

## Unit 213

## Geotechnical engineering

### Unit summary

This unit is about the geotechnical conditions which effect the design of load bearing foundations and earth retaining structures. It also includes geotechnical engineering involved in the conservation, preservation and protection of existing structures.

### Aims

The unit aims to develop understanding of the behaviour of soils and rock and the interaction between the ground and any structures founded on it.

### Prerequisites

None.

### Learning outcomes

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

- Create and interpret simple engineering geological models in plan and cross section
- Analyse soils and rock and undertake ground investigations
- Undertake soil analysis techniques
- Investigate stress states in natural and man made situations
- Determine appropriate foundations and earth retaining structures

### 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.

## **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
- 2.1.1 Determine the production requirements of engineering products and processes
- 2.1.2 Specify production methods and procedures to achieve production requirements
- 2.1.3 Obtain the resources to implement the production methods and procedures
- 2.1.4 Schedule production activities to implement the production methods and procedures
- 2.2.2 Solve production problems with engineering solutions
- 2.3.1 Monitor the production process
- 2.3.2 Evaluate the production process
- 4.1.1 Determine the operational requirements of engineering products or processes
- 4.1.2 Specify operational methods and procedures to achieve operational requirements
- 4.3.2 Evaluate operational processes
- 6.1.1 Analyse the risks arising from engineering products and processes
- 6.1.2 Specify methods and procedures to reduce risks
- 7.1.1 Develop objectives for projects
- 7.2.3 Evaluate projects
- 8.1.1 Maintain and develop own engineering expertise

## **Unit 213**

## **Geotechnical engineering**

### Outcome 1

Create and interpret simple engineering geological models in plan and cross section

#### **Knowledge requirements**

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

- 1 read and interpret a geological map including
  - a constructing structure contours (strike lines)
  - b drawing the position of outcrops and intersections of strata with proposed engineering works
  - c drawing cross sections depicting geological sequence and structure
  - d identify geotechnical settings and the modes of failure to which they might give rise
- 2 classify aquifers and predict the behaviour of ground water in excavations
  - a confined aquifer (water table or phreatic surface)
  - b unconfined aquifer (piezometric surface, artesian conditions)

## Unit 213

## Geotechnical engineering

### Outcome 2

Analyse soils and rock and undertake ground investigations

#### Knowledge requirements

##### The candidate knows how to:

- 1 assess the features of rocks as an engineering material
  - a types of rock
  - b constituents of various rocks
  - c classification
  - d folds and faults
- 2 review the engineering behaviour of principle rock types
- 3 undertake testing methods appropriate to rock types
- 4 analyse rock masses
  - a description
  - b classification
  - c behaviour
- 5 undertake rock masses mapping
- 6 implement discontinuity analysis
  - a translational failures
  - b toppling failures
  - c rotational failures
- 7 analyse rock anchoring designs
- 8 describe the principle methods of excavations in rock
- 9 analyse rock support systems during excavations
- 10 undertake site and ground investigations
  - a planning procedures
  - b methods
  - c producing reports

## Unit 213

## Geotechnical engineering

### Outcome 3

### Undertake soil analysis techniques

#### Knowledge requirements

#### The candidate knows how to:

- 1 describe and classify soils
  - a physical properties
  - b phase relations
  - c index properties
  - d particle size distributions
  - e mineralogy
- 2 analyse total and effective stress concepts
- 3 investigate the strength and deformation characteristics of soils
  - a triaxial tests
  - b Mohr-Coulomb analysis
  - c stress path analysis
  - d stiffness at small strain
- 4 conduct stress analysis within a soil mass and determine pressure distribution due to foundation loads
- 5 assess the effect of settlement on stress distribution
- 6 analyse the settlement of granular soils
- 7 investigate the settlement of clays
  - a immediate
  - b consolidation
  - c secondary settlement
- 8 investigate the rates of settlement of clays
- 9 investigate the effects of vertical drains on settlement

## Unit 213

## Geotechnical engineering

### Outcome 4

Investigate stress states in natural and man made situations

#### Knowledge requirements

##### The candidate knows how to:

- 1 analyse lateral earth pressures and stress states in natural and man made situations
  - a banks
  - b retaining walls
  - c piling
- 2 analyse the effects of pore water pressures and uniform surcharges
- 3 design soil retaining walls
- 4 assess the effectiveness cantilever and anchored sheet pile walls
- 5 assess the effectiveness of ground anchors
- 6 use graphical and mathematical techniques to solve problems involving water flow in soils
- 7 investigate soil compressibility
  - a fundamentals consolidation
  - b normal and over-consolidated soils
  - c pre-consolidation pressure
  - d primary and secondary consolidation
- 8 solve consolidation settlement problems using calculations
- 9 conduct soil tests
  - a laboratory
  - b insitu
- 10 investigate soil slopes
  - a principle concept
  - b methods of analysis
  - c effects of water

## Unit 213

## Geotechnical engineering

### Outcome 5

Determine appropriate foundations and earth retaining structures

#### Knowledge requirements

##### The candidate knows how to:

- 1 determine the bearing capacity of foundations
  - a shallow
  - b deep
- 2 determine foundation types
  - a pads
  - b rafts
  - c buoyant
  - d basements
  - e piled
  - f strip
- 3 determine ultimate and allowable bearing capacities of types of foundations
- 4 analyse the problems associated with foundation deformation and its effect on building
- 5 undertake foundation geotechnical analysis
- 6 determine necessary ground treatments
  - a drainage and dewatering
  - b exclusion techniques
  - c soil stabilisation/modification
  - d cement and lime stabilisation
  - e reinforcement
  - f geotextiles
- 7 determine field application and equipment for ground treatments
- 8 assess the need for grout and grouting of rocks and soils
- 9 understand the environmental aspects of geotechnical processes

## Unit 213 Geotechnical engineering

### Recommended reading list

<b>Core texts</b>	<b>Author(s)</b>	<b>Publisher</b>	<b>ISBN</b>
Foundation Analysis and Design	Bowles	McGraw Hill	0079122477
Principles of Foundation Engineering	Das	PWS	0534954030
Soil Mechanics Principles and Practice	Barnes	Palgrave	033377776X
A Geology for Engineers	Blyth, De Freitas	Butterworth-Heinemann	0713128828
Engineering Properties of Soils and Rocks	Bell	Blackwell Science	0632052058
Engineering Rock Mass Classifications	Bieniawski	John Wiley	0471601721
Geology for Civil Engineers	McLean, Gribble	Spon Press	0419160000
Introduction to Rock Mechanics	Goodman	John Wiley	0471812005
Foundations of Engineering Geology	Waltham	Blackie	0751400718 o/p
Hemispherical Projection Methods in Rock Mechanics	Priest	Allen and Unwin	0046220070 o/p
An Introduction to the Mechanics of Soils and Foundations	Atkinson	McGraw Hill	007707713X
<b>Other useful texts</b>			
Elements of Soil Mechanics	Smith, Smith	Blackwell Science	0632041269
Foundation Design and Construction	Tomlinson	Longman HE	058222697X
Foundations on Rock	Wyllie	Routledge	0419232109
Principles of Geotechnical Engineering	Das	PWS	0534981569
Rock Slope Engineering	Hoek, Barry	Spon Press	0419160108
A Short Course in Foundation Engineering	Menzies, Simons	Thomas Telford Ltd	0727727516
Design Methodology in Rock Engineering	Bieniawski	AA Balkema, Netherlands	9054101210