

# ES3E8-15 Precision, Measurement and Control

**21/22**

**Department**

School of Engineering

**Level**

Undergraduate Level 3

**Module leader**

Xianping Liu

**Credit value**

15

**Module duration**

20 weeks

**Assessment**

60% coursework, 40% exam

**Study location**

University of Warwick main campus, Coventry

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## Description

### Introductory description

ES3E8-15 Precision, Measurements and Control

[Module web page](#)

### Module aims

The module will provide engineers with an opportunity to develop their understanding of the important cross-disciplinary factors in measurement, instrumentation, and control that underpin modern machine functionality.

Both instrumentation and control are perceived as important topics for engineers to have some theoretical foundation in, along with an ability to translate that theory into practical applications.

The module provides mechanically biased engineers with an opportunity to develop their measurement knowledge, and couple this to deliver control in practical engineering systems.

### Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- Further Instrumentation principles. Operation and performance of selected sensors and transducers, and their conditioners, and the limits imposed by measurement systems and the conditions of use. Examples of sensing force, torque, temperature, pressure, flow, displacement, voltage, and current. Parameter – measuring device interactions in precision measurement.
- Measurement. Understand the need for rigorous metrology concepts in design and use of measurement systems. Understand the importance and use of gauging and mastering, and traceability to national standards.
- Precision. Precision and accuracy constraints. Sources of uncertainty. Random and systematic effects. The combinational effects of errors in the measurement chain. Methods of uncertainty categorization, and reduction.
- Complex Control. Consolidate understanding of commonly applied control techniques, and develop understanding by considering alternative and enhanced control using methods other than PID. Methods for system identification. Breakdown of control.

## **Learning outcomes**

By the end of the module, students should be able to:

- Appraise measurement limitations imposed by instruments and physical conditions, and interactions between the test system and the thing being measured.
- Discriminate between different sensor types and strategies for taking effective measurements in demanding conditions.
- Communicate the need for rigorous metrology concepts in design and use of measurement systems. Evaluate the importance and use of gauging and mastering, and traceability to national standards.
- Analyse and communicate uncertainty. Analysis of uncertainty reduction methods.
- Numerically evaluate complex control systems to interpret their stability or otherwise.
- Evaluate practical alternatives and enhanced methods of system identification and control above simple methods such as PID. Understand 'the Control Frontier'.

## **Indicative reading list**

1. Leach, R.K., Smith, S.T., Basics of Precision Engineering, Taylor Francis (ISBN 978-1-4987-6085-0). (New book - expected June 2017):
2. Morris, A.S., Langari, R., Measurement and Instrumentation: Theory and Application, 2012, Butterworth-Heinemann.
3. Bentley, J.P., 2005, Principles of Measurement Systems (4th Ed.), Longman Scientific & Technical. (Print book and e-book).
4. Dally, J., Riley, W.F., McConnell, K.G., 2006, Instrumentation for Engineering Measurements (2nd Ed.), Wiley.
5. Holman, J.P., 2012, Experimental Methods for Engineers (8th Ed.), McGraw Hill.
6. Beckwith, T.G., Marangon, R.D., Lienhard, J.H., 2009, Mechanical Measurement (6th Ed.), Addison Wesley.

7. Nise, N.S., 2015, Control Systems Engineering (7th Ed.), Wiley.
8. Hughes, A., 2013, Electric Motors and Drives: Fundamentals, Types and Applications (4th Ed.), Elsevier.

### **Subject specific skills**

- Ability to apply relevant practical and laboratory skills
- Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality

### **Transferable skills**

- Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions
  - Overcome difficulties by employing skills, knowledge and understanding in a flexible manner
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## **Study**

### **Study time**

Type	Required
Lectures	28 sessions of 1 hour (19%)
Seminars	2 sessions of 1 hour (1%)
Practical classes	1 session of 3 hours (2%)
Other activity	4 hours (3%)
Private study	113 hours (75%)
Total	150 hours

### **Private study description**

Guided independent learning - 113 hrs

### **Other activity description**

4 x 1hr revision class.

## **Costs**

No further costs have been identified for this module.

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## **Assessment**

You must pass all assessment components to pass the module.

### Assessment group D3

	Weighting	Study time
Assignment 1 A 2,250-word assignment (9 pages max.)	30%	
Assignment 2 A 2,250-word assignment (9 pages max.)	30%	
Online Examination QMP online examination	40%	
~Platforms - AEP,QMP		

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- Online examination: No Answerbook required
  - Students may use a calculator
  - Engineering Data Book 8th Edition

### Feedback on assessment

- Worked examples in revision class.
- Written feedback on laboratory report.
- Model solutions to past papers.
- Worked examples in examples class(es).
- Support through advice and feedback hours.
- Cohort level feedback on examinations

[Past exam papers for ES3E8](#)

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## Availability

### Pre-requisites

To take this module, you must have passed:

- All of
  - [ES2C6-15 Electromechanical System Design](#)

## Courses

This module is Core for:

- Year 3 of UESA-H315 BEng Mechanical Engineering
- Year 4 of UESA-H314 BEng Mechanical Engineering with Intercalated Year
- Year 3 of UESA-H316 MEng Mechanical Engineering
- Year 4 of UESA-H317 MEng Mechanical Engineering with Intercalated Year

This module is Core optional for:

- Year 3 of UESA-H115 MEng Engineering with Intercalated Year
- UESA-H317 MEng Mechanical Engineering with Intercalated Year
  - Year 3 of H317 Mechanical Engineering with Intercalated Year
  - Year 4 of H317 Mechanical Engineering with Intercalated Year

This module is Optional for:

- Year 3 of UESA-H113 BEng Engineering
- Year 3 of UESA-H114 MEng Engineering
- Year 4 of UESA-H115 MEng Engineering with Intercalated Year

This module is Option list A for:

- Year 4 of UESA-H111 BEng Engineering with Intercalated Year
- UESA-H112 BSc Engineering
  - Year 3 of H112 Engineering
  - Year 3 of H112 Engineering