4B10 INSTRUMENTATION AND EXPERIMENTAL TECHNIQUES

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Semester: 2

Module Organisation
The module runs for 12 weeks of the academic year and comprises three lectures and one tutorial per week (except the study week). Total contact time is 33 hours.

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<th>Start Week</th>
<th>End Week</th>
<th>Lectures per week</th>
<th>Lectures total</th>
<th>Tutorials per week</th>
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Module Description
This module aims to advance the student’s knowledge and understanding of instrumentation and experimental techniques, for applications in industrial and general engineering practice as well as scientific research environments. The module covers the entire measurement chain from physical sensors of different types, signal conditioning and transmission, noise suppression and grounding, data acquisition, analog-to-digital conversion and data processing. Basic concepts of statistics, error propagation and uncertainty analysis will be introduced from the perspective of experimental measurements.

Learning Outcomes
On successful completion of this module, students will be able to:

- Identify the correct type of instrument and sensor design for a particular experimental measurement application, and match this instrument with a signal conditioning and data acquisition system to obtain an integrated measurement chain

- Identify potential noise sources and understand techniques to minimize their influence on the measurement process

- Assess systematic errors and the influence of the presence of an instrument on the process to be measured. Recognize the importance of validation against established reference techniques

- Perform a statistical analysis to estimate the uncertainty margins on a directly or indirectly measured quantity, and identify the main contributors in the overall uncertainty

- Understand important concepts (e.g., dynamic range, signal-to-noise ratio, bandwidth, response time, drift, etc) for various types of instrumentation.
Module Content
- Basic statistical concepts (error and uncertainty, confidence level and uncertainty margins, systematic errors, repeatability)
- Propagation of errors and uncertainties
- Design of experiments
- Characteristics of physical instruments and sensors for a range of measured quantities (e.g., temperature, heat flux, imaging, pressure, strain, acceleration, velocity, displacement, flow rate, concentration, etc)
- Validation of experimental measurements
- Signal conditioning (dynamic range, noise attenuation)
- Data acquisition (sampling frequency and duration, aliasing, bandwidth)
- Data analysis and regression

Module Notes
Blackboard

Teaching Strategies
This module is taught as a series of lectures

Assessment Modes
Written exam

Recommended Texts