BIOMEDICAL SIGNAL PROCESSING - 2024/5

Module code: ENG3168

Module Overview

Students must have a qualitative understanding of the importance of biomedical signal processing. Furthermore, students should be able to apply fundamental signal processing concepts quantitatively to biomedical engineering problems. This module builds a basic understanding of signal processing concepts relevant to biomedical engineering.

Module provider

Mechanical Engineering Sciences

Module Leader

ABASOLO Daniel (Mech Eng Sci)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 6

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 82

Lecture Hours: 13

Tutorial Hours: 22

Guided Learning: 11

Captured Content: 22

Module Availability

Semester 1

Prerequisites / Co-requisites

None.

Module content

Indicative content includes:

- Biomedical Signals. Origin and characteristics
- Biomedical Signal Acquisition
- Linear Time-invariant systems. Convolution
- Spectral analysis of biomedical signals. The Fourier transform, the periodogram, Welch's method and parametric and non-parametric methods
- Filter design and noise removal
- Time-frequency analysis of biomedical signals. The spectrogram
- Wavelet analysis of biomedical signals. The Continuous Wavelet Transform and the Discrete Wavelet Transform
- Non-linear analysis of biomedical signals. Chaos theory, fractals, and other non-linear signal processing algorithms

Assessment pattern

Assessment type	Unit of assessment	Weighting
Coursework	COURSEWORK	30
Examination	EXAM (2 HOURS)	70

Alternative Assessment

N/A

Assessment Strategy

The assessment strategy is designed to provide students with the opportunity to demonstrate understanding of biomedical signal processing methods as well as the ability to analyse time-domain and frequency-domain characteristics of different biomedical signals. The coursework assignment allows students to demonstrate their knowledge and understanding of filters, and time-domain, frequency-domain and time-frequency signal processing techniques. The coursework assignment also tests report writing skills as well as the students' ability to comment critically on their results and present them to specialist and non-specialist audiences. The final examination tests the deeper understanding of the different biomedical signal processing methods presented in the module, including open-ended questions asking the students to come up with possible signal processing options for real-life biomedical engineering problems.

Thus, the summative assessment for this module consists of:

- Coursework [Learning outcomes 2, 3, 5, 6]

- Examination [Learning outcomes 1, 2, 4, 5]

Formative assessment and feedback

- Formative verbal feedback is given in tutorials
- Formative Multiple Choice Tests are available on SurreyLearn to give feedback on the understanding of biomedical signal processing techniques
- Extensive written feedback is given on the coursework assessment

Module aims

- An introduction to biomedical signals and biomedical signal acquisition
- A systematic understanding and critical awareness of the importance of biomedical signal processing as an essential component of knowledge for a Biomedical Engineer
- A comprehensive understanding of the importance of noise and their sources
- A systematic understanding of spectral analysis techniques and their advantages and disadvantages
- An introduction to time-frequency analysis and its need in biomedical signal processing
- An introduction to wavelet analysis in biomedical signal processing
- An introduction to chaos theory, fractals and non-linear analysis and their application in biomedical signal processing
- An introduction to biomedical signal processing with Matlab
- An introduction to linear time invariant systems
- An introduction to filter design and its need in biomedical signal processing

Learning outcomes

Ref		Attributes Developed	
001	Identify the origin and characteristics of biomedical signals	K	C1
002	Propose remedial action for different sources of noise	KC	C1, C2
003	Identify the advantages and disadvantages of different spectral analysis methods, wavelets and non-linear analysis methods, being able to understand the importance of the appropriate selection of input parameters	KC	C1, C3
004	Evaluate the adequacy of different signal processing techniques for biomedical signal analysis	KCP	C4, C5
005	Interpret the nature of physical processes and pathological conditions based on observations of biomedical signals to evaluate the usefulness of biomedical signal processing in a clinical context	KCP	C2, C/M8, C17

Ref		Attributes Developed	
006	Develop the computer programming skills to write basic programs in Matlab for biomedical signal processing	PT	C3

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to:

Introduce basic biomedical signal processing principles through theory with worked examples. This is delivered principally through lectures and tutorial classes. In the latter, students will have to write Matlab scripts and functions for the analysis of biomedical signals. Learning would be reinforced with the application of the biomedical signal processing principles to real biomedical signals in a coursework assignment.

The learning and teaching methods include:

- Lectures
- Matlab based tutorials
- Pre-recorded lectures and solutions to tutorials

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: ENG3168

Other information

The School of Mechanical Engineering Sciences is committed to developing graduates with strengths in Employability, Digital Capabilities, Global and Cultural Responsibilities, Sustainability, and Resourcefulness and Resilience. This module is designed to allow students to develop knowledge, skills and capabilities in the following areas:

Employability: students will be able to demonstrate to a prospective employer their ability to document their planning, research, and analysis in the written coursework. This also allows students to explain their work using technical language.

Digital Capabilities: students will have the opportunity to analyse real biomedical signals using Matlab, writing and testing their own code. Furthermore, their digital capabilities will be enhanced via the writing of the coursework report using data analysis software, generating figures and/or tables, etc., and using appropriate referencing style.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Biomedical Engineering BEng (Hons)	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Biomedical Engineering MEng	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Mechanical Engineering BEng (Hons)	1	Optional	A weighted aggregate mark of 40% is required to pass the module
Mechanical Engineering MEng	1	Optional	A weighted aggregate mark of 40% is required to pass the module