ES2D5-15 Planar Structures and Mechanisms

24/25

Department
School of Engineering
Level
Undergraduate Level 2
Module leader
Albert Bartok-Partay
Credit value
15
Module duration
10 weeks
Assessment
30% coursework, 70% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

n/a

Module web page

Module aims

This is a new, stream-specific module for Mechanical Engineers. There are two themes: structures and mechanisms.

The first part of the module aims to develop engineers' understanding of mechanisms and how to describe their state in terms of position, velocity, and acceleration.

The second part of the module aims to supply Mechanical Engineers with specific skills related to the calculation of stress and strain and how this impacts on design.

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. Outline Syllabus
   Analysis of Mechanisms:
   i) Basic components used in modelling mechanisms: links, sliders, pin-joints. Number of degrees of freedom of a mechanism.
   ii) Analytical techniques for kinematic analysis of mechanisms to obtain position, velocity and acceleration. Whilst the focus will be on analytical approaches, graphical methods will be referenced as an aid to understanding.
   iii) Calculation of deflections and stresses due to axial, bending and torsional loads. Quantification of a link stiffness and its dependence on link dimensions and material properties.
   iv) Shaking forces as consequence of mechanism inertia. Calculation of balancing shaking forces in important special cases, rotating systems and slider crank mechanisms.

Strength of Materials:
i) Identification of common idealised states within a material within the context of linear elastic theory and superposition of states of load and hence stress / deflection of a material.
ii) States of stress and strain in typical configurations: beams / shafts / columns / discs / pressure vessels.
iii) Failure criteria, von Mises, Tresca, and their relation to states of loading and material suitability.
iv) Matrix methods for analysis of systems of links with focus on deflection and strength of components.
v) Material selection in relation to the state of load / stress within a component.

Learning outcomes

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

- Analyse the kinematics of some common planar mechanisms; determine positions, velocities and accelerations. Apply this analysis to key engineering planar mechanisms. [C1, C2, M1, M2]
- Model the internal and external forces and torques (kinetics) in some common planar mechanisms necessary to maintain a kinematic state. [C1, C2, M1, M2]
- Create, apply and analyse models for stress configurations in planar mechanisms and demonstrate a developed understanding of the role of stiffness under general loading conditions. Appreciate the effect of dimensional scaling and material property ratios. [C1, C2, C3, M1, M2, M3]
- Demonstrate a developed understanding of the limitations of linear elastic theory under general loading conditions. [C4, C6, M4, M6]
- Select and apply some common states of stress and strain and the typical failure criteria that arise from them. Assess material suitability in terms of application criteria. [C4, C13, M4, M13]
- Understand how mechanism inertia can lead to shaking forces and calculate how to compensate for such forces (balance) in some important special cases. [C1, C2, C12(D), M1, M2, M12(D)]

Indicative reading list

- Theory of machines and mechanisms, John J. Uicker, Jr., Gordon R. Pennock, Joseph E. Shigley, 4th edition, (Oxford University Press 2011).
- Mechanics of Machines, Cleghorn, W. L. (Oxford University Press 2010).
- Design of Machinery: an Introduction to the Synthesis and Analysis of Mechanisms and Machines, Norton, RL, 5th edition (McGraw Hill 2012).
- Dynamics of Mechanical Systems, Prentis JM, 2nd edition (Wiley 1980).
- Strength of Materials and Structures, Case J, Chilver AH & Ross CTF, 4th edition, e-Book (Elsevier 1999).
- Structural and stress analysis, Megson, T. H. G., 3rd edition, e-Book (Elsevier 2014).
- Elasticity. Theory, Applications, and Numerics. Sadd, Martin H., 3rd edition, e-Book (Elsevier 2014).
  Mechanics of Composite Materials, Kaw, Autar K., 2nd edition, e-Book (CRC Taylor & Francis 2006).

Interdisciplinary

Merging material science, kinematics, and mechanics of continuous media.

Subject specific skills

Ability to apply relevant practical and laboratory skills.
Plan to specification, taking into consideration external constraints.
Model complex, real-world engineering problems, predicting behaviour including failure.

Transferable skills

Numeracy: apply mathematical and computational methods to communicate parameters, model and optimise solutions.
Apply problem solving skills, information retrieval, and the effective use of general IT facilities.
Ability to justify assumptions by an appropriate mix of reasoning, mathematical models and empirical observations.
Communicate (written and oral; to technical and non-technical audiences) and work with others to create and maintain working relationships.
Commit to personal learning and professional development.

Study

Study time

Type	Required
Lectures	29 sessions of 1 hour (19%)
Seminars	9 sessions of 1 hour (6%)
Total	150 hours

Type	Required
Tutorials	(0%)
Practical classes	1 session of 3 hours (2%)
Private study	109 hours (73%)
Total	150 hours

Private study description

104 hrs Guided independent learning.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D7

	Weighting	Study time
Analysis Assignment (6 pages) Analysis Assignment	30%	
Online Examination 2 hour on campus QMP ~Platforms - AEP,QMP	70%	

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

Feedback on assessment

- Students receive cohort feedback on their assignments;
- Student support through advice and feedback hours;
- Worked examples in revision lectures;
- Model solutions to some past paper questions
- Cohort level feedback on examinations.

Past exam papers for ES2D5

Availability

Post-requisite modules

If you pass this module, you can take:

- ES4G3-15 Dynamics of Mechanical Systems

Courses

This module is Core for:

- Year 2 of UESA-H315 BEng Mechanical Engineering
- Year 2 of UESA-H316 MEng Mechanical Engineering