5B10 INSTRUMENTATION AND EXPERIMENTAL TECHNIQUES

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Semester: 2

Module Organisation

The module runs for 12 weeks of the academic year. Three lecture slots are scheduled but some of these will be used for practical instruction rather than as conventional lectures. Total contact time is 33 hours.

Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
1	12	3	33	0	0

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.
Fundamental concepts of statistics, error propagation and uncertainty analysis will be introduced from the perspective of experimental measurements. The ISO Guide to Uncertainty in Measurement (GUM) will be introduced.
Instruction in LabView will be given and the National Instruments MyDaq will be used to implement practical solutions to data acquisition problems.
Particular focus will be placed on the design of a sound level meter (SLM) complying with the IEC 61672 standard. Students will implement a version of this SLM on a National Instruments myDAQ.

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.

- Implement a data acquisition solution using LabView and the National Instruments myDAQ.

Module Content

- Basic statistical concepts (errors and uncertainty, confidence level and uncertainty margins, systematic errors, repeatability). The ISO Guide to Uncertainty in Measurement
- Characteristics of physical instruments and sensors for a range of measured quantities (e.g., temperature, pressure, strain, acceleration, velocity, displacement, flow rate, concentration, etc)
- Signal conditioning (amplification, filtering, dynamic range, noise suppression)
- Data acquisition (sampling frequency and duration, aliasing, bandwidth, performance characteristics for analog to digital converters)
- Uncertainty in measurements and the ISO Guide to Uncertainty in Measurement
- LabView and data acquisition using the MyDaQ
- Environmental Noise Measurement

Module Notes

Blackboard and via e-mail

Teaching Strategies

This module is taught as a series of conventional lectures supplemented by a practical introduction to LabView and the National Instruments myDAQ for data acquisition. Every student will have the use of a myDAQ for the duration of the course. The objective is to equip students to implement data acquisition solutions using the NI MyDaQ.

Students will be expected to complete a substantial data acquisition project and to write technical report in the form of a conference paper.

Assessment Modes

Written exam (60%) plus the following practical data acquisition exercise using LabView and the National Instruments MyDAQ.

- Development of a Sound Level Meter based on the National Instruments myDAQ and implemented using LabView. Measurement microphones will be provided.(40%)

Recommended Texts

- *Experimentation, Validation, and Uncertainty Analysis for Engineers*, H. W. Coleman and W. G. Steele, John Wiley & Sons, Inc., 2009