ADVANCED STRESS ANALYSIS - 2024/5

Module code: ENGM301

Module Overview

As engineers it is important to avoid structure or component failure due to overloading or excessive deflection, and stress analysis is the way of assessing such conditions. This module extends the stress analysis delivered in earlier years to cover advanced topics to provide the student with a comprehensive range of skills. This includes increased complexity due to component shape (non-symmetric sections, plates) and stresses caused by loading conditions not previously considered in detail (pressure, torsion and shear forces). Many structures, components and forms of loading are too complex to obtain exact solutions for. In such cases Energy methods can often be used to provide approximate solutions, enabling the engineer to carry out structural assessment. The module shows how energy methods can be used to find the response of structural systems to static loads.

A key element of the module is problem solving, thus developing students' resourcefulness. Efficient mechanical design, covering a full range of engineering materials, facilitates lightweighting, and in this way supports a sustainability agenda.

Module provider

Mechanical Engineering Sciences

Module Leader

VIQUERAT Andrew (Mech Eng Sci)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 7

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 62

Lecture Hours: 33

Tutorial Hours: 11

Guided Learning: 11

Captured Content: 33

Module Availability

Semester 1

Prerequisites / Co-requisites

N/A

Module content

Indicative content includes:

- Asymmetric bending of beams
  - Product 2nd moment of area
  - Symmetric sections, asymmetric loading
  - Asymmetric sections
  - Axes of maximum and minimum bending stiffness
- Torsion of non-circular sections
  - Thin closed tubes - stress and twist
  - Open straight thin walled sections - stress and twist
  - Thin walled cellular structures - stress and twist
- Shearing of thin walled sections
  - Open sections - shear distribution and shear centre
  - Closed sections - shear distribution and shear centre
- Pressurised thick walled cylinders
  - Lames equations Internal and external pressure
  - Compound cylinders
- Energy theorems
  - Method of virtual forces and displacements
  - Theorem of stationary total potential energy

- Deflection of beams
    - Strain and potential energy in terms of deflection
    - Choice of suitable deflected shapes for various end conditions
    - Solutions for constant and stepped section beams

- Circular plates
    - Moment-deflection stress relationships
    - General deflection equation
    - Displacement and stresses for various boundary conditions
    - Annular plates

- Deflection of plates
    - Moment and torque-deflection-stress relationships
    - Strain energy expression for plate in terms of deflections
    - Solution of different types of planar edge boundary conditions

- Buckling of beams and plates
    - Beams in-plane energy terms
    - Plates in-plane energy terms

Assessment pattern

Assessment type	Unit of assessment	Weighting
School-timetabled exam/test	Class Test - 1 of 2 (30 mins)	15

Assessment type	Unit of assessment	Weighting
School-timetabled exam/test	Class Test - 2 of 2 (30 mins)	15
Examination	Exam (2 hrs)	70

Alternative Assessment

Alternative coursework for class test(s): written assignment involving quantitative analysis covering the same topics.

Assessment Strategy

The assessment strategy is designed to provide students with the opportunity to demonstrate their proficiency in applying some of the core concepts of stress analysis to real problems. The summative assessment for this module consists of

- two class tests [Learning outcome 1, 2]
- examination [Learning outcomes 1, 2]

Formative assessment and feedback Formative verbal feedback is given in tutorials and following the assignment

Module aims

- To complete the strength and stiffness analyses of previous modules by considering other forms of commonly encountered structures and structural loading
- To provide an awareness of the role of energy principles generally in determining approximate solutions for complex structural problems

Learning outcomes

Ref		Attributes Developed	
001	Calculate the strength and stiffness of a representative range of structures subject to static loading	KC	M1,M2
002	Demonstrate a comprehensive understanding of the concept of stationery potential energy and use this to obtain estimates of the response of rectangular plates to both lateral and in-plane loading.	KC	M1,M2

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The material is delivered in a series of lectures for which there are supporting tutorial questions. Problems in solving the tutorial questions are covered in the tutorial sessions. The module is supported through SurreyLearn with extensive online module information, notes, tutorial solutions and past papers with numerical solutions.

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: ENGM301

Other information

The School of Mechanical Engineering Sciences is committed to developing graduates with strengths in Employability, Digital Capabilities, Global and Cultural Capabilities, Sustainability, and Resourcefulness and Resilience. This module is designed to allow students to develop knowledge, skills, and capabilities in the following areas:

- Sustainability
  - To reflect on how the discipline/topic is impacted by, and impacts, aspects of social and environmental wellbeing, both now and into the future.
- Resourcefulness and resilience
  - Demonstrate an ability to share informed opinions constructively, using evidence, and be open to different opinions and able to adapt perspectives.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Advanced Mechanical Engineering MSc	1	Compulsory	A weighted aggregate mark of 50% is required to pass the module
Aerospace Engineering MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Mechanical Engineering MEng	1	Compulsory	A weighted aggregate mark of 50% is required to pass the module

Please note that the information detailed within this record is accurate at the time of publishing and may be subject to change. This record contains information for the most up to date version of the programme / module for the 2024/5 academic year.