IMPERIAL

# Module Specification

## Basic details

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|---|---|---|---|
| UID | | Cohorts covered (Earliest cohort) | 2025 |
| Long title | Advanced Instrumentation | | |
| New code | ELEC70130 | New short title | |
| Brief description of module *(approx. 600 chars.)* | This module will give you an surve yof electrical measurement theory and practice, especially in high noise and interference settings, including at high frequencies. A main objective is to provide you with a working knowledge of the capabilities and limitations of several alternative measurement strategies, and practical skills to apply these. | | |
| 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 | 10 | *Incl. seminars, tutorials, problem classes.* |
| Lab/ practical | 10 | |
| 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

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|---|---|
| Is placement activity allowed? | No |

## Module delivery

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|---|---|---|---|
| Delivery mode | Taught/ Campus | Other | |
| Delivery term | Term 1 | Other | |

## Ownership

| | |
|---|---|
| Primary department | Electrical Engineering |
| Additional teaching departments | |
| Delivery campus | South Kensington |

## Collaborative delivery

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|---|---|
| Collaborative delivery? | N |

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| External institution | N/A |
| External department | N/A |
| External campus | N/A |

## Associated staff

| Role | CID | Given name | Surname |
|---|---|---|---|
| | | | |
| Module Leader | | Christos | Papavassiliou |
| Guest lecturers | | Industry | |
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## Learning and teaching

### Module description

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| Learning outcomes | On successful completion of this module, you will be able to:<br>Analyse and evaluate the operation of continuous time voltage mode amplifiers and filters.<br>Apply discrete time signal processing techniques to noise rejection and mitigation in measurements.<br>Apply mixing and interferometry techniques in measurement applications to enhance performance.<br>Design, prototype and assess the operation of electronic circuits<br>Apply control and signal processing techniques on microcontroller platforms to control an instrument, acquire measurements and apply digital signal processing techniques to measurement results.<br>Specify a measurement system and its subsystems.<br>Write technical documentation on hardware and software produced. |
| Module content | The following topics will be covered:<br>History and recent developments in measurements and instruments<br>Continuous time amplification and filtering<br>Discrete time amplification and filtering<br>Analogue to Digital and Digital to Analog Conversion<br>Time domain measurements<br>Mixing and interference<br>Signal conditioning and Electromagnetic compatibility |
| Learning and Teaching Approach | The lectures are supported by weekly classes (study groups); and lab surgeries to support the coursework. Additional reading material is made available through the module platform, MSTeams or equivalent. An online bulletin board will be available as an auxiliary Q&A tool. |

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| Assessment Strategy | The module will be assessed by coursework, which will be carried out in self-selected groups of 2-3 students. There will be three assessments that address the main concepts of the theory and operation of a complex impedance meter, as follows:<br>C1. Analogue signal chain: Design, optimise, and simulate the two amplifiers required to measure a complex impedance. Design and implement a calibration strategy to equalise the frequency response of these amplifiers. Ensure unconditional dynamic stability of the amplifiers under capacitive loading. The deliverable will be a group report.<br>C2. Digital signal chain: Write and simulate a signal processing program to implement a complex impedance measurement system out of two sampled time-domain waveforms of voltage and current. Implement digital filtering techniques. The deliverable will be a group report.<br>C3. Design and prototype, calibrate and demonstrate an instrument to measure the frequency dependence of the complex impedance of a two-terminal device over a frequency range of two decades. Decide on the trade-off between analogue, DSP-based and hybrid approaches to the task.<br>3a. Demonstration of the operation and capabilities of the instrument developed. The assessment will be in the form of a group oral interview.<br>3b. Documentation datasheet, submitted as a group report, documenting the operation, calibration and achieved performance of their instrument.<br><br>Formative assessment will be done by the following methods:<br>(a) in-class quizzes with answers explained and discussed immediately and<br>(b) face-to-face discussions with the teaching team during practical sessions |
| Feedback | Written feedback will be provided on the two design and simulation pieces (C1 and C2) and on the datasheet (C3b) of the coursework, which are intended to address the main challenges in implementing the analogue and digital subsystems of the instrument. Oral feedback will be given on Demonstration (C3a). Informal feedback on the coursework progress will be given during practical sessions. |
| Reading list | You will be provided with: lecture notes and/or copies of slides used in lectures and tutorials, data sheets and application notes for instruments and components from their manufacturers, academic journal articles and other web resources. A reading list of relevant textbooks will be available. |

## Quality assurance

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| Date of first approval | |
| Date of last revision | |
| Date of this approval | |
| Module leader | Christos Papavassiliou |
| Notes/ comments | |

## Office use only

| | |
|---|---|
| QA Lead | |
| Department staff | |
| Date of collection | |
| Date exported | |
| Date imported | |

Template version

## Assessment details

| Grading method | Numeric | Pass mark | 50% |
|---|---|---|---|

## Assessments

| Assessment type | Assessment description | Weighting | Pass mark | Must pass? |
|---|---|---|---|---|
| Coursework | Analogue signal chain design report | 25% | 50% | N |
| Coursework | Digital Signal Chain Design report | 25% | 50% | N |
| Practical | Demonstration | 20% | 50% | N |
| Coursework | Documentation and datasheet | 30% | 50% | N |
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