

## Unit 211

# The design of engineering structures

### Unit summary

This unit is about the structural action of common building materials and techniques and the development of an engineer's ability to use computational and calculation methods to determine loads and forces from first principles. It also includes British Codes of Practice for Steelwork, Concrete, Timber and Masonry.

### Aims

The unit aims to develop the candidate's ability to investigate the behaviour of steelwork, reinforced concrete, timber and masonry in buildings and bridges.

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

- Demonstrate understanding of the behaviour of steelwork elements, their support and connections in buildings and bridges
- Understand the design and detailing of reinforced concrete elements in buildings, walls and bridges
- Design and detail structural masonry and timber elements in buildings
- Use the British Loading Codes of Practice.

### 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:

PS4.1

Develop a strategy for using skills in problem solving over an extended period of time.

PS4.2

Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required when tackling **one** complex problem with at least three options.

PS4.3

Evaluate your overall strategy and present the outcomes from your work using a variety of methods.

## **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
- 1.4.1 Establish a design brief for engineering products or processes
- 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
- 6.1.1 Analyse the risks arising from engineering products and processes
- 6.2.1 Assure the quality of engineering products or processes
- 8.1.1 Maintain and develop own engineering expertise

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### Outcome 1

Demonstrate understanding of the behaviour of steelwork elements, their support and connections in buildings and bridges

#### Knowledge requirements

##### The candidate knows how to:

- 1 use design techniques for structural steel elements in simple
  - a frames and trusses
  - b plain columns
  - c beams
  - d crane girders
  - e lattice gantry columns
  - f plate girders
  - g hollow section truss members
- 2 use elastic and plastic design techniques for rigid portal frames
- 3 design connections in steel frames
  - a brackets
  - b haunches
  - c column splices
  - d base-plates
- 4 produce designs of composite floor beams including checks on pull-out shear studs

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### Outcome 2

Understand the design and detailing of reinforced concrete elements in buildings, walls and bridges

#### Knowledge requirements

##### The candidate knows how to:

- 1 design in-situ and pre-cast concrete elements
  - a simply supported and continuous beams of
    - i rectangular section
    - ii T section
    - iii L section
  - b singly and doubly reinforced slabs
    - i two-way spanning
    - ii one-way spanning
  - c plain and ribbed slabs
  - d "short" columns subject to axial and moment loading
- 2 assess the use of sub-frames in analysis
- 3 design crank members in staircases
- 4 design combined and balanced foundations
- 5 assess the principles and design of pre-stressed concrete
  - a pre-tensioned
  - b post-tensioned

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### Outcome 3

Design and detail structural masonry and timber elements in buildings

#### Knowledge requirements

##### The candidate knows how to:

- 1 produce designs for load-bearing brickwork and block-work for vertical loading
- 2 assess the design of masonry panels for lateral loading
- 3 assess the design of Industrial sheds
  - a reinforced brickwork
  - b reinforced cavity retaining walls
  - c pierced walls
- 4 design solid timber sections as
  - a beams
  - b columns
- 5 assess the design of
  - a built-up members
  - b glued-laminated members
  - c timber truss design
- 6 assess structural timber applied to
  - a formwork
  - b falsework

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### **Outcome 4**

Use the British Loading Codes of Practice.

#### **Knowledge requirements**

##### **The candidate knows how to:**

- 1 use codes of practice to aid design
- 2 extract information from codes of practice
- 3 check designs and design calculations against codes of practice

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### Recommended reading list

<b>Core texts</b>	<b>Author(s)</b>	<b>Publisher</b>	<b>ISBN</b>
Reinforced Concrete Design	Mosley, Bungey, Hulse	Palgrave	0333739566
Steel Designers Manual	Steel Construction Inst.	Blackwell Science	0632049251
Timber Designers' Manual	Ozelton, Baird, Steer	Blackwell Science	0632039787
Introduction to Load Bearing Brickwork Design	Hendry, Sinha, Davies	Prentice Hall	0135391725 o/p
Structural Steel design	Dowling, Knowles, Owen	Butterworth- Heinemann	0408037172 o/p
Structural Steelwork	MacGinley, Ang	Butterworth- Heinemann	0750660440 9 o/p
<b>Other useful texts</b>			
Constructional Steel Design	Dowling, Harding, Bjorhovde	Chapman & Hall	1851668950
Load Bearing Brickwork		British Ceramic Society	0901092398