

## 1E11 EXPERIMENTAL METHODS [5 credits]

**Lecturer(s):** Mr Dermot Geraghty ([tgerghty@tcd.ie](mailto:tgerghty@tcd.ie)) Overall Coordinator  
Dr Martin Burke ([martin.burke@tcd.ie](mailto:martin.burke@tcd.ie))  
Dr Brian Caulfield ([brian.caulfield@tcd.ie](mailto:brian.caulfield@tcd.ie))

### Module organisation

The module runs for the first half (12 weeks) of the academic year and comprises of three lectures plus a one-hour tutorial per week (total contact time of 43 hours).

### Module description, aims and contribution to programme

- introduce students to modern experimental techniques in engineering;
- study the role of error and uncertainty in measurement and data analysis;
- describe the operating principles of commonly used measurement devices ;
- equip students to prepare and conduct experiments including selection of instrumentation and data collection, analysis and presentation;
- introduce the principles of data conversion including analog to digital converters and digital to analog converters;
- introduce students to surveying as an example of a measurement technique.

### Learning outcomes

Upon completion of this module, students will be able to:

- identify the sources and nature of experimental error;
- identify and quantify the static and dynamic characteristics of instruments e.g. bandwidth;
- fit a linear least squares line to a set of data both manually and using Excel;
- devise an experimental procedure for thermocouple calibration;
- apply simple electrical principles in sensing application e.g. resistance strain measurement and the Wheatstone bridge;
- select sensors for temperature, strain and displacement measurement;
- write a technical report;
- outline the issues around the digitisation of experimental data;
- explain the nature of the analogue-to-digital and digital-to-analogue conversion processes;
- perform calculations on the requirements of data conversion applications in experimental scenarios;
- take field measurements using an automatic level and a theodolite;
- explain how to detect error in field measurements;
- understand how new technologies are being obtain field measurements.

## **Course content**

### ***Measurement in general***

- Why engineers take measurements;
- Uncertainties in measurements and error analysis;
- Probability distributions;
- Line fitting;
- The characteristics of instruments;
- Designing and experiment;
- Writing a technical report.

### ***Sensors for***

- Temperature and heat measurement;
- Motion and dimensional measurement;
- Force, torque and mechanical power measurement;
- Flow measurement;
- Pressure and sound measurement;
- Electrical measurements;
- An introduction to surveying.

### ***Data acquisition and analysis***

- Signal conditioning;
- Analog to digital conversion;
- Digital to analog conversion;
- Error sources in data acquisition.

## **Teaching strategies**

The module is taught using a combination of lectures and tutorials.

## **Assessment**

The formal written end-of-year two-hour examination will contribute 70%, assignments contribute 15% and laboratory assessment will contribute 15%.

## **Required textbook**

*Experimental Methods: An Introduction to the Analysis and Presentation of Data*, Les Kirkup, Wiley

*Measurement Systems - Application and Design*, Ernest O Doebelin, 5<sup>th</sup> edition, McGraw-Hill

## **Further information**

<http://www.tcd.ie/Engineering/undergraduate/baiyear1/modules/1E11.pdf>