

# ES2D5-15 Planar Structures and Mechanisms

**21/22**

**Department**

School of Engineering

**Level**

Undergraduate Level 2

**Module leader**

Petr Denissenko

**Credit value**

15

**Module duration**

10 weeks

**Assessment**

40% coursework, 60% exam

**Study location**

University of Warwick main campus, Coventry

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## 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 supply Mechanical Engineers with specific skills related to the calculation of stress and strain and how this impacts on design.

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

### 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, e.g. reciprocating engines.

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:

- Model the behaviour of some common planar mechanisms and calculate the velocities, accelerations (kinematics) and forces, torques (kinetics) associated with their motion.
- Predict the deflections, stresses, etc. under general loading (axial, bending, torsional) and be able to assess the consequences on design of planar structural systems.
- Appreciate the rationale and limitations for using linear elastic theory under general loading conditions and be able to converse with specialists.
- Demonstrate a developed understanding of the key role of stiffness under various forms of loading, the effect of dimensional scaling and material property ratios.
- Choose between and apply some common (idealized) states of stress and strain and the typical failure criteria that arise from them. Assess material suitability in terms of application criteria.
- Model stress configurations.
- Understand how mechanism inertia can lead to shaking forces and calculate how to compensate for such forces (balance) in some important special cases.

## 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

## Transferable skills

Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions

Apply problem solving skills, information retrieval, and the effective use of general IT facilities

Communicate (written and oral; to technical and non-technical audiences) and work with ot

## Study

### Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Seminars	3 sessions of 1 hour (2%)
Tutorials	10 sessions of 1 hour (7%)
Practical classes	1 session of 3 hours (2%)
Private study	104 hours (69%)
Total	150 hours

### Private study description

104 hrs Guided independent learning.

## Costs

No further costs have been identified for this module.

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## Assessment

You must pass all assessment components to pass the module.

### Assessment group D3

	Weighting	Study time
Analysis Assignment (10 pages)	20%	
Analysis Assignment on Matrix Methods		
Analysis Assignment (10 pages)	20%	
Analysis Assignment on material properties and failure		
Online Examination	60%	
2 x 1 hour QMP online tests to be scheduled in same time slot with short break inbetween		
~Platforms - AEP,QMP		

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- 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](#)

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## Availability

### Post-requisite modules

If you pass this module, you can take:

- ES480-15 Dynamic Analysis 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

This module is Option list A for:

- Year 2 of UESA-H113 BEng 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-H114 MEng Engineering