ES3C3-15 Planar Structures and Mechanisms

20/21

Department
School of Engineering
Level
Undergraduate Level 3
Module leader
Petr Denissenko
Credit value
15
Module duration
10 weeks
Assessment
40% coursework, 60% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES3C3-15 Planar Structures and Mechanisms

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.

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.
- Demonstrate an advanced 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.
- Appreciate the rationale and limitations for using linear elastic theory under general loading conditions and be able to converse with specialists.
- Understand how mechanism inertia can lead to shaking forces and calculate how to compensate for such forces (balance) in some important special cases, e.g. reciprocating engines.

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).

Subject specific skills

TBC

Transferable skills

TBC

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.

Assessment

You must pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

Assessment group D3

	Weighting	Study time	Eligible for self-certification
Assessment component			
Analysis Assignment Analytical Assignment	20%		No
Reassessment component is the same			
Assessment component			
Laboratory Assignment Experimental lab	20%		No
Reassessment component is the same			
Assessment component			
Online Examination 2x1 hour QMP, separated by 1 h break. ~Platforms - AEP,QMP	60%		No

---

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

Reassessment component is the same

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 ES3C3

Availability

Courses

This module is Core for:

- Year 3 of UESA-H310 BEng Mechanical Engineering
- Year 3 of UESA-H311 MEng Mechanical Engineering