ES97D-15 Biomedical Imaging and Medical Devices

22/23

Department
School of Engineering
Level
Taught Postgraduate Level
Module leader
Joanna Collingwood
Credit value
15
Module duration
10 weeks
Assessment
100% coursework
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES97D-15 Biomedical Imaging and Medical Devices

[Module web page]

Module aims

To introduce students to the fundamental principles and applications of medical imaging in the human body, and to imaging and sensing in the brain. Techniques include Magnetic Resonance Imaging (MRI), X-ray Computed Tomography (CT), Positron Emission Tomography (PET), Electroencephalography (EEG), Magnetoencephalography (MEG), and Ultrasound. The module will provide students with a firm grounding in the basic theory underpinning the core methods in clinical practice, as well as an awareness of emerging technologies and their applications.

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.

Lectures and Seminars:

1. Introduction to Imaging and Sensing, to include a general introduction to the course. Introduction or revision of core concepts including statistics, vector calculus, k-space, Fourier transforms.
2. Magnetic Resonance Imaging (MRI), to include: the physical basis of MRI, sequences commonly used in the clinic and research, system interfaces, data formats and post-processing tools, quality control in image acquisition and interpretation, functional MRI and statistical approaches to data processing, instrumentation, safety.
3. Magnetic Resonance Spectroscopy (MRS), to include: the physical origin of the Nuclear Magnetic Resonance (NMR) spectrum, methods of spatial localisation and quantitative analysis, characteristic spectra in health and disease.
4. Electroencephalography (EEG), to include: the physical, electrophysiological, and technological principles underlying the generation and measurement of Electroencephalography (EEG) signals, spatio-temporal nature of EEG signals, and the link with Magnetoencephalography (MEG), Brain mapping using EEG and EMG.
5. Computed Tomography (CT) to include: the physical and mathematical basis for X-Ray Computed Tomography (CT), concept of a sinogram, Radon Transform for image reconstruction by back-projection, processing tools including 3D reconstruction, instrumentation, and safety. Production of X-ray images, attenuation coefficients, choice of suitable energy, contrast, hardware.
6. Radionuclide Imaging (RI) to include: the theory of radioactive decay and detectors, radiopharmaceuticals and their production, nuclear medicine imaging systems, clinical applications, instrumentation including Positron Emission Tomography (PET) and Single-Photon Emission Computed Tomography (SPECT) systems.
7. Ultrasound in Medicine to include: ultrasound imaging, generation and detection of ultrasound, ultrasound propagation, choice of frequency, A-scan, B-scan, M-mode imaging and echo cardiography. Use of Doppler techniques for blood flow etc. Use of ultrasound in therapy.
8. Introduction to Image Processing, to include: Segmentation, registration and fusion, and quantification; software including open-source packages.
9. Advanced Techniques and Applications, with topics including (but not exclusively): Transcranial Sonography, Multimodal imaging (PET-MRI), Dual-energy CT, Imaging for Current Applications (choice of topics might include Surgery, Spinal Cord Imaging, Dementia, Automated Segmentation, etc.)

Examples Classes (2 hours) worked examples reflecting the level at which the module will be examined, and an opportunity for the students to raise questions about the course content.

Learning outcomes

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

- Demonstrate an advanced understanding of the complex underlying principles of modern medical imaging and sensing.
- Critically evaluate, compare and contrast the primary methods in clinical practice for investigation of the human body and brain.
- Perform quantitative and qualitative assessments related to the theoretical and practical constraints on state-of-the-art imaging and sensing technologies, including spatial and temporal resolution, sensitivity, and specificity for the structural or functional properties to be detected.
- Understand key drivers for the development of advanced applications, including an appreciation of how medical imaging and sensing support areas of diagnostics, surgery, and therapy.
- Understand how recent developments, e.g. in multimodal imaging, are advancing progress at the frontiers of medical research and delivered healthcare.

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

Research element

The coursework gives the student the opportunity to research a topic independently and in depth, using published sources, and to present their findings.

Interdisciplinary

This module integrates content from biomedical engineering, medical physics, and medicine.

Subject specific skills

Awareness of, and conceptual understanding of the core medical imaging technologies and applications in the clinical and research environment, combined with direct insights from - and an opportunity to interact with - radiology practitioners.

This module has a track record of equipping students to apply for clinical physics/engineering careers in the NHS, and/or to enter postgraduate research in the field of medical imaging.

Transferable skills

This module enables the student to develop their ability and confidence to assimilate and use conceptual-level understanding of an extensive technical syllabus in an unfamiliar area.

This module also supports the student to independently and competently find and collate information on a challenging topic, and to communicate this in an accessible way in a short video, encouraging development of organisational and presentation skills at a high level.

A guide to working with high-level technical resources such as peer-reviewed journal papers is embedded in the module, to support access to, and confidence in using, advanced imaging material in the main syllabus and independent research undertaken for the coursework. This is valuable as a long term skill, but also has immediate benefit for those using such sources in their independent project work.

Study

Study time

Type	Required
Lectures	10 sessions of 2 hours (13%)
Seminars	4 sessions of 2 hours (5%)
Other activity	2 hours (1%)
Private study	120 hours (80%)
Total	150 hours

Private study description

Guided independent learning 120 hours

Other activity description

Assessment Support Classes – 2 hours – giving guidance on how to approach preparation of the assessed work for the module, and an opportunity for the students to raise questions.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group A1

Assessment component	Weighting	Study time	Eligible for self-certification

	Weighting	Study time	Eligible for self-certification
Medical imaging technology video	30%		Yes (extension)

Create a five-minute video that explains the fundamental principles of a core medical imaging method in a way that could be understood by a non-specialist.

Reassessment component is the same

Assessment component

Essay - Compare and contrast medical imaging modalities in current clinical practice	70%		Yes (extension)

Structured written coursework that tests all the stated learning objectives for this assessment.

Reassessment component is the same

Feedback on assessment

Assessments marked with detailed written comments.
Face-to-face (including online) feedback in seminars.
Cohort-level feedback on main essay.

Availability

Anti-requisite modules

If you take this module, you cannot also take:

- ES3H5-15 Biomedical Imaging and Medical Devices

Courses

This module is Core for:

- Year 1 of TESA-H800 Postgraduate Taught Biomedical Engineering

This module is Optional for:

- Year 4 of UESA-H116 MEng Engineering with Exchange Year
- Year 5 of UESA-H115 MEng Engineering with Intercalated Year

This module is Option list A for:

- Year 4 of UESA-H114 MEng Engineering

This module is Option list B for:

- Year 4 of UESA-HH31 MEng Systems Engineering
- Year 4 of UESA-HH33 MEng Systems Engineering with Exchange Year
- Year 5 of UESA-HH32 MEng Systems Engineering with Intercalated Year
- Year 4 of UCSA-G408 Undergraduate Computer Systems Engineering
- Year 5 of UCSA-G409 Undergraduate Computer Systems Engineering (with Intercalated Year)