ES2C5-15 Dynamics and Fluid Mechanics

25/26

Department
School of Engineering
Level
Undergraduate Level 2
Module leader
Peter J. Thomas
Credit value
15
Module duration
10 weeks
Assessment
20% coursework, 80% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES2C5-15 Dynamics and Fluid Mechanics

Module web page

Module aims

The principal aims of the module are to develop upon a firm understanding of mechanical concepts from the first year. Furthermore the module aims to generate a familiarity with key techniques used in the analysis and testing of mechanical systems, and then to introduce fundamental concepts underpinning solid and fluid dynamics.

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.

The module is delivered in two parts: Dynamics and Fluid Mechanics. The topics covered are:

Dynamics

- The principles of work and energy (potential energy, conservative and non-conservative forces)
- Analysis of rigid-body motion: kinematics and kinetics.
- Analysis of standard mechanisms: slider-crank, four bar link.
- Deriving governing equations for general systems using energy methods.
- Step response and frequency response of second-order systems: oscillation, vibration and resonance.
- Supporting laboratory exercises.

Fluid Mechanics

- Viscosity: real and inviscid fluids
- Pressure and its measurement (manometers)
- Reynolds number: laminar and turbulent flow
- Conservation of mass and momentum (the continuity and momentum equations).
- Application of Bernoulli's equation
- Model testing, dimensional analysis, and drag coefficients
- Laminar and turbulent flows; pipe flows, surface roughness, Moody Chart.
- Compressibility effects.
- The role of pressure in fluid mechanics and the 1-D wave equation for an acoustic wave.
- Supporting laboratories in wind-tunnel measurement of flow around a cylinder, and internal flow in a converging/diverging pipe.

The above topics will be augmented with deeper teaching of the practical applications of mathematical methods. Methods used will include vector calculus, linear algebra, differential and partial differential equation solutions.

Learning outcomes

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

- Analyse basic mechanical systems. Understand that forces maybe either conservative or non-conservative and appreciate how these apply in modelling real-world applications. [C1, C2, M1]
- Employ the principles of work and energy as a means to generate governing equations and evaluate system response. [C1, C2, C3, M1, M3]
- Perform kinematic and dynamic analysis of rigid bodies employing vector methods and graphical solutions as appropriate. [C1, C2, C3, M1, M3]
- Demonstrate knowledge and understanding of the well-established equations of fluid mechanics and be able to classify different types of flow regime and fluid behaviour using appropriate dimensionless numbers. [C2, C12, M2, M12]
- Apply Bernoulli’s principle to a range of applications to predict inviscid fluid-flow behaviour, while being able to identify its limitations. Show appreciation for extensions to fluid mechanics theory, e.g. compressibility, surface tension. [C1, C2, C3, M1, M2, M3]
- Analyse experimental measurements of velocity and pressure, and be able to quantify and analyse the various forms of error. [C4, C12, M4, M12]

Indicative reading list

Recommended Options for Literature : Fluid Mechanics
(1) Potter, M.C., Wiggert, D.C., Ramadan, B.H., 2017, Mechanics of Fluids (5th Edition), Cengage Learning, Stamford. ISBN 978-1-305-63761-0.
(2) White, F.M., 2016, Fluid Mechanics (8th Edition), McGraw-Hill, New York. ISBN 9789814720175.
(3) Douglas, J.F., Gasiorek, J.M., Swaffield, J.A., Jack, L.B., 2011, Fluid Mechanics (6th Edition, or latest edition whenever new editions become available), Prentice Hall, Pearson Education Limited, Harlow, UK.

Recommended options for Literature : Dynamics and Vibration
(1) F. Beer and E. Russell Johnston Jr., Vector Mechanics for Engineers: Dynamics (2009).
(2) R. C. Hibbeler, Engineering Mechanics: Dynamics (2012).
(3) A. M. Bedford, Engineering Mechanics: Dynamics (2007).

Subject specific skills

1. Plan and manage the design process, including cost drivers, evaluating outcomes, and working with technical uncertainty
2. Knowledge and understanding of the need for a high level of professional and ethical conduct in engineering and the use of technical literature, other information sources including appropriate codes of practice and industry standards
3. 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
4. Ability to apply relevant practical and laboratory skills
5. 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

Study time

Type	Required
Lectures	28 sessions of 1 hour (19%)
Practical classes	10 sessions of 1 hour (7%)
Other activity	2 hours (1%)
Private study	110 hours (73%)
Total	150 hours

Private study description

110 hours private study.

Other activity description

2 x 1 hour Examples/Revision/Examination Advice classes

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D5

	Weighting	Study time	Eligible for self-certification
QMP Laboratory test	20%		No
QMP test based on laboratories			
Online Examination	80%		No

2 * 1 hour QMP online tests to be scheduled in same time slot with short break inbetween

	Weighting	Study time	Eligible for self-certification
~Platforms - AEP,QMP			

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

Feedback on assessment

- Exam advice class.
- Written feedback on laboratory reports.
- Model solutions to past papers.
- Support through advice and feedback hours.
- Examples clinics.
- Cohort feedback on examinations.

Past exam papers for ES2C5

Availability

Courses

This module is Core for:

- Year 2 of UESA-H161 BEng Biomedical Systems Engineering
- Year 2 of UESA-H163 MEng Biomedical Systems Engineering

This module is Optional for:

- Year 2 of UESA-H113 BEng Engineering
- UESA-H112 BSc Engineering
    - Year 2 of H112 Engineering
    - Year 2 of H112 Engineering