IMPERIAL

Module Specification

Basic details

UID		Cohorts covered (Earliest cohort)	
Long title	Microelectromechanical Systems (MEMS)		
New code	ELEC70102	New short title	
Brief description of module *(approx. 600 chars.)*	To study the underlying physical principles, methods of fabrication and applications of a broad range of micro-scale devices that combine mechanical, electrical/electronic and optical functionalities.		

Available as a standalone module/ short course? No

Statutory details

	ECTS	CATS	Non-credit
Credit value	5	10	N

HECOS codes

FHEQ level: L7

Allocation of study hours

	Hours	
Lectures	20	
Group teaching	0	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	20	
Other scheduled	0	*Incl. project supervision, fieldwork, external visits.*
Independent study	85	*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 2	Other	

Ownership

Primary department	Department of Electrical and Electronic Engineering
Additional teaching departments	0
Delivery campus	South Kensington

Collaborative delivery

Collaborative delivery?	No

External institution	
External department	
External campus	

Associated staff

Role	CID	Given name	Surname
Module Leader		Andrew	Holmes

Learning and teaching

Module description

Learning outcomes	By the end of the module you will be able to: * Explain the operational principles of a range of micro-scale devices; * Calculate key performance parameters for a range of micro-scale devices given information about their construction and dimensions; * Suggest possible fabrication schemes for devices given information about their construction and dimensions; * Carry out design calculations to determine key device parameters (e.g. dimensions) given the device layout and performance requiremenets; * Deduce the scaling behaviour of specific device characteristics starting from basic scaling laws.
Module content	Introduction: micro- and nano-scale size domains; scaling of physical laws; MEMS materials and processes; MEMS devices and applications; Micromechanics: plane statics; Euler beam theory and application to beams and membranes; MEMS suspension design; MEMS resonators; damping; Fabrication Technologies: semiconductor materials; photolithography; direct-write methods (e-beam, FIB, scanning probe); doping; thin film growth and deposition; metallisation; wet and dry etching; silicon micromachining; metal MEMS processes; MEMS Sensors: physical sensors e.g. pressure, acceleration, strain, flow; chemical sensors; MEMS Actuators: microactuators based on various principles e.g. electrothermal, electrostatic, electromagnetic, piezoelectric and SMA; actuator applications e.g. inkjet, electrical and optical switching; Microfluidics: scaling laws for microfluidics; transport in micro-channels; microfluidic components e.g. filters, mixers/reactors, valves/controllers, pumps;
Pattern of learning and teaching activities	The module will be taught through a series of 20 lectures. The content will be delivered in mixed-mode, with a combination of traditional lectures and flipped classroom sessions. In the second half of term the students will carry out an individual coursework exercise. This will involve making experimental measurements on a MEMS device and then comparing the results obtained with calculated and/or simulated results. Each student will submit a 10-page report which will be assessed.

Learning and Teaching Approach	Time will be allocated in the lecture schedule for looking at worked examples. Also, a series of problem sheets will be issued to help students test their understanding of the module content. Model answers will be provided.
Assessment Strategy	There will be two assessment elements: (1) a closed book, written examination with a weighting of 75%; (2) the coursework report of up to 15 pages, commented code and demonstartion which will account for the remaining 25%.
Feedback	Summative written feedback will be provided on the coursework report. Summative feedback on the exam will be provided in the form of annotated model solutions. Formative feedback will be given through the discussion of worked examples.
Reading list	Foundations of MEMS, C. Liu (Prentice Hall, 2005) Microsystem Design, S. Senturia (Kluwer, 2001) Fundamentals of microfabrication, M.J. Madou (2nd Ed, CRC Press, 2002) Semiconductor manufacturing technology, M. Quirk and J. Serda (Prentice Hall, 2001) Theory of elasticity, S.P. Timoschenko and J.N. Goodier (McGraw-Hill, 1970) Structures: theory and analysis, M.S. Williams and J.D. Todd (MacMillan Press,2000) Theory of vibration with applications, W.T. Thompson (4th Ed, Stanley Thornes,1993)

Quality assurance

Date of first approval	February 2022
Date of last revision	June 2026
Date of this approval	
Module leader	Prof. Andrew Holmes
Notes/ comments	

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Template version

Assessment details

			Pass mark
Grading method	Numerical		50%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
Examination	closed book written examination	75%	50%	N
Coursework	Report up to 15 pages, Commented code & Demonstration	25%	50%	N
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
		100%		