

Level 4 Diploma in Civil Engineering (9209-03)

March 2015 Version 1.4

QUALIFICATION HANDBOOK



Qualification at a glance

Subject area	Engineering
City & Guilds number	9209-03
Age group approved	18+
Entry requirements	N/A
Assessment	<ul style="list-style-type: none"> Externally set, internally marked assignments Dated written papers
Fast track	N/A
Support materials	<ul style="list-style-type: none"> Qualification handbook Assessment pack Sample assignments Online tutor and learner support material
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	City & Guilds number	Accreditation number
Level 4 Diploma in Civil Engineering	9209-03	601/5535/8

Version and date	Change detail	Section
V1.1 Oct 2014	Test specifications added. Grading information added.	4 Assessment 5 Grade profile
V1.2 Dec 2014	Range amended (units 442, 444 & 447), and assessment criteria reworded (unit 447)	6 Units
V1.3 Jan 2015	UAN numbers and QAN added.	1 Introduction (Structure) and 6 Units
V1.4 March 2015	Minor amendment to assessment strategy regarding sample questions	4 Assessment



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1 Introduction

This document tells you what you need to do to deliver the qualification:

Area	Description
Who is the qualification for?	It for learners who work or want to work as Civil Engineers in the Engineering sector
What opportunities for progression are there?	It allows learners to progress into employment or to the following City & Guilds qualifications: <ul style="list-style-type: none">• Level 5 Advanced Technician Diploma in Civil Engineering

Structure

To achieve the **Level 4 Diploma in Civil Engineering** learners must achieve the **five** mandatory units plus a minimum of **three** optional units. Learners may chose the elective unit but this will not count towards the optional units.

City & Guilds unit number/UAN	Unit title	Unit Level	GLH	NLH
Mandatory units				
Unit 439 R/506/9181	Applied Mathematics for Civil Engineering	4	60	150
Unit 440 Y/506/9182	Site Surveying	4	60	150
Unit 441 D/506/9183	Structural Mechanics	4	60	150
Unit 442 H/506/9248	Geotechnics and Soil Mechanics	4	60	150
Unit 443 K/506/9249	Materials for Civil Engineering	4	60	150
Optional units				
Unit 444 D/506/9250	Hydraulics in Civil Engineering	4	60	150
Unit 445 H/506/9251	Highway Engineering	4	60	150
Unit 446 K/506/9252	Communications, Manual Drafting and CAD for Engineers	4	60	150
Unit 447 M/506/9253	Civil Engineering Construction Techniques	4	60	150
Elective unit				
Unit 422 A/506/9305	Personal and Professional Development	4	25	100

2 Centre requirements

Approval

If there is no fast track approval for this qualification, existing centres who wish to offer this qualification must use the **standard** Qualification Approval Process.

Resource requirements

Physical resources and site agreements

The equipment, systems and machinery must meet industrial standards and be capable of being used under normal working conditions.

Centre staffing

Staff delivering this qualification must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the areas for which they are delivering training and experience of providing training. This knowledge must be to the same level as the training being delivered
- Trainers must hold or be working towards a recognised training qualification.
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Centre staff may undertake more than one role, eg tutor and assessor or internal quality assurer, but cannot internally verify their own assessments.

Assessors and Internal Quality Assurer

Assessors

Although not specifically required for this qualification, City & Guilds recommends that Assessors hold, or are working towards, the relevant Level 3 TAQA qualification, covering the assessment types required for this qualification. Further information about the City & Guilds TAQA qualification can be found at **www.cityandguilds.com**. Assessors must be able to demonstrate clear experience in assessing learning and understand City & Guilds' quality assurance requirements. They must also have the required industry certification and experience as outlined above.

Internal Verifiers / Internal Quality Assurers

Although not specifically required for this qualification, City & Guilds recommends that Internal Verifiers / Internal Quality Assurers hold, or are working towards, the Level 4 TAQA qualification. Further information about the City & Guilds TAQA qualification can be found at

www.cityandguilds.com. Internal Verifiers / Internal Quality Assurers must be able to demonstrate clear experience in quality assurance processes and understand City & Guilds' specific quality assurance requirements. They must also have the required industry certification and experience as outlined above.

Continuing professional development (CPD)

Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification is in line with best practice, and that it takes account of any national or legislative developments.

Learner entry requirements

City & Guilds recommends that learners have completed a suitable engineering related qualification at level 3 or above prior to enrolling on the course.

Without evidence of formal qualifications, learners must demonstrate adequate prior knowledge and experience to ensure they have the potential to gain the qualification.

Age restrictions

City & Guilds cannot accept any registrations for learners under 18.



3 Delivering the qualification

Initial assessment and induction

An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs,
- support and guidance they may need when working towards their qualification.
- any units they have already completed, or credit they have accumulated which is relevant to the qualification.
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the learner fully understands the requirements of the qualification, their responsibilities as a learner, and the responsibilities of the centre. This information can be recorded on a learning contract.

Support materials

The following resources are available for this qualification:

Description	How to access
Sample exam questions	www.cityandguilds.com
Assignment guide	www.cityandguilds.com
Sample schemes of work	www.smartscreen.co.uk
Further reading /links	www.cityandguilds.com
Equipment lists	www.cityandguilds.com
Recognition lists	www.cityandguilds.com



4 Assessment

City & Guilds has written the following assessments to use with this qualification:

Unit	Title	Assessment method	Where to obtain assessment materials
422	Personal and Professional Development	Assignment set by City & Guilds, internally marked, externally verified	www.cityandguilds.com
439	Applied Mathematics for Civil Engineering	Dated entry written exam paper	Question papers ordered via Walled Garden
440	Site Surveying	Assignment set by City & Guilds, internally marked, externally verified Assignment	www.cityandguilds.com
441	Structural Mechanics	Dated entry written exam paper	Question papers ordered via Walled Garden
442	Geotechnics and Soil Mechanics	Dated entry written exam paper	Question papers ordered via Walled Garden
443	Materials for Civil Engineering	Dated entry written exam paper	Question papers ordered via Walled Garden
444	Hydraulics in Civil Engineering	Dated entry written exam paper	Question papers ordered via Walled Garden
445	Highway Engineering	Dated entry written exam paper	Question papers ordered via Walled Garden

Unit	Title	Assessment method	Where to obtain assessment materials
446	Communications, Manual Drafting and CAD for Engineers	Assignment set by City & Guilds, internally marked, externally verified Assignment	www.cityandguilds.com
447	Civil Engineering Construction Techniques	Dated entry written exam paper	Question papers ordered via Walled Garden

Test specifications

The way the knowledge is covered by each test is laid out in the tables below:

Test 1: Unit 439 Applied Mathematics for Civil Engineering
Duration: 3 hours
Grading: Pass/Merit/Distinction

Outcome	Number of marks	%
1 Be able to use algebraic methods to analyse and solve civil engineering problems	20	20
2 Be able to solve civil engineering problems using trigonometry	25	25
3 Be able to use differential and integral calculus to solve civil engineering problems	25	25
4 Be able to use statistical concepts to describe data	20	20
5 Be able to apply probability techniques to solve civil engineering problems	10	10
Total	100	100

Test 2: Unit 441 Structural Mechanics
Duration: 3 hours
Grading: Pass/Merit/Distinction

Outcome	Number of marks	%
1 be able to determine reactions and forces, bending moments, shear forces and deflections	40	40
2 be able to design simple beams and columns	30	30
3 be able to calculate pressures and factors of safety on retaining walls	30	30
Total	100	100

Test 3: Unit 442 Geotechnics and Soil Mechanics
Duration: 3 hours
Grading: Pass/Merit/Distinction

Outcome	Number of marks	%
1 Understand common rock types, their formation and use	20	20
2 Understand the properties of soil	40	40
3 Be able to analyse the shear strength of soils and the mechanics of cohesion	20	20
4 Understand the basic principles of soil compaction and consolidation	20	20
Total	100	100

Test 4: Unit 443 Materials for Civil Engineering
Duration: 2 hours
Grading: Pass/Merit/Distinction

Outcome	Number of marks	%
1 Know the materials used in civil engineering	20	20
2 Understand how the physical properties of civil engineering materials affect their use	40	40
3 Understand how civil engineering materials are protected from deterioration and failure in use	40	40
Total	100	100

Test 5: Unit 444 Hydraulics for Civil Engineering
Duration: 3 hours
Grading: Pass/Merit/Distinction

Outcome	Number of marks	%
1 Understand static and dynamic fluids	20	20
2 Understand the principles of fluid flow in pipes and channels	20	20
3 Be able to design pipe networks	45	45
4 Understand the characteristics of pumps	15	15
Total	100	100

Test 6: Unit 445 Highway Engineering
Duration: 3 hours
Grading: Pass/Merit/Distinction

Outcome	Number of marks	%
1 Be able to design the alignment of a highway	30	30
2 Understand the principles of pavement design	30	30
3 Understand the principles of highway lighting	20	20
4 Understand the principles of highway drainage	20	20
Total	100	100

Test 7: Unit 447 Civil Engineering Construction Techniques
Duration: 3 hours
Grading: Pass/Merit/Distinction

Outcome	Number of marks	%
1 Understand the techniques and resources used to construct earthworks	25	25
2 Understand the techniques used to construct substructures	20	20
3 Understand the techniques used to construct superstructures	30	30
4 Understand the techniques used to construct infrastructure	25	25
Total	100	100

Time constraints

The following time constraints must be applied to the assessments of this qualification:

- each assignment has suggested durations ; please refer to the individual assignments and to the Assessor Guidance. Centre staff should guide learners to ensure excessive evidence gathering is avoided. Centres finding that assignments are taking longer, should contact the External Quality Assurer for guidance
- all assignments must be completed and assessed within the learner's period of registration. Centres should advise learners of any internal timescales for the completion and marking of individual assignments
- all dated entry written exam papers must be sat within the learner's period of registration.

Assessment strategy

City & Guilds provide sample questions for each unit assessed by dated entry written exam paper.

The purpose of these sample questions is to provide examples of the type of question that will be set, giving an indication of the breadth and depth of knowledge that is expected. It should be noted that these are sample questions and **not** a full sample question paper.

Dated entry examinations will take place in June and December, with the first exam series in June 2015.

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification.

RPL is not allowed for this qualification.

5 Grade profile

Purpose and use of this qualification grade profile

City & Guilds has taken the decision to grade the individual assessments included in this qualification, and provide a grade associated with each unit. This decision is based on market research with employers and colleges that suggests grading can be of use both as a motivational tool within the learning environment, and also to learners presenting evidence of their skills to prospective employers.

For this reason, the tasks have been developed to extend learners beyond the minimum required for Pass. As a basis for developing the tasks and their related grading criteria, City & Guilds consulted a number of stakeholders to discover what the grades at each level should mean in practice, and how they might be used. The following descriptors are based on that consultation.

The descriptors were used in the development of the task grading criteria and should be used by assessors to understand the intended outcomes of the grading.

They should be referred to during the centre's standardising exercises in addition to the specific grading criteria for the unit to support a consistent understanding of the standard across units, centres and assessors. The grades achieved by a learner would be considered by universities for subsequent entry into the correct year of a degree programme.

Levels

Level 4

The Level 4 Diplomas in Civil Engineering focus on advanced engineering. The learners will have the potential to fulfil a role within Engineering that requires a high level of responsibility, for example within first level management, requiring the use of personal initiative and critical judgement.

Holders of these qualifications may also be able to advance into the second year of a selected university engineering degree programme.

Level 5

The Level 5 Diplomas in Civil Engineering focus on advanced engineering. The learner will have the potential to fulfil a role within Engineering that requires a high level of responsibility, for example leading to middle management and/or project management, requiring the use of personal initiative and critical judgement.

Holders of these qualifications may also be able to advance into the third year of a selected university engineering degree programme.

To take this qualification a learner must first achieve the 9209 Level 4 Diploma in Civil Engineering.

Delivery of learning

Learning is delivered by approved colleges and training providers in simulated learning environments, not in the workplace. Learners will however have access to real work environments in which to further develop the breadth of their skills and their experience.

Grading

The majority of tasks are graded Pass / Merit / Distinction. Pass reflects the minimum requirements that are expressed in the unit, with Merit and Distinction showing progression in skills and knowledge as well as recognising behaviours important to the industry.

	Pass	Merit	Distinction
Level 4	<p>Learner: Capable of making informed decisions, likely to have achieved a grade at Level 3 (Merit / Distinction), starting to have sufficient skills to bring value to the industry, is becoming comfortable with occupational systems and procedures.</p> <p>Evidence: Complex tasks may present some challenge, partial attempt at assessment, well defined tasks completed with a level of guidance, able to follow the required process, acceptable skills / knowledge / competence displayed for the industry, can plan, can solve problems.</p> <p>Limited reflection on the outcomes of the task.</p>	<p>Learner: Broader understanding of systems and procedures, can work with minimal guidance, determination to resolve issues, taking ownership and responsibility for own learning, desire to progress.</p> <p>Evidence: Full attempt at assessment, well defined tasks completed with minimal guidance, able to follow the required process, higher level skills / knowledge / competence displayed for the industry, can plan, can solve problems more effectively and confidently.</p> <p>Sufficient reflection on the outcomes of the task.</p>	<p>Learner: High level of understanding and evaluation of overall systems and procedures, showing potential to achieve a higher level of academic study. Has an ability to carry out tasks without guidance and shows own initiative.</p> <p>Evidence: Full achievement of assessment completely independently, within the time given, ie efficient use of time.</p> <p>Detailed / in-depth reflection on the outcomes of the task with recommendations for improvement / alternatives.</p>

	Pass	Merit	Distinction
Level 5	<p>Learner: Capable of making informed decisions, likely to have achieved a grade at Level 4 (Merit / Distinction), has sufficient skills to bring value to the industry, is fairly comfortable with occupational systems and procedures.</p> <p>Evidence: Complex tasks may present some challenge, but most assessments attempted, well defined tasks completed with a level of guidance, able to follow the required process, acceptable skills / knowledge / competence displayed for the industry, can plan, can solve problems. Satisfactory reflection on the outcomes of the task.</p>	<p>Learner: Full understanding of systems and procedures, can work with minimal to no guidance, determination to resolve issues, taking ownership and responsibility for own learning, desire to excel.</p> <p>Evidence: Full attempt at assessment, well defined tasks completed with minimal guidance, able to follow the required process, higher level skills / knowledge / competence displayed for the industry, can plan, can solve problems more effectively and confidently. Good reflection on the outcomes of the task.</p>	<p>Learner: High level of understanding, evaluation and competence in overall systems and procedures, clearly achieving a higher level of academic study. Has an ability to carry out tasks without guidance and shows own initiative.</p> <p>Evidence: Full achievement of assessment completely independently, within the time given, ie efficient use of time. Detailed / in-depth reflection on the outcomes of the task with recommendations for improvement / alternatives.</p>



6 Units

Structure of units

These units each have the following:

- City & Guilds reference number
- title
- level
- guided learning hours
- notional learning hours
- unit aim
- information on assessment
- learning outcomes which are comprised of a number of assessment criteria
- notes for guidance.

Unit 422

Personal and Professional Development

Level:	4
UAN:	A/506/9305
GLH:	25
Assessment method:	Assignment
Aim:	The purpose of this unit is to enable learners to develop an understanding of the different methods and resources available to them for planning their personal and professional development.

They will learn how to identify factors that may affect targets or goals, prioritise actions and understand how feedback from others can be utilised to aid their development and career progression. They will be able to develop a plan which can either be used during progress of a course of study or as a tool in their future careers.

Learning outcome
The learner will: 1. understand how to plan for personal and professional development
Assessment criteria
The learner can: 1.1 describe the benefits of personal and professional development 1.2 identify development opportunities for career and personal progression 1.3 analyse development opportunities that may support career and personal progression.

Range
<p>Benefits</p> <p>personal - update skills, gain new skills, increase motivation, confidence</p> <p>professional - career progression, meeting organisation goals, how role fits into organisation</p> <p>Development opportunities</p> <ul style="list-style-type: none"> • internal and external • skills: inter-personal, enterprise, self-management and leadership • knowledge: qualifications

Learning outcome
The learner will:
2. understand how people learn
Assessment criteria
The learner can:
2.1 explain the principles of how people learn
2.2 describe different learning styles
2.3 evaluate learning resources to support development
2.4 analyse the use of different learning strategies .

Range
<p>Principles</p> <p>relevant theories, methodologies, pedagogies, codes of ethics</p> <p>Learning styles</p> <p>visual, aural, physical, logical, social, solitary</p> <p>Learning resources</p> <p>libraries; organisation's resources, IT, internet, progress files, portfolio development</p> <p>Learning strategies</p> <p>awareness of personal style e.g. activist, pragmatist, theorist, reflector, interactions with others, taking responsibility for own development, effective time-management, structured reflection</p>

Learning outcome
The learner will:
3. be able to produce personal and professional development plans
Assessment criteria
The learner can:
3.1 carry out self-audit of skills and experience
3.2 identify targets for personal and professional development
3.3 use methods to track personal development
3.4 create a personal and professional development plan.

Range
<p>Self-audit personal reflections, feedback from others; skills scan; revisiting job role</p> <p>Targets SMART target setting, responding to feedback, realigning targets, addressing strengths and weaknesses</p> <p>Methods task manager, blog, project management tools, diaries, performance review/plan, objectives, monitoring, reflecting and planning</p>

Learning outcome
The learner will: 4. be able to make recommendations for personal and professional development
Assessment criteria
The learner can: 4.1 explain the benefits of reflective practice 4.2 evaluate progress against development plan 4.3 recommend opportunities for further development.

Range
<p>Benefits extent to which targets have been met/not met, recognise any changes in expectations; suggest further support required, identify barriers to progress</p> <p>Progress the learner should regularly identify progress against original plan and refine plan accordingly</p>

Level:	4
UAN:	R/506/9181
GLH:	60
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to enable learners to develop an understanding of a range of mathematical operations and analysis techniques that are required to solve engineering problems.

On completion of this unit, learners will be able to:

- apply algebraic methods to analyse and solve civil engineering problems
- apply trigonometric methods of analysis to solve civil engineering problems
- apply differential and integral calculus methods to solve civil engineering problems
- apply statistical techniques to solve civil engineering problems
- apply probability techniques to solve civil engineering problems

Learning outcome
The learner will: 1. be able to use algebraic methods to analyse and solve civil engineering problems
Assessment criteria
The learner can 1.1 evaluate basic algebraic functions 1.2 solve engineering problems that are described by algebraic equations, exponential and logarithmic functions.

Range
<p>Basic algebraic functions algebraic functions (graph of a function, inverse of a function, odd and even functions, linear functions, gradient of a linear function, points of intersection); common engineering functions (polynomial, rational, modulus, unit step, unit impulse); use of symbols; indices (positive and negative); laws of indices; algebraic formulae (transposition, factorisation, evaluation of algebraic fractions)</p> <p>Algebraic equations, exponential and logarithmic functions linear equations; quadratic equations; polynomial equations; simultaneous equations; solving inequalities; partial fractions</p> <p>Exponential and logarithmic functions laws of logarithms; solving exponential and logarithmic equations</p>

Learning outcome
The learner will: 2. be able to solve civil engineering problems using trigonometry
Assessment criteria
The learner can: 2.1 evaluate basic trigonometric functions 2.2 solve problems using trigonometric identities 2.3 solve problems using vector analysis .

Range
<p>Basic trigonometric functions angles; sine; cosine; tangent; secant; cosecant; cotangent of an angle; inverse functions; \sin^{-1}; \cos^{-1}; \tan^{-1}; trigonometric functions and their graphs; amplitude; frequency; phase and period of a sine or cosine function</p> <p>Trigonometric identities compound and double angle formulae for sine and cosine; 'sums to product' and 'product to sums' formulae; solve trigonometric equations; application to resolution and resultant of forces</p> <p>Vector analysis scalar and vector quantities; scalar and vector product of two vectors; angle between two vectors; static forces, frameworks</p>

Learning outcome
The learner will: 3. be able to use differential and integral calculus to solve civil engineering problems
Assessment criteria
The learner can: 3.1 determine first and higher order derivatives of functions 3.2 use differential calculus to solve problems 3.3 determine indefinite and definite integrals of algebraic and trigonometric functions and differential equations 3.4 use integral calculus to solve problems.

Range
<p>Functions algebraic, trigonometric, logarithmic</p> <p>Differential calculus product rule; quotient rule; chain rule; implicit and logarithmic differentiation; maximum and minimum values of a function; points of inflection</p> <p>Intergrals integration as the reverse of differentiation; indefinite integrals; table of integrals for common functions (constant, ax^n ($n \neq -1$), $1/x$, $\sin(ax \pm b)$, $\cos(ax \pm b)$, $e(ax \pm b)$), definite integrals; integration methods: integration by parts, by substitution, by using partial fractions; integration of trigonometric functions and differential equations.</p> <p>Integral calculus applications of integration to areas; volumes of revolution; centres of mass; moments of inertia; mean value and root-mean-square (rms) values.</p>

Learning outcome
The learner will: 4. be able to use statistical concepts to describe data
Assessment criteria
The learner can: 4.1 present data in appropriate forms 4.2 apply statistics to describe data.

Range
<p>Forms data presentation: bar charts, tally charts, line diagrams, histograms, cumulative frequency diagrams, scatter plots</p> <p>Statistics concept of central tendency to include mean, median and mode; dispersion to include standard deviation, variance, interquartile range of grouped data, normal distribution.</p>

Learning outcome
The learner will: 5. be able to apply probability techniques to solve civil engineering problems
Assessment criteria
The learner can: 5.1 use probability to solve problems.

Range
<p>Probability empirical probability, mutually exclusive and non-exclusive events, conditional probability, discrete probability distribution, permutations and combinations, general binomial distribution, normal distribution</p>

Level:	4
UAN:	Y/506/9182
GLH:	60
Assessment method:	Assignment
Aim:	The purpose of this unit is to enable learners to develop an understanding of the principles of site surveying and the production of drawings and the skills to use site surveying instruments.

In addition, learners will also gain an understanding of the procedures used to set out civil engineering works alongside an appreciation of the use surveying instruments.

Learning outcome
The learner will: 1. know how to use linear surveying equipment to produce drawings to scale
Assessment criteria
The learner can: 1.1 define linear surveying terminology 1.2 describe the equipment used to complete linear surveys.

Range
Linear surveying terminology chainage, running measurements, offsets, tie lines, check lines, sloping ground measurements, linear measurements around obstructions, triangulation, trilateration, grid, intersection
Equipment tapes, bands, ranging poles, chains, Electronic Distance Measurement (EDM)

Learning outcome
The learner will: 2. be able to use linear surveying equipment to produce drawings to scale
Assessment criteria
The learner can: 2.1 perform linear surveys 2.2 produce plan drawings from practical linear surveys.

Range
Plan drawings to scale, standard conventions, manually drafted or by Computer-Aided Design (CAD)

Learning outcome
The learner will: 3. know how to use levelling instruments
Assessment criteria
The learner can: 3.1 define levelling surveying terminology 3.2 describe equipment used to complete a level survey 3.3 explain accuracy checks for levelling surveys.

Range
Levelling surveying terminology back sight, fore sight, intermediate sight, datum, Ordnance Bench Mark (OBM), Temporary Bench Mark (TBM), height of collimation, rise and fall, flying levels
Equipment automatic levels, tilting levels, rotating lasers
Accuracy checks for common errors, relationship between scale of plan and measurement accuracy, temporary and permanent adjustments

Learning outcome
The learner will: 4. be able to use levelling equipment
Assessment criteria
The learner can: 4.1 complete levelling surveys using booking methods 4.2 produce section drawings from completed levelling surveys.

Range
Booking methods height of collimation or rise and fall methods
Section drawings longitudinal section and cross sections

Learning outcome
The learner will: 5. know how to use angular measuring instruments
Assessment criteria
The learner can: 5.1 define angular surveying terminology 5.2 describe equipment used to perform angular measurements 5.3 explain the errors which can occur when recording angles 5.4 explain how errors may be reduced to improve the accuracy of recorded angular measurements.

Range
Terminology azimuth, zenith angles, Whole Circle Bearing(WCB), horizontal angle, angles of elevation and depression
Equipment Theodolites, total station, data loggers, Electronic Distance Measurement (EDM)
Errors common errors, principles of good intersection of lines of sight, increasing distance and link to angular error
How errors may be reduced error analysis and least square method, Bowditch method of correction of closure error in a traverse

Learning outcome
The learner will: 6. be able to use angular measuring instruments
Assessment criteria
The learner can: 6.1 measure horizontal angles 6.2 calculate height and distances from recorded angular measurements using trigonometry.
Range
Measure face left, face right booking procedure to record angles
Measurements Pythagoras theorem, sine rule; cosine rule

Learning outcome

The learner will:

7. understand the principles of setting out construction projects

Assessment criteria

The learner can:

7.1 describe the **procedures used to set out a domestic building**

7.2 describe the **procedures used to set sight rails, and gradients**

7.3 describe the procedures used to set out and level foundations.

Range**Procedures used to set out a domestic building**

3:4:5 triangles, checking diagonals, corner profiles

Procedures used to set sight rails, and gradients

transfer of datum, set out pegs, sight rails

Level:	4
UAN:	D/506/9183
GLH:	60
Assessment method:	Dated written paper
Aim:	This unit enables learners to develop an understanding of the analysis of beams, columns, frameworks and retaining walls structural concepts and develop skills to determine properties of typical structure materials.

Learning outcome
The learner will: 1. be able to determine reactions and forces, bending moments shear forces and deflections
Assessment criteria
The learner can: 1.1 calculate reactions, shear force and bending moment values for various loadings on beams 1.2 draw diagrams for various loadings 1.3 calculate deflections at mid-span for simply supported beams 1.4 draw associated shear force and bending moment diagrams for a three element pin-jointed frame 1.5 determine the magnitude and type of forces in frameworks using a range of methods and loading conditions.

Range
Beams simply supported beams with/without overhangs, cantilevers
Diagrams shear force, bending moment
Loadings point, uniformly distributed, combination of loads
Range of methods graphical (Bow's notation), method of sections (frame cutting, equilibrium of part frame), method of resolution (joint equilibrium)

Learning outcome
The learner will: 2. be able to design simple beams and columns
Assessment criteria
The learner can: 2.1 calculate first and second moments of area of sections of sections 2.2 determine the size of rectangular beam sections 2.3 determine the section sizes for axially loaded columns .

Range
Sections rectangular, circular, trapezoidal, compound shapes Beam sections rectangular, T, I and channel Beam steel, timber, concrete Columns Type: short/long columns, section (solid, rectangular, H section, circular) Columns steel, timber, concrete

Learning outcome
The learner will: 3. be able to calculate pressures and factors of safety on retaining walls
Assessment criteria
The learner can: 3.1 calculate the pressure on retaining walls 3.2 determine factors of safety against sliding and overturning 3.3 calculate the stress conditions at the toe and heel of a retaining wall.

Range
Pressure from retained soils and liquids Walls types - mass (rectangular and trapezoidal)

Unit 442

Geotechnics and Soil Mechanics

Level:	4
UAN:	H/506/9248
GLH:	60
Assessment method:	Dated written paper
Aim:	This unit enables learners to develop an understanding of common rock types and their use in civil engineering. Learners will analyse the properties and characteristics of different types of soil using standard tests, and apply the knowledge and understanding obtained to the design of earthworks, excavations and foundations.

Learning outcome
The learner will: 1. understand common rock types, their formation and use
Assessment criteria
The learner can: 1.1 describe the classification of rock types 1.2 describe common rock forming minerals including their mode of formation 1.3 describe features of geological maps 1.4 explain the structural implications of geological maps in foundation design.

Range
Rock igneous (granite, basalt, dolerite, andersite, gabbro, rhyolite, syenite), sedimentary (limestone, sandstone, mudstone, shale, conglomerate), metamorphic (slate, schist)
Minerals (rock forming) quartz, mica, feldspars, calcite
Features bedding, dip, strike, cline, fold, faults, slip, settlement, drift
Structural implications difficulty of excavation, fragmentation

Learning outcome
The learner will: 2. understand the properties of soil
Assessment criteria
The learner can: 2.1 describe soil classification methods 2.2 explain soil properties 2.3 describe the nature of drained and undrained soil stresses 2.4 describe the movement of water through soils 2.5 describe methods of site investigation 2.6 explain the mechanics of soil friction and cohesion 2.7 describe how to determine the shear strength of soils using tests 2.8 explain the shear strength of soils.

Range
Soil classification methods particle size analysis, consistency limits, plasticity indices Soil properties dry, bulk, saturated and submerged densities, void ratio, porosity, moisture content, liquid limit, degree of saturation, permeability, specific gravity Soil stresses pressure (total, effective, neutral), definitions and calculations for Movement of water soil permeability, hydraulic gradient Methods trial pits, hand auger, rotary boring, percussion rig boring Tests shear box, triaxial compression Explain importance of shear strength, Mohr's circles, shear failure for various soil types, shear strength envelope, shear testing with different drainage conditions

Learning outcome
The learner will: 3. be able to analyse the shear strength of soils and the mechanics of cohesion
Assessment criteria
The learner can: 3.1 establish basic engineering properties of soils using either primary or secondary data 3.2 determine total stress 3.3 calculate stresses .

Range
<p>Properties of soil dry, bulk, saturated and submerged densities, void ratio, porosity, moisture content, liquid limit, degree of saturation, permeability, specific gravity</p> <p>Total stress effective stress, and hydrostatic pore pressure for ground conditions</p> <p>Stresses incline planes, general two dimensional systems, direct/shear stress on any plane, principal plane/ stresses, maximum shear stress</p>

Learning outcome
The learner will: 4. understand the basic principles of soil compaction and consolidation
Assessment criteria
The learner can: 4.1 compare soil compaction and consolidation 4.2 explain the basic principles of soil consolidation 4.3 describe the nature of lateral pressure which can exist within a soil mass 4.4 determine the pressure on retaining walls due to liquid and active earth pressure 4.5 calculate factors of safety of retaining walls.

Range
<p>Lateral pressure Rankine theory of pressures, Coulomb wedge theory, methods of calculating lateral forces on a structure, influence of ground water.</p>

Level:	4
UAN:	K/506/9249
GLH:	60
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to enable learners to develop an understanding of the materials used in civil engineering, their properties and uses, the causes of failure of such materials and the methods used to prevent failure.

Learning outcome
The learner will: 1. know the materials used in civil engineering
Assessment criteria
The learner can: 1.1 identify the materials used in civil engineering 1.2 describe how civil engineering materials are manufactured from naturally-occurring raw ingredients 1.3 describe the tests performed on civil engineering materials.

Range
Materials Metals, timber, concrete, polymers, bricks and blocks
Raw ingredients Metallic ores; clay, limestone/chalk, aggregates; oil; clay or sand/lime
Tests Strength (compressive, tensile, shear, flexural), moisture content, workability

Learning outcome
The learner will: 2. understand how the physical properties of civil engineering materials affect their use
Assessment criteria
The learner can: 2.1 describe the physical properties of civil engineering materials 2.2 explain how the properties of civil engineering materials affect their use .

Range
<p>Physical properties strength, elasticity, porosity, water absorption, thermal movement, moisture movement, durability, workability, density</p> <p>Use resistance to loads, water and other forms of chemical and physical degradation' durability, ease of installation, relative costs, implications for sustainability and the environment</p>

Learning outcome
<p>The learner will: 3. understand how civil engineering materials are protected from deterioration and failure in use</p>
Assessment criteria
<p>The learner can: 3.1 explain the mechanisms by which civil engineering materials deteriorate and fail in use 3.2 justify the methods used to protect civil engineering materials.</p>

Range
<p>Mechanisms over-loading, corrosion, fatigue, creep, fungal and insect attack, sulphate attack, ultra-violet (UV) attack, efflorescence</p> <p>methods selection of resistant materials; appropriate design solutions for the exclusion of water, treatment of materials including preservation of timber, use of sulphur-resistant cement in concrete and anti-corrosion measures for metals</p>

Level:	4
UAN:	D/506/9250
GLH:	60
Assessment method:	Dated written paper
Aim:	The aim of this unit is to develop the learner's understanding of the concepts, theory and application of hydraulics and establish their relevance in civil engineering.

This unit will enable learners to demonstrate and explore key hydraulics phenomena and investigate the design of pipe networks, the characteristics of flow in open channels and the types and operation of pumps.

Learning outcome
The learner will: 1. understand static and dynamic fluids
Assessment criteria
The learner can: 1.1 describe the properties of fluids 1.2 explain how pressure acts on submerged bodies in fluids 1.3 determine centres of pressure 1.4 explain buoyancy and stability of floating bodies.

Range
Properties of fluids density, viscosity, surface tension, compressibility, hydrostatic pressure, static pressure and head, pressure at a point
Pressure hydrostatic vertical pressure distribution, pressures at equal depth, pressure at a point, forces acting at boundaries
Centres of pressure immersed planes (inclined and vertical)
Buoyancy and stability metacentric height, centre of gravity, Archimedes' Principle

Learning outcome
The learner will: 2. understand the principles of fluid flow in pipes and channels
Assessment criteria
The learner can: 2.1 explain the continuity equation and Bernoulli's energy equations 2.2 explain the principles of momentum 2.3 explain flow measurement methods in pipes and channels 2.4 explain the characteristics of open channel flow.

Range
Flow measurement methods orifice plates, venture meters, venturi flumes, weirs, pitot tubes
Characteristics types of flow, steady, uniform and varied, gradually varied flow, rise in bed level, flow resistance

Learning outcome
The learner will: 3. be able to design pipe networks
Assessment criteria
The learner can: 3.1 carry out risk assessments 3.2 mitigate risks before carrying out experiments 3.3 determine losses in pipelines 3.4 design pipe networks 3.5 perform calculations relating to flow in open channels .

Range
Losses in pipelines major losses (energy) and minor losses (others)
Design D'Arcy-Weisbach theory, Moody diagrams, pie design charts
Flow in open channels Velocity and discharge calculations, rectangular and trapezoidal channels, normal and critical depths, D'Arcy, Chezy and Manning equations, functions of weirs

Learning outcome
The learner will: 4. understand the characteristics of pumps
Assessment criteria
The learner can: 4.1 describe types of pumps 4.2 explain the performance curves of pumps 4.3 explain the operation of pumps .

Range
Types of pumps rotodynamic and hydrostatic pumps, pumps in parallel and in series
Operation of pumps pump resistance, pump choice

Level:	4
UAN:	H/506/9251
GLH:	60
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to enable learners to develop an understanding of the key issues considered in designing highways. Learners will be able to design the alignment of highways that are safe and which take into account lighting and drainage requirements.

Learning outcome
The learner will: 1. be able to design the alignment of a highway
Assessment criteria
The learner can: 1.1 determine the visibility requirements for a highway 1.2 design the vertical alignment of a highway to relevant national standards to ensure safety 1.3 design the horizontal alignment of highway sections to relevant national standards to ensure safety.

Range
Visibility Stopping Sight Distance; Full Overtaking Sight Distance
Vertical alignment radii and curve lengths for sag and crest curves; visibility checks
Horizontal alignment radii of circular curves including superelevated curves; transition curves; visibility checks; offsets

Learning outcome
The learner will: 2. understand the principles of pavement design
Assessment criteria
The learner can: 2.1 explain the functions of pavement layers 2.2 explain the importance of ground conditions on pavement design 2.3 compare pavement types 2.4 explain the effect of design traffic on pavement design.

Range
<p>Functions skid resistance; smooth running surface; distribution of loads to lower layers and subgrade; drainage</p> <p>Pavement types jointed Reinforced Concrete Pavements, Continuously Reinforced Concrete Pavements/Roadbases; Flexible; Flexible Composite Pavements</p> <p>Design traffic loading of standard axles over lifespan of the pavement</p>

Learning outcome
The learner will:
3. understand the principles of highway lighting
Assessment criteria
The learner can:
3.1 explain methods of discerning hazards and features on highways
3.2 describe the purpose of highway lighting
3.3 describe the factors determining the shape and size of a bright patch
3.4 compare different street lighting arrangements .

Range
<p>Methods Silhouette, reverse silhouette</p> <p>Purpose distinguish hazards; enable highway alignment to be perceived; improved safety</p> <p>Factors mounting height, lamp type, lantern type, pavement surface, weather conditions</p> <p>Arrangements single sided, staggered, opposite, high mast, span wire</p>

Learning outcome
The learner will:
4. understand the principles of highway drainage
Assessment criteria
The learner can:
4.1 describe drainage systems
4.2 explain the factors that influence how pipe diameter and gradients are selected.

Range
<p>Drainage systems French/filter drains; positive drainage; open drainage</p> <p>Factors: storm intensity; return period</p>

Unit 446

Communications, Manual Drafting and CAD for Engineers

Level:	4
UAN:	K/506/9252
GLH:	60
Assessment method:	Assignment
Aim:	This unit has two purposes. The first is to enable learners to develop an understanding of the methods used to communicate in civil engineering. This includes verbal and written communication methods (including presentational techniques) and the interpretation of civil engineering drawings, schedules and specifications. There is a strong emphasis on the correct use of technical language, grammar, spelling and punctuation. The second purpose is to develop an understanding of Computer Aided Design and Building Information Modelling (BIM) in civil engineering projects. Learners will be able to draw detailed scaled civil engineering structures using CAD.

Learning outcome
The learner will: 1. understand the range of communication methods used in civil engineering
Assessment criteria
The learner can: 1.1 describe standard forms of contract 1.2 explain the purpose of information sources used in civil engineering 1.3 interpret civil engineering information from graphical sources .

Range
<p>Information sources manuals, contracts, specifications, design standards</p> <p>Graphical sources sketches, working drawings, component drawings, maps, Global Positioning System (GPS), Geographic Information System (GIS), specifications</p>

Learning outcome
The learner will: 2. understand how to communicate effectively in the workplace
Assessment criteria
The learner can: 2.1 explain the importance of interpersonal and communication skills in the optimisation of performance 2.2 evaluate the effectiveness of feedback when developing communication skills 2.3 assess methods of communication appropriate to different audiences.

Range
<p>Interpersonal and communication skills written; verbal; visual; outcomes; key points; intonations; accuracy; urgency; level of importance; adaptation; audience; barriers; achieved purpose; formality; variety of situations</p> <p>Effectiveness of feedback analysis of formal and informal feedback; reflection</p> <p>Methods of communication written; verbal; visual; format; layout; presentation; objectives; discussion; adaptation</p>

Learning outcome
The learner will: 3 be able to communicate in civil engineering
Assessment criteria
The learner can: 3.1 use effective speaking and listening skills in a civil engineering context 3.2 produce written documents to an acceptable standard .

Range
Context meetings, interviews, presentations, team discussions, telephone conversations
Written documents paper and electronic: reports, business letters, minutes of meetings, method statements, notices, presentations
Acceptable standard clear and accurate use of technical language, grammar, spelling, punctuation

Learning outcome
The learner will: 4. be able to hand draw structures
Assessment criteria
The learner can: 4.1 sketch technical, scaled drawings of civil engineering structures in different projections 4.2 produce title blocks 4.3 sketch cross sections of structures 4.4 sketch detailed structural components .

Range
Structures site plans; buildings; roads; bridges
Projections isometric; first and third angle orthographic; single and multiple point perspective
Title blocks to include: drawing title, drawing number, scale, units and notes
Components steel reinforced concrete, I beams, floor slabs, beam and column joints, girders, foundations

Learning outcome
The learner will: 5. be able to produce technical drawings using CAD
Assessment criteria
The learner can: 5.1 sketch civil engineering structures in two dimensions 5.2 produce drawings using coordinate systems 5.3 create different line types 5.4 create layers for complex drawings 5.5 apply standard drawing tools 5.6 create and apply blocks 5.7 produce scaled pages with multiple viewports.

Range
Drawing tools line, polyline, circle, trim, extend, copy, offset, hatch, explode, mirror

Level:	4
UAN:	M/506/9253
GLH:	60
Assessment method:	Dated written paper
Aim:	The purpose of this unit is to enable learners to develop an understanding of the technology and resources associated with civil engineering projects including earthworks, substructures, superstructure and infrastructure.

Learning outcome
The learner will: 1. understand the techniques and resources used to construct earthworks
Assessment criteria
The learner can: 1.1 describe the techniques and resources used in earthworks 1.2 explain the techniques used to control groundwater 1.3 compare the earthmoving equipment used in earthworks 1.4 explain health and safety best practice to be followed when constructing earthworks.

Range
Earthworks deep excavation, trenching works, stabilising ground, formation of slopes, cuttings and embankments
Techniques sumps, wells, deep filters, wellpoints, electro-osmosis, French drains, ground freezing
Equipment excavators, bulldozers, scrapers, tractor shovels, graders, transport vehicles
Health and safety best practice risk assessments, method statements, compliance with relevant legislation (Health and Safety at Work Act, Management of Health and Safety at Work Regulations, Construction Design and Management Regulations)

Learning outcome
The learner will: 2. understand the techniques used to construct substructures
Assessment criteria
The learner can: 2.1 describe the techniques and resources used in substructure work 2.2 explain the factors that affect the selection of suitable foundations 2.3 explain health and safety best practice to be followed when constructing substructures.

Range
Resources vehicles, plant, equipment
Substructure work piling, stabilising ground, foundations, drainage, public utilities, culverts, underpasses
Factors soil characteristics, water table, design loads, disposition of loads
Health and safety best practice risk assessments, method statements, compliance with relevant legislation (Health and Safety at Work Act, Management of Health and Safety at Work Regulations, Construction Design and Management Regulations)

Learning outcome
The learner will: 3. understand the techniques used to construct superstructures
Assessment criteria
The learner can: 3.1 describe the techniques and resources used in superstructure work 3.2 explain how construction techniques influence the design of a structural framed building 3.3 explain health and safety best practice to be followed when constructing superstructures.

Range
Resources vehicles, plant, equipment
Superstructure work bridges, retaining walls, steel and concrete framed buildings
Construction techniques Composite construction, pre-cast concrete, in-situ concrete, structural steel
Design Rectangular grid spacing, beams along grid lines, beam depth to span ratio, floor to ceiling heights, structural floors to limit deflection

Health and safety best practice
risk assessments, method statements, compliance with relevant legislation; Health and Safety at Work Act, Management of Health and Safety at Work Regulations, Construction Design and Management Regulations)

Learning outcome

The learner will:
4. understand the techniques used to construct infrastructure

Assessment criteria

The learner can:
4.1 describe the techniques and **resources** used in **infrastructure work**
4.2 explain the construction of **surface drainage** of roads
4.3 explain **health and safety best practice** to be followed when constructing infrastructure.

Range

Resources
vehicles, plant, equipment
Infrastructure work
roads, rigid and flexible pavements, railways, ancillary works
Surface drainage
soakaways, filter drains, surface water channels, kerbs and gullies
Health and safety best practice
risk assessments, method statements, compliance with relevant legislation(Health and Safety at Work Act, Management of Health and Safety at Work Regulations, Construction Design and Management Regulations)



Appendix 1 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centres and Training Providers homepage** on **www.cityandguilds.com**.

Centre Guide – Delivering International Qualifications contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve ‘approved centre’ status, or to offer a particular qualification. Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

Useful contacts

UK learners General qualification information	T: +44 (0)844 543 0033 E: learnersupport@cityandguilds.com
International learners General qualification information	T: +44 (0)844 543 0033 F: +44 (0)20 7294 2413 E: intcg@cityandguilds.com
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: centresupport@cityandguilds.com
Single subject qualifications Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 F: +44 (0)20 7294 2404 (BB forms) E: singlesubjects@cityandguilds.com
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: intops@cityandguilds.com
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: walledgarden@cityandguilds.com
Employer Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 E: business@cityandguilds.com
Publications Logbooks, Centre documents, Forms, Free literature	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413

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