IMPERIAL

Module Specification

Basic details

UID		Cohorts covered (Earliest cohort)	2025
Long title	Physical imaging systems		
New code	ELEC70135	New short title	

Brief description of module *(approx. 600 chars.)*

Physical imaging systems allow two- and even three-dimensional scenes to be visualised using scattered or directly emitted acoustic or electromagnetic waves. Imaging is generally a parallel operation, carried out using lenses or mirrors to shape wavefronts and an array of sensors to detect the wave in question. However, serially scanned imaging can also be used when it is difficult to construct a suitable array. For electromagnetic waves, a wide range of frequencies may be used, often yielding dramatically different information. Optical imaging is well known to everyone with a smartphone camera, but sonar and radar have enabled long-range detection under water and in the air, and thermal imaging has allowed the previously unthinkable possibility of night vision. Similarly, magnetic resonance imaging, ultrasound, and tomographic X-ray imaging have revolutionised medicine while radio telescopes have transformed understanding of the early universe.

The aim of this module is to explain the physical operation of different imaging systems, starting with acoustic imaging and rising in frequency through electromagnetic methods operating at radio, microwave, terahertz, thermal, optical and X-ray frequencies. In each case, the components, physical operation, image processing and limitations associated with each modality will be explored. Using this knowledge, you will characterise an imaging system and perform software simulations to characterise performance or extract features of interest.

Available as a standalone module/ short course? N

Statutory details

	ECTS	CATS	Non-credit	
Credit value	5	10	N	HECOS codes
FHEQ level	Level 7			

Allocation of study hours

	Hours	
Lectures	20	
Group teaching	0	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	5	
Other scheduled	0	*Incl. project supervision, fieldwork, external visits.*
Independent study	100	*Incl. wider reading/ practice, follow-up work, completion of assess*
Placement	0	*Incl. work-based learning and study that occurs overseas.*
Total hours	125	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? No

Module delivery

Delivery mode	Taught/ Campus	Other	
Delivery term	Term 1	Other	

Ownership

Primary department	Electrical Engineering
Additional teaching departments	
Delivery campus	South Kensington

Collaborative delivery

Collaborative delivery?	N
External institution	N/A
External department	N/A
External campus	N/A

Associated staff

Role	CID	Given name	Surname
Module Leader		Zahid	Durrani

Learning and teaching

Module description

Learning outcomes	On successfully completing this module, you will be able to: - Appraise operation of different imaging systems based on their physical principles - Calculate design parameters based on the known characteristics of imaging systems - Analyse performance of imaging systems in view of design constraints - Construct model imaging systems and extract imaging features of interest
Module content	1. Acoustic imaging systems 2. RF imaging. MRI 3. Microwave imaging. Radar 4. THz imaging 5. Free-space infra-red and optical imaging 6. Guided-wave optics 7. X-ray imaging. Computer tomography.

Learning and Teaching Approach	Taught material will be introduced in traditional-style face-to-face lectures (20 hrs). These will be supported by reading assigned before the lectures and online quizzes run during the lectures. The latter will serve as formative assessment. Additional feedback will be provided during question-and-answer sessions regularly built into the lectures. The lectures will also introduce coursework requirements. You will be assigned a coursework on several of the imaging systems discussed. All coursework will be based on numerical simulations. The coursework will be done in teams of two students. The teaching activity during the coursework period will be face-to-face sessions oriented towards giving you individual and targeted support.
Assessment Strategy	The module will be assessed by coursework. The coursework will comprise several assignments to simulate an imaging system and extract features of interest in images. Coursework will be caried out in groups of two students, which will be self-selected. You will have to submit a report with your solutions to the assignments. The report will receive written feedback. Formative assessment will be done, first, by quizzes run for the entire cohort during lectures and, second, by discussing progress on coursework with the teaching team during the coursework sessions.
Feedback	Informal feedback during lectures can be obtained by participating in lecture quizzes, and question-and-answer sessions. An online discussion board will run by the module leader. Informal feedback on coursework progress can be obtained by joining the support classes and engaging in the discussions within the cohort or within coursework groups. Written feedback will be given as annotated comments on the final report that point out errors, highlight solutions and direct you to additional information sources.
Reading list	1.Kolev N. “Sonar systems” Intech (2011) 2.Kremkau F.W., Forsberg F. “Sonography: principles and instruments” Elsevier (2015) 3.McRobbie D.W., Moore E.A., Graves M.J. “MRI from picture to proton” Cambridge University Press (2009) 4.Budge M.C., German S.R. “Basic radar analysis” Artech House (2020) 5.Pavlidis D. “Fundamentals of terahertz devices and applications” Wiley (2021) 6.Dakin J., Culshaw B. “Optical fiber sensors: principles and components” Boston (1988) 7.Syms R.R.A., Cozens J.R. “Optical guided waves and devices” McGraw Hill Book Co (1992) 8.Vollmer M., Möllmann K.-P. “Infrared thermal imaging: fundamentals, research and
Required equipment/ software	laptop computer; MATLAB

Quality assurance

Date of first approval	
Date of last revision	
Date of this approval	
Module leader	Zhaid Durrani

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Notes/ comments	

Template version

Assessment details

Grading method	Numeric	Pass mark	50%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
Coursework	Group project report	100%	50%	N
		100%		