ES3D9-15 Applied Control - Instruments, Measurement and Electrical Machines

20/21

Department
School of Engineering
Level
Undergraduate Level 3
Module leader
Xianping Liu
Credit value
15
Module duration
20 weeks
Assessment
30% coursework, 70% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES3D9-15 Applied Control - Instruments, Measurement and Electrical Machines

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, electrical machines, 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. This module is a core part of the BEng and MEng degrees listed in section 14 and ensures that our graduates will have that necessary foundation and experience. The incorporation of electrical machines provides mechanically biased engineers with an opportunity to couple instrumentation

and control in practical engineering systems, and is in keeping with our approach to teach all engineering disciplines from a basis of general engineering.

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.

- Measurements. Methods of acquiring signals from sensors. Precision and accuracy constraints. Random and systematic effects, noise reduction by filtering, conditioner constraints such as bandwidth. The combinational effects of errors in the measurement chain.
- Instrumentation principles. Operation and performance of selected sensors and their conditioners. Revision of relevant electrical principles such as loading. Examples of sensing force, torque, temperature, pressure, displacement, etc.
- Motion Drive systems. Overview of DC, single-phase and three-phase AC for use in machines (with refresher on basic electrical principles). Typical forms and uses of: electromagnetic actuators; DC motors; AC motors; stepper-motors; and linear motors.
- Applied Control. The need for and benefits afforded by control. Open-loop control. Closed-loop control. Feedback in electronic and mechanical systems. Bang-bang control. Two and Three-term analogue controller as an exemplar system. Notions of gain, phase, and stability as functions of frequency (without detailed analysis). Methods for tuning systems (Ziegler-Nichols).

Learning outcomes

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

- Understand the need for rigorous metrology concepts in design and use of measurement systems.
- Appreciate measurement limitations, analyse and communicate uncertainty.
- Discriminate between different sensor types for taking measurements to allow effective control of machines and processes. Practical experience via a laboratory on sensors.
- Understand the key operational principles of electrical machines, and provide an ability to distinguish important features of electromagnetic actuators and rotating machines. Practical experience via a laboratory on electrical machines.
- Understand commonly applied techniques that allow quantitative control of system outputs using system inputs and applying corrective actions. Interpretation of abstract theories on control for use in practical applications.
- To consolidate the learning, apply a systems approach to demonstrate understanding of current measuring instruments and control strategies to devise forms of control for electrical machines. Practical experience devising a control loop for an electrical machine.

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	20 sessions of 1 hour (13%)
Seminars	3 sessions of 2 hours (4%)
Tutorials	4 sessions of 2 hours (5%)
Practical classes	3 sessions of 3 hours (6%)
Other activity	4 hours (3%)
Private study	103 hours (69%)
Total	150 hours

Private study description

Material from ES2C6 (lectures on control and electro-machines).
Material from ES3E8 (lectures on measurement)
103 hours guided independent learning

Other activity description

2x2h revision class

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D1

	Weighting	Study time	Eligible for self-certification
Assessment component			
Laboratory Report 2250 words (excluding figures) Laboratory report	30%		No
Reassessment component is the same			
Assessment component			
Online Examination Assessment weighting unchanged: exam now 2 * 1 hour online QMP tests. ~Platforms - QMP	70%		No

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- Students may use a calculator
- Engineering Data Book 8th Edition
- Graph paper

Reassessment component is the same

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 office hours.
- Cohort level feedback on examinations.

Past exam papers for ES3D9

Availability

Courses

This module is Core for:

- Year 3 of UESA-H310 BEng Mechanical Engineering
- Year 3 of UESA-HH36 BEng Systems Engineering
- Year 3 of UESA-H311 MEng Mechanical Engineering