outcomes

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

- - Understand the structure of the communication process.
- - Explain the main control issues in communication networks.
- - Understand the principles of digital signal processing and have a knowledge of its main areas of application.
- - Design, implement and analyse the behaviour of simple digital signal processing algorithms.

Indicative reading list

Please see Talis Aspire link for most up to darte list.

View reading list on Talis Aspire

Subject specific skills

At the end of the course students should be able to:
calculate the information content and entropy of a random variable from its probability distribution;
relate the entropies of variables in terms of their probabilities;
construct efficient codes for data on communication channels;
understand the concept of digital signals;
understand encoding and communication schemes in terms of the spectral properties of signals;
describe compression schemes, and efficient coding using Fourier Transform and other representations for data.

Transferable skills

At the end of the course students should be able to:
Using MatLab to work on other problems related to mathematics
Have a better understanding of advanced mathematics;
Equipped with basic knowledge to work on other areas such as audio, video and in general big data processing;
Applications in other sciences: genomics; neuroscience; astrophysics; noisy signal classification; and pattern recognition including biometrics.

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Seminars	10 sessions of 1 hour (7%)
Private study	110 hours (73%)
Total	150 hours

Private study description

There are many online materials useful for our module such as textbooks for machine learning and in general you should read:

- https://en.wikipedia.org/wiki/Digital_signal_processing
- Hari Krishna Garg: Digital Signal Processing Algorithms, CRC Press, ISBN 0-8493-7178-3
- P. Gaydecki: Foundations Of Digital Signal Processing: Theory, Algorithms And Hardware Design, Institution of Electrical Engineers, ISBN 0-85296-431-5
- Ashfaq Khan: Digital Signal Processing Fundamentals, Charles River Media, ISBN 1-58450-281-9
- Sen M. Kuo, Woon-Seng Gan: Digital Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, ISBN 0-13-035214-4
- Paul A. Lynn, Wolfgang Fuerst: Introductory Digital Signal Processing with Computer Applications, John Wiley & Sons, ISBN 0-471-97984-8
- Richard G. Lyons: Understanding Digital Signal Processing, Prentice Hall, ISBN 0-13-108989-7
- Vijay Madisetti, Douglas B. Williams: The Digital Signal Processing Handbook, CRC Press, ISBN 0-8493-8572-5
- James H. McClellan, Ronald W. Schafer, Mark A. Yoder: Signal Processing First, Prentice Hall, ISBN 0-13-090999-8
- Bernard Mulgrew, Peter Grant, John Thompson: Digital Signal Processing – Concepts and Applications, Palgrave Macmillan, ISBN 0-333-96356-3
- Boaz Porat: A Course in Digital Signal Processing, Wiley, ISBN 0-471-14961-6
- John G. Proakis, Dimitris Manolakis: Digital Signal Processing: Principles, Algorithms and Applications, 4th ed, Pearson, April 2006, ISBN 978-0131873742

- John G. Proakis: A Self-Study Guide for Digital Signal Processing, Prentice Hall, ISBN 0-13-143239-7
- Charles A. Schuler: Digital Signal Processing: A Hands-On Approach, McGraw-Hill, ISBN 0-07-829744-3
- Doug Smith: Digital Signal Processing Technology: Essentials of the Communications Revolution, American Radio Relay League, ISBN 0-87259-819-5
- Smith, Steven W. (2002). Digital Signal Processing: A Practical Guide for Engineers and Scientists. Newnes. ISBN 0-7506-7444-X.
- Stein, Jonathan Yaakov (2000-10-09). Digital Signal Processing, a Computer Science Perspective. Wiley. ISBN 0-471-29546-9.
- Stergiopoulos, Stergios (2000). Advanced Signal Processing Handbook: Theory and Implementation for Radar, Sonar, and Medical Imaging Real-Time Systems. CRC Press. ISBN 0-8493-3691-0.
- Van De Vegte, Joyce (2001). Fundamentals of Digital Signal Processing. Prentice Hall. ISBN 0-13-016077-6.
- Oppenheim, Alan V.; Schafer, Ronald W. (2001). Discrete-Time Signal Processing. Pearson. ISBN 1-292-02572-7.
- Hayes, Monson H. Statistical digital signal processing and modeling. John Wiley & Sons, 2009. (with MATLAB scripts)
- David MacKay Information Theory, Inference, and Learning Algorithms (Hardback, 640 pages, Published September 2003)
- https://www.cl.cam.ac.uk/teaching/1920/InfoTheory/
- Cover, T.M. & Thomas, J.A. (2006). Elements of information theory. New York: Wiley.

In addition, students should:

- Review lecture notes
- Complete coursework
- Revise for examinations

Costs

No further costs have been identified for this module.

Assessment

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

Students can register for this module without taking any assessment.

Assessment group D2

	Weighting	Study time
Programming assignment (Coursework)	20%	
In-person Examination	80%	

	Weighting	Study time
CS249 exam - A paper which examines the course content and ensures learning outcomes are achieved.		

- Answerbook Gold (24 page)
- Students may use a calculator

Assessment group R1

	Weighting	Study time
In-person Examination - Resit CS249 resit examination	100%	

- Answerbook Gold (24 page)
- Students may use a calculator

Feedback on assessment

Feedback in seminars

Past exam papers for CS249

Availability

Courses

This module is Optional for:

- Year 2 of UCSA-I1N1 Undergraduate Computer Science with Business Studies
- Year 2 of UCSA-G406 Undergraduate Computer Systems Engineering
- Year 2 of UCSA-G408 Undergraduate Computer Systems Engineering
- Year 2 of USTA-G305 Undergraduate Data Science (MSci) (with Intercalated Year)

This module is Option list A for:

- UCSA-G500 Undergraduate Computer Science
  - Year 2 of G500 Computer Science
  - Year 2 of G500 Computer Science
  - Year 2 of G500 Computer Science
- UCSA-G503 Undergraduate Computer Science MEng

    - Year 2 of G500 Computer Science
    - Year 2 of G503 Computer Science MEng
    - Year 2 of G503 Computer Science MEng
- USTA-G302 Undergraduate Data Science
    - Year 2 of G302 Data Science
    - Year 2 of G302 Data Science

This module is Option list B for:

- UCSA-G4G1 Undergraduate Discrete Mathematics
    - Year 2 of G4G1 Discrete Mathematics
    - Year 2 of G4G1 Discrete Mathematics
- Year 2 of UCSA-G4G3 Undergraduate Discrete Mathematics