IMPERIAL

Module Specification

Basic details

UID		Cohorts covered (Earliest cohort)	
Long title	Laboratory in Sensor Systems		
New code	ELEC70132	New short title	

Brief description of module (approx. 600 chars.)

Wireless sensor networks (WSNs) are increasingly being integrated into industrial settings for a variety of applications, such as monitoring equipment operation, environmental conditions, and health and safety. These networks consist of multiple sensor nodes that collect data and communicate wirelessly to a control centre, eliminating the need for extensive wiring and enabling placement in locations that are difficult or hazardous for humans to access. The design of WSNs involves considerations for power consumption, multi-sensor communication timings, reliability, security, and network visibility.
The Lab is divided into two main sections. The first involves designing, fabricating, and characterising a sensor. Design will rely on COMSOL simulations, fabrication will occur in the cleanroom, and characterisation will be conducted in the electronics lab. Sensor packaging will utilise 3D printing. The second section requires assembling an entire sensor system using lab-made sensors along with additional sensors that detect the same parameter through different physical principles. A multi-modal system will be calibrated and integrated. Wireless communication should be implemented, and decisions regarding on/off MCU signal processing must be made. An in-depth analysis of the advantages and disadvantages of various approaches will be performed.

Available as a standalone module/ short course? N

Statutory details

	ECTS	CATS	Non-credit	
Credit value	10	20	N	HECOS codes

FHEQ level: Level 7

Allocation of study hours

	Hours	
Lectures	10	
Group teaching	0	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	34	
Other scheduled	0	*Incl. project supervision, fieldwork, external visits.*
Independent study	206	*Incl. wider reading/ practice, follow-up work, completion of assess*
Placement		*Incl. work-based learning and study that occurs overseas.*
Total hours	250	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? No

Module delivery

Delivery mode	Taught/ Campus	Other	
Delivery term		Other	Term 1, Term 2

Ownership

Primary department	Electrical and Electronic 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		Kristel	Fobelets
Lecturer		Zahid	Durrani
Lecturer		Wenkun	He

Learning and teaching

Module description

Learning outcomes	By the end of this module, you will be able to: •identify, explain and justify the requirements and needs of the different operational aspects of wireless sensor networks. •identify and explain how different fabrication steps define micro-features on material surfaces. •conduct basic cleanroom experiments to fabricate piezoresistive micro-devices in a safe manner. •employ appropriate software tools such as MATLAB and COMSOL for sensor design and signal analysis. •apply different characterisation techniques to assess and validate sensor parameters such as power consumption, sensitivity, accuracy, precision, linearity and range. •design and test PCBs that connect microprocessors to the sensor network. •produce and validate a sensor system with electronic readout and wireless communication system. •work as a member of a team to create, critically analyse and present system that fulfils the requirements of a sustainable wireless sensor network, conforming to EDI principles.

Module content	Lectures -laboratory practice -cleanroom safety and processes -COMSOL simulation tool -3D printing Practice -of concepts taught in core modules -characterisation methodologies
Pattern of learning and teaching activities	**Autumn term:** Lab practice and COMSOL will be delivered in the first two weeks of the module Supervised cleanroom laboratory work will be timetabled as sets of 1.5 or 3 hrs per week (depending on the activity) during Weeks 3 to 9. Students will have access to the electrical lab outside these hours for independent work, and will have on-request access to the cleanroom for their fabrications under the supervision of TAs or a member of the teaching staff. **Spring term:** Teaching aspects will be delivered in the first two weeks of term. Supervised laboratory practice will be timetabled in 3-hr sets per week. Students will have access outside these hours for independent work.
Learning and Teaching Approach	The tasks in this module will be completed in teams. **Task 1 (length of 1 term)** Each team must fabricate a sensor in the cleanroom and design a readout circuit and a characterisation methodology. The lab work in the cleanroom is guided for safety reasons. The electrical lab work is mainly student-led, focusing on characterisation and, possibly, the application of the sensors. This team effort will be supported by: •In-lab lectures on lab skills, including: - safety in cleanroom experiments, - fabrication processes, - characterisation techniques - COMSOL - 3D printing •supervised timetabled experimentation in the lab with help from GTAs **Task 2 (length of 1 term)** This laboratory adopts an inquiry-based and experiential learning approach in which students design, implement, test and evaluate an integrated sensor system to address a realistic engineering measurement challenge. Working in teams, students combine practical experimentation with system-level thinking, applying concepts from sensing, instrumentation, data acquisition, calibration, signal analysis and system integration. Through iterative design, measurement, validation, and reflection, students develop both technical and professional skills, including problem-solving, critical evaluation of experimental data, teamwork, and the communication of engineering decisions. The laboratory emphasises the comparison of alternative sensing approaches, consideration of uncertainty and robustness, and evidence-based engineering judgement in the development of a complete measurement system This team effort will be supported by: •supervised timetabled experimentation in the lab with help from GTAs •team meetings with members of staff for feedback
Assessment Strategy	Both laboratories will be assessed via a: -One written report per group per Task (1, 2) - maximum 10 pages in IEEE two-column format -A group presentation/demonstration of 15 min with 3 minutes of question and answer time
Feedback	Written feedback on the report. Verbal feedback after the oral assessment. Verbal formative feedback will also be provided during the lab sessions and team meetings.

Reading list	•Wireless Sensor Networks ; 1st ed. 2020. by Senchun Chai, Zhaoyang Wang, Baihai Zhang, Lingguo Cui, Runqi Chai. Singapore : Springer Singapore : Imprint: Springer; 2020; Wireless Networks, 2366-1186; Wireless Networks, 2366-1186 ISBN 9789811557576; ISBN 9789811557569; ISBN 9789811557583; ISBN 9789811557590; Springer Nature eBook •Dependable Embedded Systems / 1st ed. 2021. Henkel, Jörg. editor.; Dutt, Nikil. editor.; SpringerLink (Online service) Cham : Springer International Publishing : Imprint: Springer; 2021; Embedded Systems, 2193-0155; Embedded Systems, 2193-0155 ISBN 9783030008659; ISBN 9783030008642; ISBN 9783030008666; Springer eBooks •A Survey of Potential Security Issues in Existing Wireless Sensor Network Protocols Institute of Electrical and Electronics Engineers; 2017-Sep 2327-4662; http://hdl.handle.net/10044/1/53004; https://dx.doi.org/10.1109/JIOT.2017.2749883; EP/N023242/1; oai:spiral.imperial.ac.uk:10044/1/53004 •Safety documentation in the 'Laboratory Safety Documents' folder (General Lab safety, Risk assessments, and chemical safety forms (COSHH)), within the Blackboard 'Spring Term Laboratory in Sensors' folder. •Process sheet and introductory lectures within the Blackboard 'Spring Term Laboratory in Sensors' folder. •A. S. Fiorillo, C. D. Critello, and S. A. Pullano, “Theory, technology and applications of piezoresistive sensors: A review,” Sensors and Actuators A: Physical, vol. 281, pp. 156–175, Oct. 2018, doi: https://doi.org/10.1016/j.sna.2018.07.006. •W. Chen and X. Yan, “Progress in achieving high-performance piezoresistive and capacitive flexible pressure sensors: A review,” Journal of Materials Science & Technology, vol. 43, pp. 175–188, Apr. 2020, doi: https://doi.org/10.1016/j.jmst.2019.11.010. •A. Boisen, S. Dohn, S. S. Keller, S. Schmid, and M. Tenje, “Cantilever-like micromechanical sensors,” Reports on Progress in Physics, vol. 74, no. 3, p. 036101, Feb. 2011, doi: https://doi.org/10.1088/0034-4885/74/3/036101.
Required equipment/ software	

Quality assurance

Date of first approval	
Date of last revision	August 2026
Date of this approval	
Module leader	Kristel Fobelets

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Notes/ comments	

Template version

Assessment details

Grading method	Pass/Fail	Pass mark	100%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
Coursework	Report max 10 pages (1 per group) for each lab task. Each lab task carries the same weighting	60%	50%	N
Practical	Group demonstration/presentation (15 min with 3 min of question and answer time) for each Lab task. Each task carries the same weighting.	40%	50%	N
Coursework	Self-reflection on individual performance as part of the team	0%	50%	Y
		100%	50%	Y