

Unit 210

The analysis of engineering structures

Unit summary

The unit is about the deformity of structures and the principles of elastic and plastic analysis of simple indeterminate forms.

Aim

The unit aims to equip the candidate with the techniques used to analyse the reactions of structures under various loading conditions. Internal stresses and forces are analysed to determine design specifications and avoid collapse or serious deformation.

Prerequisites

It is expected that candidates will have a working knowledge of the materials in the four compulsory papers of the Certificate examination.

Learning outcomes

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

- Undertake elastic analysis of structures.
- Undertake plastic analysis of structures.
- Understand the mechanics of deformable bodies.
- Understand stability and instability.

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
- 4.1.1 Determine the operational requirements of engineering products or processes
- 6.1.1 Analyse the risks arising from engineering products and processes
- 7.1.1 Develop objectives for projects
- 7.1.2 Plan the delivery of projects
- 7.2.3 Evaluate projects
- 8.1.1 Maintain and develop own engineering expertise

Unit 210

The analysis of engineering structures

Outcome 1

Undertake elastic analysis of structures.

Knowledge requirements

The candidate knows how to:

- 1 define and determine strain energy
- 2 apply the principle of virtual work
- 3 use virtual forces in obtaining displacements
- 4 use virtual displacements in obtaining equilibrium equations
- 5 apply the principle of minimum potential energy
- 6 analyse statically determinate and statically indeterminate structures
 - a calculation of forces for
 - b calculate displacements for
 - c generate influence lines for
 - i pinjointed frames
 - ii beams
 - iii rigid jointed frames
 - iv arches
- 7 apply to structures the force method
 - a displacement method including slope deflection and moment distribution
 - b statical and Kinematic indeterminacy
 - c effect of temperature and lack of fit
 - d matrix formulations
 - e computer methods based on the stiffness matrix

Unit 210

The analysis of engineering structures

Outcome 2

Undertake plastic analysis of structures.

Knowledge requirements

The candidate knows how to:

- 1 analyse frames and beams using graphical procedures applied to
 - a plastic collapse of simple steel frames
 - b plastic collapse for continuous beams
- 2 analyse frames and beams using the method of exploring mechanisms applied to
 - a plastic collapse of simple steel frames
 - b plastic collapse of continuous beams
- 3 apply plastic analysis to reinforced concrete slabs
- 4 use plastic analysis techniques for reinforced concrete slabs
 - a upper bound method (yield-line theory)
 - b lower bound method (strip theory)

Unit 210

The analysis of engineering structures

Outcome 3

Understand the mechanics of deformable bodies.

Knowledge requirements

The candidate knows how to:

- 1 understand and apply plane elasticity
 - a equilibrium and compatibility conditions
 - b stress functions
 - c applications
- 2 use finite element method for deformable bodies

Unit 210

The analysis of engineering structures

Outcome 4

Understand stability and instability.

Knowledge requirements

The candidate knows how to:

- 1 investigate the general principles and criteria of elastic instability
- 2 assess struts and frames for instability
- 3 use Euler load for pin-ended struts and effect of other end conditions
- 4 investigate the effects on structures/beams/columns of
 - a initial curve
 - b lateral load
 - c eccentric load
- 5 investigate lateral torsional buckling of beams

Unit 210 The analysis of engineering structures

Recommended reading list

Core texts	Author(s)	Publisher	ISBN
Structural Analysis	Ghali, Neville	Spon Press	0419212000
The Finite Element Method Volume 1: The Basics	Zienkiewicz, Taylor	Butterworth- Heinemann	0750650494
Theory of Elasticity	Timoshenko	McGraw Hill	0070858055
Theory of Plates and Shells	Timoshenko	McGraw Hill	0070858209
Understanding Structural Analysis	Brohn	Arnold	034074068X