

MODULE TITLE: 4B1 Mechanics of Solids

CODE: ME4B01

LEVEL: Senior Sophister (Optional module)

CREDITS: 5

LECTURER(S): Dr Danny Kelly (kellyd9@tcd.ie)

MODULE ORGANISATION

This module runs for the 12 weeks of semester two (except during study/assignment week) and comprises three lectures plus one one-hour tutorial per week. Total contact time is 44 hours.

Semester	Start Week	End Week	Associated Practical Hours	Lectures		Tutorials	
				Per week	Total	Per week	Total
2	1	12	0	3	33	1	11
Total Contact Hours: 44							

MODULE DESCRIPTION, AIMS AND CONTRIBUTION TO THE PROGRAMME

Mechanics of Solids expands upon fundamental topics of beam bending developed in the third year course 3B3, extending these to cover specialized topics which are important in beam design, such as the analysis of composite and non-symmetric beams, inclined loads, shear stresses in thin walled beams and shear centres. Next, a more fundamental view is taken of the theory of elasticity. The use of stress functions is developed and applied to problems such as thick-walled pressure vessels and holes in plates. Finally, the theory of the finite element method and its use in solving problems in mechanics is introduced.

LEARNING OUTCOMES

On completion of this module, the student will be able to:

- calculate the distribution of stress in composite beams and build-up beams. Determine the influence of an inclined load on the stress distribution within a beam;
- calculate the shear stresses in beams of thin-walled open cross-section;
- calculate the shear centre of a beam. Design a beam to meet certain requirements;
- demonstrate a fundamental knowledge of the theory of elasticity, including equilibrium equations, compatibility equations, boundary conditions, stress functions etc;
- use stress functions to determine the stress distribution in a number of engineering structures, given the appropriate boundary conditions;
- understand the importance of the theory of elasticity in the design of engineering components;
- demonstrate a basic understanding of the finite element method;
- use strain gauges in a laboratory assignment to investigate composite beams.

MODULE SYLLABUS

- **Stresses in beams**
 - composite beams;
 - inclined loads;
 - shear stresses in beams of thin-walled open cross-section;
 - calculating the shear centre;
 - built-up beams.
- **Theory of Elasticity**
 - equilibrium and compatibility equations in Cartesian and polar coordinates;
 - stress functions;
 - beams;
 - thick-walled pressure vessels;
 - concentrated load at a point;
 - hole in a plate;

- introduction to plates and shells.
- ***Finite element method***
 - linear interpolation models;
 - derivation of element matrices;
 - assembly of element matrices.

TEACHING STRATEGIES

This part of the course is taught using a combination of lectures, laboratories and tutorials. During the tutorials and laboratories the students work in groups thereby encouraging teamwork and cooperation.

RECOMMENDED TEXT(S)

- *Theory of Elasticity*, Timoshenko, McGraw-Hill
- *Mechanics of Materials*, Gere, 5th edition, Nelson Thornes

ASSESSMENT

This module is assessed by a formal written two-hour examination (85% of the final mark) together with laboratory experiment marks (15%).

LABORATORY

Analysis of a Composite Beam