Unit 209 Mechanics of solids

Unit summary

This unit is about the elastic behaviour of engineering components and using theoretical, numerical and experimental techniques to determine stresses, strain and deflections under various load conditions.

Aims

The unit aims to give students a thorough grounding in elastic behaviour and an introduction to non elastic behaviour of engineering components using classical theory, approximate numerical methods and experimental techniques.

Prerequisites

It is expected that candidates will have a working knowledge of the materials in the four compulsory papers of the Certificate examination and with other material as set out in the syllabus for subject 9107-105 Mechanical and structural engineering.

Learning outcomes

There are **three** outcomes to this unit. The candidate will be able to:

- Calculate stresses, strain and deflections in a range of components under various load conditions.
- Select appropriate methods for the detail design of components.
- Demonstrate an understanding of the basis of computer software used in stress analysis

Guided learning hours

It is recommended that 300 hours should be allocated for this unit. 120 of those hours are actual taught hours. This may be on a full time or part time basis.

Key Skills

This unit contributes towards the Key Skills in the following areas:

N4.1

Develop a strategy for using application of number skills over an extended period of time.

N4.2

Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving:

- deductive and inferential reasoning;
- algebraic manipulation.

N4.3

Evaluate your overall strategy and present the outcomes from your work, including use of charts, diagrams and graphs to illustrate complex data.

IT4.1

Develop a strategy for using IT skills over an extended period of time.

IT4.2
Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of IT for **two** different, complex purposes.

IT4.3
Evaluate your overall strategy and present the outcomes from your work using at least **one** presentation, showing integration of text, images and number.

Occupational Standards
This unit has been mapped to the following National Occupational Standards:

1.1.1 Identify the requirements of clients for engineering products or processes
1.1.2 Produce specifications for engineering products or processes
1.3.1 Undertake research into engineering products or processes
1.3.2 Evaluate the results of research
1.4.2 Develop a strategy for the design process
1.4.3 Create designs for engineering products or processes
1.4.4 Evaluate designs for engineering products or processes
8.1.1 Maintain and develop own engineering expertise

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Outcome 1 Calculate stresses, strain and deflections in a range of components under various load conditions.

Knowledge requirements
The candidate knows how to:

1 use Mohr's Circle to determine
   a stresses on inclined planes
   b combined bending torsion and axial loading
2 use and position on components strain gauge rosettes
3 use calculations and or graphic means to determine
   a shear force and bending moments in laterally loaded beams
   b bending stress and shear stress distribution in beams
   c deflection of beams
   d solution of statically indeterminate beams
   e centre of shear in beams
4 extend shear force, bending moment, bending stress, shear stress and
   a deflection analysis to
   b beams of asymmetric cross section
   c composite beams
   d beams of "elastic-perfectly plastic" material
5 determine shear stress and twist of
   a circular solid sections
   b thin walled cylinders
   c simple open sections
6 apply Euler critical loads to determine buckling for a combination of
   a free conditions
   b pinned conditions
   c built in end conditions
7 determine limiting stress condition
8 use analytical methods to determine stresses and displacements in rings, cylinders and discs under axi-symmetric loading
   a internal/external pressure
   b shrink fits
   c rotation
9 apply Lame equations to problem solving

10 employ finite element analysis
   a discretisation
   b types of elements
   c relationship between
      i nodal forces
      ii nodal displacements
      iii stiffness matrix
11 represent examples of linear elements using springs
12 obtain stiffness matrix using
   a one-dimensional quadratic elements
   b displacement functions
   c shape functions
   d principle of virtual work
13 determine stresses from primary unknown nodal displacements
14 understand the underlying assumptions and approximate nature of the results of Finite Element Method
15 analyse engineering materials behaviour when loadings and service conditions
   a involve
   b fatigue
   c yield criteria
   d fracture mechanics
   e creep
   f viscoelasticity
16 assess and select materials for applications
   a plastics
   b composites
   c ceramics
   d modern materials

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Outcome 2 Select appropriate methods for the detail design of components.

Knowledge requirements
The candidate knows how to:

1 implement the analytic techniques in Outcome 1 to engineering designs involving

- a beams
- b columns
- c thin cylinder applications
- d pressure vessels
- e structural steelwork
- f shafts
- g buildings

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Outcome 3 Demonstrate an understanding of the basis of computer software used in stress analysis

Knowledge requirements
The candidate knows how to:

1 undertake and solve engineering design calculations and mechanics of materials problems using various computer software packages

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Recommended reading list

Core texts	Author(s)	Publisher	ISBN
Mechanics of Engineering Materials	Benham, Crawford, Armstrong	Pearson Higher Education	0582251648
Mechanics of Materials	Gere, Adin, Nelson	Thornes	0748769897
Mechanics of Solids and Structures DWA	Rees	World Scientific Pub Co.	1860942172