ES2C6-15 Electromechanical System Design

22/23

Department
School of Engineering
Level
Undergraduate Level 2
Module leader
Mark Dooner
Credit value
15
Module duration
10 weeks
Assessment
40% coursework, 60% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

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Module web page

Module aims

The module aims to develop an understanding of electrical power generation, transmission, distribution and consumption and of how integrated engineering systems with energy conversion stages operate. It also aims to an understanding of the underpinning science behind energy conversion in electromechanical systems and instil the fundamental engineering principles and mathematical techniques of electromechanical power conversion. The module aims to show applications of instrumentation and measurement in integrated electromechanical engineering systems, apply the principles of engineering control and feedback and design an electromechanical system with motors, actuators, sensors, control, etc.

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.

Fundamentals of Electrical power

- AC power (real, reactive, complex and apparent power)
- Power factor correction and reactive power compensation in AC systems
- 3-Phase AC system (Star systems, delta systems, phase quantities, line quantities)
- Transformers (equivalent circuit, leakage reactance, magnetizing inductance etc).
- Power Systems, Transformers, distribution
- AC and DC Motors
- Basics of Power Electronics
  Instrumentation and Measurements
- Magnetic circuits and Systems (Fields, flux, Ampere's law, Reluctance, magnetic cores, permeability, Magnetomotive force, B-H curves, air-gaps etc)
- Sensors (speed sensors, current sensors, voltage sensors etc) and conditioning
- Data acquisition
- Basic control system with gain, error, and feedback (open loop and closed loop)
- Block diagram and signal flow representation of control systems (system modelling and reduction techniques)
- PID control by Op-amps
- Stability (transfer functions, criterion, Nyquist stability, Zeigler Nicholls)

Learning outcomes

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

- Understand measurement and instrumentation in modern electro-mechanical systems.
- Conceptualise, design and evaluate an electro-mechanical systems.
- Apply the mathematical principles and formulations behind real, reactive, complex and apparent power.
- Evaluate the design and efficiency of a power system with transformers and motors.
- Appreciate and understand the operation of motors for energy conversion in modern electro-mechanical systems.
- Use sensors, op-amps, actuators and feedback to implement control in modern electromechanical systems.

Indicative reading list

Stephen J. Chapman, Electric Machinery Fundamentals, 5th edition, McGraw Hill, 2012.
Measurement and Instrumentation: Theory and Application, Second Edition, Alan S. Morris and Reza Langari, Academic Press, Elsevier, 2016
Introduction to Instrumentation and Measurements, Third Edition, Robert B. Northrop, 2014 , CRC Press

Research element

Group design projects involve the use of research to develop solutions to electromechanical

problems involving energy conversion, sensing, measurement, feedback and control. Students will consult datasheets, technical literature and manufacturer application notes when designing electromechanical systems.

Interdisciplinary

The module comprises of topics from electrical power, electronic sensing, mechanical design and mechanical structures.

Subject specific skills

1. Plan and manage the design process of electromechanical energy conversion and control systems including power sources, transformers, motors and controllers.
2. Designing and evaluating the performance of electromechanical systems and developing control strategies. Using control theory to ensure stable operation of electromechanical systems.
3. The use of technical literature, datasheets, other information sources including appropriate codes of practice and industry standards in the development of electromechanical energy conversion and control systems
4. Knowledge and understanding of risk issues, including health & safety, environmental and commercial risk, risk assessment and risk management techniques and an ability to evaluate commercial risk
5. Ability to apply relevant practical and laboratory skills in the design of systems that include electromechanical energy conversion, sensing, feedback and closed/open loop control.
6. Knowledge of professional codes of conduct, how ethical dilemmas can arise, relevant legal and contractual issues.

Transferable skills

1. Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions
2. Apply problem solving skills, information retrieval, and the effective use of general IT facilities
3. Communicate (written and oral; to technical and non-technical audiences) and work with others
4. Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
5. Exercise initiative and personal responsibility, including time management, which may be as a team member or leader
6. Awareness of the nature of business and enterprise in the creation of economic and social value
7. Overcome difficulties by employing skills, knowledge and understanding in a flexible manner
8. Ability to formulate and operate within appropriate codes of conduct, when faced with an ethical issue
9. Appreciation of the global dimensions of engineering, commerce and communication
10. Be professional in their outlook, be capable of team working, be effective communicators, and be able to exercise responsibility and sound management approaches.

Study

Teaching split

Provider	Weighting
School of Engineering	90%
WMG	10%

Study time

Type	Required
Lectures	25 sessions of 1 hour (17%)
Seminars	3 sessions of 1 hour (2%)
Tutorials	2 sessions of (0%)
Project supervision	8 sessions of 1 hour (5%)
Other activity	15 hours (10%)
Private study	99 hours (66%)
Total	150 hours

Private study description

99 Guided Independent Learning

Other activity description

12 hours of self-directed design lab implementation
2x1 hour revision classes
1 hour design project briefing

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D4

	Weighting	Study time
Design Project Report	40%	

	Weighting	Study time
Design project group report including peer assessment	2000 words	
Online Examination	60%	
QMP online examination		
~Platforms - AEP,QMP		

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

Feedback on assessment

- Support through advice and feedback hours.
- Written feedback on marked design report.
- Cohort-level feedback on final exam.

Past exam papers for ES2C6

Availability

Post-requisite modules

If you pass this module, you can take:

- ES3E7-15 Power Systems and Electrical Machines
- ES3E8-15 Precision, Measurement and Control

Courses

This module is Core for:

- Year 2 of UESA-H335 BEng Automotive Engineering
- Year 2 of UESA-H161 BEng Biomedical Systems Engineering
- Year 2 of UESA-H216 BEng Civil Engineering
- Year 2 of UESA-H63W BEng Electronic Engineering
- Year 2 of UESA-H113 BEng Engineering
- Year 2 of UESA-HN15 BEng Engineering Business Management
- Year 2 of UESA-HH75 BEng Manufacturing and Mechanical Engineering
- Year 2 of UESA-H315 BEng Mechanical Engineering
- Year 2 of UESA-HH35 BEng Systems Engineering
- UESA-H112 BSc Engineering

    - Year 2 of H112 Engineering
    - Year 2 of H112 Engineering
- Year 2 of UESA-HN11 BSc Engineering and Business Studies
- Year 2 of UESA-H336 MEng Automotive Engineering
- Year 2 of UESA-H163 MEng Biomedical Systems Engineering
- Year 2 of UESA-H217 MEng Civil Engineering
- Year 2 of UESA-H63X MEng Electronic Engineering
- Year 2 of UESA-H114 MEng Engineering
- Year 2 of UESA-HH76 MEng Manufacturing and Mechanical Engineering
- Year 2 of UESA-H316 MEng Mechanical Engineering
- UESA-HH31 MEng Systems Engineering
    - Year 2 of HH31 Systems Engineering
    - Year 2 of HH35 Systems Engineering
- Year 2 of UESA-H605 Undergraduate Electrical and Electronic Engineering
- Year 2 of UESA-H606 Undergraduate Electrical and Electronic Engineering MEng

This module is Optional for:

- Year 2 of UCSA-G406 Undergraduate Computer Systems Engineering
- Year 2 of UCSA-G408 Undergraduate Computer Systems Engineering