

MODULE TITLE	Data, Signals and Systems		CREDIT VALUE	15
MODULE CODE	ECM2906		MODULE CONVENER	Prof Stuart Townley
DURATION: TERM	1	2	3	
DURATION: WEEKS	0	11	0	
Number of Students Taking Module (anticipated)	50			

DESCRIPTION - summary of the module content

Solar flares occur on eleven-year cycles, surfers wait for “every seventh wave”, porpoise calls have a distinctive signature that can be detected against the background noise of their marine environment, bats locate prey by elaborate use of sonar. In each case, complex time-series data is decomposed into frequency-determined characteristics. This decomposition is then used for explanative and predictive purposes. The analysis of these complex frequency characteristics is at the core of systems and transforms. You will study classical mathematical techniques of Fourier and Laplace transforms, applied in a modern context of a data-rich world. You will use real data from Cornwall-based applications in marine ecology, renewable wave energy and environment and human health. Pre-requisite modules: “Calculus and Geometry” (ECM1901), “Vector and Matrices” (ECM1902), or equivalent, and familiarity with MATLAB.

AIMS - intentions of the module

The broad aims of the module are to develop the mathematics of modern signal processing, that is the interplay between signals and series, and the systems that operate on them, and then to apply these techniques to real data arising from scientific and engineering applications. Signal processing is ubiquitous across all aspects of science and technology – smart phones, on-line music and video streaming, digital TVs and cameras could not function without signal processing, whilst many areas of applied science would struggle to function. The mathematics of signal processing finds its roots in the 19th century work of Fourier, but leads up to modern tools of discrete Z-transforms and wavelets. This module will uncover the amazing and beautiful mathematics that underpins the digital revolution of the last few decades. The module also illustrates a fundamental issue: the lead-time for technology transfer from theoretical mathematics to commercial/technological products can be decades, if not centuries.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module, **you should be able to:**

Module Specific Skills and Knowledge:

- 1 Demonstrate a sound understanding of essential mathematical aspects of signal processing, including an appreciation of the temporal and frequency content in data and the representation of time series data in terms of basis functions;
- 2 Reconstruct signals from their frequency content;
- 3 Appreciate the fundamental limitations of reconstructing a signal from its frequency- or time-sampled form;

Discipline Specific Skills and Knowledge:

- 4 Demonstrate sufficient knowledge of signal processing techniques for applications in engineering and science;
- 5 Show awareness and skills in applying a range of mathematical modelling techniques;

Personal and Key Transferable / Employment Skills and Knowledge:

- 6 Formulate and solve problems;
- 7 Communicate reasoning and solutions effectively in writing;
- 8 Make appropriate use of learning resources;
- 9 Demonstrate self-management and time management skills.

SYLLABUS PLAN - summary of the structure and academic content of the module

Theme 1. Modelling of systems: examples of systems arising in engineering and scientific applications including electrical circuits, wave energy systems and biological systems; state space models, nonlinear systems, linearization, numerical solutions [8 hours];

Theme 2. Laplace and inverse Laplace transforms, partial fractions and use of Laplace transform tables; using Laplace Transforms to solve and manipulate linear ordinary differential equations [8 hours];

Theme 3. Generic interpretation of system data; odd and even functions; periodic functions; signal processing using Fourier series and Fourier transforms; the celebrated Nyquist-Shannon sampling theorem [8 hours];

Theme 4. Transfer functions and input-output systems; poles and zeros; stability; gain and phase; frequency response and Bode; block diagram algebra; Simple feedback control, Z-transforms [8 hours];

Applied group project on one of the four themes in supported matlab classes [12 hours]

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching Activities	44.00	Guided Independent Study	106.00	Placement / Study Abroad	0.00
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DETAILS OF KEY LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled Learning and Teaching Activities	16	Formal lectures of new material
Scheduled Learning and Teaching Activities	16	Example classes and computer demos
Scheduled Learning and Teaching Activities	12	Tutorials for group project support
Guided Independent Study	106	Lecture & assessment preparation; wider reading

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

Form of Assessment	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Fortnightly Exercise Sheets	15 hours. Students expected (strongly encouraged) to attempt ALL formative questions	1-9	Written and Oral

SUMMATIVE ASSESSMENT (% of credit)

Coursework	50	Written Exams	50	Practical Exams	0
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DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
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Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Selection of questions similar to those from the formative sheets sat as tests.	4 times 5 = 20	At regular intervals in line with the 4-theme learning cycle, students will complete FOUR 30-minute tests. Students will be encouraged to complete ALL formative questions before hand. The tests aim to endorse understanding of formative work. But students will be able to attempt these questions from scratch.	1-9	Annotated scripts and oral feedback from module leader, discussion with peers
In depth data, signals and systems group project	30	8 hours	1-9	Written and oral
Written exam	50	1 hour 30 minutes	1-7	Annotated scripts

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

Original Form of Assessment	Form of Re-assessment	ILOs Re-assessed	Time Scale for Re-assessment
Selection of questions similar to those from the formative sheets sat as tests.	As original	1-9	August Ref/Def Period
In depth data, signals and systems group project	As original	1-9	August Ref/Def Period
Written exam	As original	1-7	August Ref/Def Period

As original

RE-ASSESSMENT NOTES

If mitigating circumstances prevent timely completion of one or more tests (normally within a specified week) or if candidates are referred or deferred, then candidates will complete a coursework assessment pro rata with the missed test(s).

If mitigating circumstances prevent candidates from completing the group project or if candidates are referred, then they will complete an alternative coursework.

If mitigating circumstances prevent attendance at the exam in May or if candidates are referred then they will sit an exam in the deferred assessment period.

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

Basic reading:

ELE - <http://vle.exeter.ac.uk>

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Kreyszig, E.	Advanced Engineering Mathematics	9th	Wiley	2006	978-0471728979	[Library]
Set	McMahon, D.	Signals and Systems Demystified		McGraw Hill	2006	978-0071475785	[Library]

CREDIT VALUE	15	ECTS VALUE	7.5
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PRE-REQUISITE MODULES	ECM1901, ECM1902
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CO-REQUISITE MODULES	
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NQF LEVEL (FHEQ)	5	AVAILABLE AS DISTANCE LEARNING	No
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ORIGIN DATE	Thursday 06 July 2017	LAST REVISION DATE	Tuesday 26 September 2023
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KEY WORDS SEARCH	Fourier series; Fourier Transforms; Laplace Transforms; Linear systems; ODEs; Signal processing
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