1E11 EXPERIMENTAL METHODS [5 credits]

Lecturer(s): Assistant Prof. John Kennedy (j kenned5@tcd.ie) - Overall Coordinator
Associate Prof. Martin Burke (martin.burke@tcd.ie)
Assistant Prof. Brian Caulfield (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).

Rationale and contribution to programme

The ability to conduct accurate and repeatable measurements is an essential task of the professional engineer. The aim of this module is to provide exposure to the concepts and processes of modern engineering measurement and experimental techniques to prepare students for conducting their first experiments in engineering. Students will study the role of error and uncertainty in measurement and data analysis, the operating principles of commonly used measurement devices and the principles of data conversion including analog to digital converters and digital to analog converters. This will equip students to prepare and conduct experiments and enable them to complete a real engineering analysis task before completion of the module.

Learning outcomes

Upon completion of this module, students will be able to:
1. Identify the sources and nature of experimental error.
2. Identify and quantify the static and dynamic characteristics of instruments e.g. bandwidth.
3. Fit a linear least squares line to a set of data both manually and using Excel.
4. Understand the role of calibration in the use of common engineering sensors.
5. Apply simple electrical principles in sensing application e.g. resistance strain measurement and the Wheatstone bridge.
6. Select sensors for a variety of engineering measurements.
7. Write a technical report.
8. Outline the issues around the digitisation of experimental data.
9. Explain the nature of the analogue-to-digital and digital-to-analogue conversion processes.
10. Perform calculations on the requirements of data conversion applications in experimental scenarios.
11. Analysis, interpret and combine data sources using statistical software packages.
Module content

**Measurement in general**
- Why engineers take measurements;
- Uncertainties in measurements and error analysis;
- Statistical approaches to estimating uncertainty
- Line fitting;
- Static and dynamic characteristics of instruments;
- Designing an experiment;
- Writing a technical report.

**Sensors for**
- Temperature measurement;
- Motion and dimensional measurement;
- Force, torque and mechanical power measurement;
- Sound and fluid flow;
- Electrical measurements;

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

**Teaching strategies**
The module content is introduced through a combination of lectures and tutorials. During the module the students will utilise this knowledge to critique a series of online experiments and perform the associated data analysis tasks. This repeated learning cycle, conducted in a blended learning environment, will prepare the students to conduct a real world experiment in the latter half of the module.

**Assessment**
The formal written end-of-year two-hour examination will contribute 75%, the online and laboratory experiment reports contribute 25%.

Students will receive formative feedback through the online environment, including a class discussion forum, on the online experiments. This formative feedback will prepare them for the full written report on the real world experiment.

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