ES4G3-15 Dynamics of Mechanical Systems

24/25

Department
School of Engineering
Level
Undergraduate Level 4
Module leader
Duncan Lockerby
Credit value
15
Module duration
10 weeks
Assessment
30% coursework, 70% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES4xx -15 Advanced Dynamics

Module aims

The principal aims of the module are to understand critically and optimise the dynamics behaviour both analytically and numerically of a complex system, develop numerical modelling with the application of concepts from advanced dynamics engineering, and analyse the stability of a dynamic system.

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.

1. `Introduction of dynamics mechanics in 3D`
2. `Kinematics of 2/3D systems`

2i. Mobility analysis of mechanical systems

2ii. Vector presentation of kinematics of a single body in 2D/3D space
2iii. Moving coordinate system
2iv. Application to kinematic analysis of rigid body systems, e.g. planar/spatial linkages mechanisms
3. Kinetics of 2D/3D systems
3i. Vector presentation of force and moment equations of a rigid body in 2D/3D
3ii. Application to kinetostatic analysis of planar linkages as a special topic
3iii. Formulation of general equations of motion of rigid body systems in moving coordinate system, e.g. planar/spatial linkages and robotic mechanisms
4. Gyroscopic motions
4i. Explanation to procession phenomena
4ii. Formulation of Euler's Equation
4iii. Steady state procession
4iv. Application to satellite and gyro compass, etc.

Learning outcomes

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

- Perform advanced kinematic analysis on spatial mechanisms using vector and matrix representations with reference to the mobility of 3D mechanical systems. [M1, M2]
- Evaluate the motions produced by driving forces or the driving forces necessary to generate specific motions of 3D mechanical systems. [M1, M2]
- Design and simulate a mechanical system to meet a target specification and evaluate performance metrics with allowance for uncertainty. [M3, M6, M17]
- Evaluate the application of advanced dynamical systems (e.g. gyroscopes, robotics). [M2, M6]

Indicative reading list

- Design of Machinery: an Introduction to the Synthesis and Analysis of Mechanisms and Machines, Norton, RL, 5th edition (McGraw Hill 2012).
- Shigley, J.E. Uicker, J.J. Theory of machines and mechanisms, McGraw-Hill Education, 2016.
- J.R. Meriam and L.G. Kraige, Engineering Mechanics, Dynamics (7th Edition), Wiley, 2006.
- Grosjean, J., Kinematics and Dynamics of Mechanisms, McGraw Hill 1991.
- AShabana, A. A., Computational Dynamics, 2nd Ed., Wiley 2001 .

Subject specific skills

1. Ability to conceive, make and realise a component, product, system or process;
2. Ability to develop economically viable and ethically sound sustainable solutions;
3. Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality;
4. Ability to seek to achieve sustainable solutions to problems and have strategies for being creative and innovative;
5. Ability to be risk, cost and value-conscious, and aware of their ethical, social, cultural,

environmental, health and safety, and wider professional engineering responsibilities;

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	30 sessions of 1 hour (20%)
Tutorials	2 sessions of 1 hour (1%)
Private study	118 hours (79%)
Total	150 hours

Private study description

118 hr of self-guided study

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time
Assignment	30%	
Lab or computer-based modelling assignment 2000 words/9 pages of text		
Examination	70%	
2 * 1 hour QMP online tests to be scheduled in same time slot with short break inbetween		
~Platforms - AEP,QMP		

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

Feedback on assessment

- Coursework will be returned with marks and detailed feedback.
- Model solutions to exam type questions.
- Support through advice and feedback hours.
- Cohort level feedback on examinations

Past exam papers for ES4G3

Availability

Pre-requisites

To take this module, you must have passed:

- All of
  - ES193-15 Engineering Mathematics
  - ES2D5-15 Planar Structures and Mechanisms
  - ES190-15 Dynamics and Thermodynamics
  - ES2C5-15 Dynamics and Fluid Mechanics

Courses

This module is Core for:

- Year 4 of UESA-H316 MEng Mechanical Engineering
- Year 5 of UESA-H317 MEng Mechanical Engineering with Intercalated Year