

## Unit 214

## Engineering surveying

### Unit summary

This unit is about the fundamental survey techniques required for civil engineering applications including roads, railways and tunnels.

### Aims

The unit aims to develop understanding and techniques of modern surveying procedures and to appreciate the importance of “setting out” in construction.

### 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:

- Apply uncertainty and quality assessment
- Carry out survey methods
- Manage data
- Apply survey methods to industrial applications

### 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.

#### WO4.1

Develop a strategy for using skills in working with others over an extended period of time.

#### WO4.2

Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in taking a leading role in managing at least **one** complex group activity.

#### WO4.3

Evaluate your overall strategy and present the outcomes from your work in at least **one** group situation.

### **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
- 4.1.1 Determine the operational requirements of engineering products or processes
- 4.2.2 Solve operational problems with engineering solutions
- 4.3.2 Evaluate operational processes
- 6.1.1 Analyse the risks arising from engineering products and processes
- 6.2.1 Assure the quality of engineering products or processes
- 6.2.2 Identify the reasons for quality assurance problems
- 6.2.3 Implement improvements to the quality of engineering products or processes
- 7.1.1 Develop objectives for projects
- 7.2.3 Evaluate projects
- 8.1.1 Maintain and develop own engineering expertise

## Unit 214

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### Outcome 1

### Apply uncertainty and quality assessment

#### Knowledge requirements

#### The candidate knows how to:

- 1 explain the meaning and purpose of engineering surveying
- 2 take measurements and understand the principles of measurement
- 3 recognise errors in measurement
- 4 undertake surveys
- 5 establish precision and accuracy limits
- 6 eliminate mistakes and systematic errors in measurement
- 7 recognise random errors and understand the general laws of probability
- 8 weight and adjust measurements

**Unit 214**  
Outcome 2

**Engineering surveying**  
Carry out survey methods

**Knowledge requirements**

**The candidate knows how to:**

- 1 measure angles using a theodolite
  - a set-up and adjustment
  - b measure, book, abstract and set-out
    - i horizontal angles
    - ii vertical angles
- 2 recognise errors in angular measurements
- 3 recognise the effects of miscentering on horizontal angles
- 4 choose the most suitable instrument
- 5 use electronic total station instruments
- 6 explain the fundamental principles of levelling
  - a test and adjust levelling instruments
  - b sources of error
  - c levelling techniques
  - d calculation of reduced levels
    - i rise and fall
    - ii height of collimation
  - e inverted staff readings
  - f sectional and contour levelling
  - g reciprocal levelling
  - h trigonometrical levelling
  - i earth curvature and refraction
  - j acceptable limits of errors in levelling
  - k digital levels
  - l precise levelling
- 7 measure distance by taping and electromagnetic methods
  - a fundamental Electronic Distance Measurement (EDM) theory
    - i errors
    - ii calibration
  - b correction and reduction of measured distances to National Grid distance
- 8 appraise developments in EDM
- 9 understand the principles of photogrammetry in surveying
- 10 interpolate measurements from aerial photographs
- 11 assess stereoscopic viewing and parallax

- 12 use Global Positioning Systems (GPS) in surveying
  - a user, space and control segments
  - b overviews of the applications of
    - i signals and codes
    - ii static and kinematic applications of GPS
    - iii real time and post processed solutions
- 13 appraise recent developments in GNSS engineering surveying instrumentation and techniques, including laser scanning

**Knowledge requirements**

**The candidate knows how to:**

- 1 handle data involving
  - a angles
  - b bearings
  - c co-ordinates
- 2 produce computations involving National Grid rectangular co-ordinates
- 3 define True North and Grid North
- 4 determine local scale factors, convergence of meridians and other parameters by
  - a approximations
  - b precise methods
- 5 correlate both surface and underground surveys to the National Grid
- 6 make Bowditch adjustment of traverses
- 7 appraise engineering survey networks

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### Outcome 4

### Apply survey methods to industrial applications

#### Knowledge requirements

#### The candidate knows how to:

- 1 implement dimensional control in engineering constructions by setting out horizontal, transition and vertical curves
  - a on the surface
  - b in tunnelling
- 2 select equipment for construction surveys
- 3 apply horizontal and vertical control
- 4 set out
  - a roads
  - b buildings
  - c pipelines
- 5 identify sources of error in surveys
- 6 monitor deformation and subsidence
- 7 survey tunnels
  - a direction control
  - b gyro-theodolite observations and computations
  - c laser instruments for alignment and setting out
- 8 determine areas from plan measurements by
  - a co-ordinates
  - b cross-sections
- 9 use general volume and earthwork formulae
- 10 construct and use mass-haul diagrams

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## Recommended reading list

<b>Core texts</b>	<b>Author(s)</b>	<b>Publisher</b>	<b>ISBN</b>
Surveying	Bannister, Raymond, Baker	Longman Higher Education	0582302498
Surveying for Engineers	Uren, Price	Palgrave	0333577051
Engineering Surveying: Theory and Examination problems for Students	Schofield	Butterworth- Heinemann	0750649879
<b>Other useful texts</b>			
Engineering Surveying Technology	Kennie, Petrie (Eds).	Blackie	0216924820
Maths for Map Makers	Allan	Whittles Publishing Services	1870325915
Surveying for Construction	Irvine	McGraw Hill	0077079981
Setting -Out Procedures	Sadgrove		0408028378 o/p