



City & Guilds Level 2 Certificate in Engineering (2850-20-27)

Version 2.7 (March 2026)

Qualification Handbook

Qualification at a glance

Subject area	4.1 Engineering
City & Guilds number	2850
Age group approved	All ages
Entry requirements	N/A
Assessment	Multiple Choice Examination, Written Examination/ Practical Demonstration/Assignment
Grading	Pass/Fail
Approvals	Full approval required
Support materials	Assignment guide, Assignments, Sample question papers Smartscreen
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	City & Guilds qualification number	Regulatory reference number	GLH	TQT
City & Guilds Level 2 Certificate in Engineering – Manufacturing Technology	2850-20	600/0880/5	300	350
City & Guilds Level 2 Certificate in Engineering – Maintenance Technology	2850-21		300	350
City & Guilds Level 2 Certificate in Engineering – Fabrication and Welding Technology	2850-22		300	350
City & Guilds Level 2 Certificate in Engineering – Electrical and Electronics Technology	2850-23		300	350
City & Guilds Level 2 Diploma in Engineering – Manufacturing Technology	2850-24	600/0881/7	360	420
City & Guilds Level 2 Diploma in Engineering – Maintenance Technology	2850-25		360	420
City & Guilds Level 2 Diploma in Engineering – Fabrication and Welding Technology	2850-26		360	420
City & Guilds Level 2 Diploma in Engineering – Electrical and Electronics Technology	2850-27		360	420

Version and date	Change detail	Section
1.2 Jan 2013	Amend Test Specification (Unit 201)	Assessment
1.3 Jun 2013	Add unit 231 to units and update structure	About this document Units
1.4 November 2014	Amend range in Outcomes 1.01, 1.02, 2.02, 3.01 Amend Additional Information in Outcome 2 & 3	Unit 203
	Amend range in Outcomes 2.02, 2.5, 2.6, 3.4 Amend Additional Information in Outcome 1	Unit 208
	Amend range in Outcomes 2.1, 3.6 Amend Additional Information in Outcome 3, 4	Unit 212
	Amend range in Outcomes 2.1, 2.2, 3.6, 3.7 Moved Additional Information in Outcome 2 to the Range	Unit 221
2.1 October 2017	Added TQT and GLH details	Qualification Structure
	Deleted QCF	Throughout
2.2 March 2022	GLH and TQT clarified and highlighted	Qualification Structure
2.3 December 2023	Reference to Apprenticeship Frameworks in England removed	About this document
2.4 April 2024	Update of Quality Assurance Statement	Centre Requirements
2.5 January 2025	Handbook transferred to latest version of the template. The section on Quality Assurance has been updated and sections on Inclusion and diversity, and Sustainability have been added	All
2.6 July 2025	Amended learning outcome titles	All units
2.7 March 2026	Clarified grading in test specification to Pass/Merit/Distinction	Units 201 and 202

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Unit 214	Welding by MIG process	85
Unit 215	Welding by TIG process	90
Unit 216	Welding by Oxy-Acetylene process	95
Unit 217	Fabricating sheet metalwork	100
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1 Introduction

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

Area	Description
Who are these qualifications for	These awards are designed to contribute towards the knowledge and understanding for the NVQ Diploma in Engineering Maintenance (City & Guilds 1788), NVQ Diploma in Mechanical Manufacturing Engineering (City & Guilds 1712) and NVQ Diploma in Fabrication and Welding (City & Guilds
What do these qualifications cover?	These qualifications are designed to contribute towards the knowledge and understanding for the NVQ Diploma in Engineering Maintenance (City & Guilds 1788), NVQ Diploma in Mechanical Manufacturing Engineering (City & Guilds 1712) and NVQ Diploma in Fabrication and Welding (City & Guilds
What opportunities for progression are there?	The qualifications provide knowledge and practical skills related to the Level 2 NVQ Diploma in Engineering Maintenance, Level 2 NVQ Diploma in Mechanical Manufacturing Engineering and Level 2 NVQ Diploma in Fabrication and Welding.
Who did we develop the qualifications with?	The units in the qualifications are endorsed by SEMTA
Is it part of an apprenticeship framework or initiative?	N/A

Structure

To achieve a full **Level 2 Certificate in Engineering**, candidates must achieve 5 units with a total credit value of **35 credits** including:

Mandatory units (14 credits)	Unit 201 Working in engineering (7 credits) Unit 202 Principles of engineering technology (7 credits)
Plus 7 credits from their chosen pathway eg:	Unit 203 Principles of manufacturing technology (7 credits) Unit 208 Principles of maintenance technology (7 credits) Unit 212 Principles of fabrication and welding technology (7 credits) Unit 221 Principles of electrical and electronics technology (7 credits)
Of the final 14 credits	7 credits (one unit) must relate to their chosen technology, plus 7 credits (one unit) from a 'free choice' option that may or may not be from their chosen pathway

To achieve a full **Level 2 Diploma in Engineering**, candidates must achieve 6 units with a total credit value of **42 credits** including:

Mandatory units (14 credits)	Unit 201 Working in engineering (7 credits) Unit 202 Principles of engineering technology (7 credits)
Plus 7 credits from their chosen pathway eg:	Unit 203 Principles of manufacturing technology (7 credits) Unit 208 Principles of maintenance technology (7 credits) Unit 212 Principles of fabrication and welding technology (7 credits) Unit 221 Principles of electrical and electronics technology (7 credits)
Of the final 21 credits	7 credits (one unit) must relate to their chosen technology pathway, plus 14 credits (two units) from a 'free choice' option that may or may not be from their chosen pathway.

Level 2 Certificate in Engineering Rules of Combination

Pathway	Mandatory units 21 credits	Technology option 7 credits	Free option 7 credits
Level 2 Certificate in Engineering – Manufacturing Technology	201 202 203	204-207	204-207, 209-211, 213-220, 222 -224
Level 2 Certificate in Engineering – Maintenance Technology	201 202 208	209-211, 222	204-207, 209-211, 213-220, 222 -224
Level 2 Certificate in Engineering – Fabrication and Welding Technology	201 202 212	213-220, 231	204-207, 209-211, 213-220, 222 -224, 231
Level 2 Certificate in Engineering – Electrical and Electronics Technology	201 202 221	211, 222-224	204-207, 209-211, 213-220, 222 -224

Level 2 Diploma in Engineering Rules of Combination

Pathway	Mandatory units 21 credits	Technology option 7 credits	Free option 14 credits
Level 2 Diploma in Engineering – Manufacturing Technology	201 202 203	204-207	204-207, 209-211, 213-220, 222 -224
Level 2 Diploma in Engineering – Maintenance Technology	201 202 208	209-211, 222	204-207, 209-211, 213-220, 222 -224
Level 2 Diploma in Engineering – Fabrication and Welding Technology	201 202 212	213-220, 231	204-207, 209-211, 213-220, 222 -224, 231
Level 2 Diploma in Engineering – Electrical and Electronics Technology	201 202 221	211, 222-224	204-207, 209-211, 213-220, 222 -224

City & Guilds unit number	Title	Unit number	Credit value	GLH	Level
2850 - 201	Working in engineering	H/503/0174	7	60	2
2850 - 202	Principles of engineering technology	R/503/0204	7	60	2
2850 - 203	Principles of manufacturing technology	K/503/0175	7	60	2
2850 - 204	Machine components using milling techniques	Y/503/0205	7	60	2
2850 - 205	Machine components using turning techniques	M/503/0176	7	60	2
2850 - 206	Using bench fitting techniques	T/503/0177	7	60	2
2850 - 207	Using Computer Aided Manufacturing processes	D/503/0206	7	60	2
2850 - 208	Principles of maintenance technology	D/503/0187	7	60	2

2850 - 209	Assembling and maintaining fluid power systems	H/503/0188	7	60	2
2850 - 210	Maintenance of mechanical devices and equipment	K/503/0189	7	60	2
2850 - 211	Maintaining electrical wiring support systems	D/503/0190	7	60	2
2850 - 212	Principles of fabrication and welding technology	H/503/0191	7	60	2
2850 - 213	Welding by Manual Metal Arc process	K/503/0192	7	60	2
2850 - 214	Welding by MIG process	M/503/0193	7	60	2
2850 - 215	Welding by TIG process	T/503/0194	7	60	2
2850 - 216	Welding by Oxy-Acetylene process	A/503/0195	7	60	2
2850 - 217	Fabricating sheet metalwork	F/503/0196	7	60	2
2850 - 218	Fabricating thick plate, bar and sections	J/503/0197	7	60	2
2850 - 219	Fabricating pipework assemblies	L/503/0198	7	60	2
2850 - 220	Fabricating steel work assemblies	R/503/0199	7	60	2
2850 - 221	Principles of electrical and electronics technology	A/503/0200	7	60	2
2850 - 222	Maintaining electrical equipment and systems	F/503/0201	7	60	2
2850 - 223	Wiring and testing electrical circuits	J/503/0202	7	60	2
2850 - 224	Constructing, testing and fault finding electronic circuits	L/503/0203	7	60	2

2850 - 231	Pattern development for plate and sheet metalwork	K/505/2726	7	56	2
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Total Qualification Time (TQT)

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected for a learner to demonstrate the achievement of the level of attainment necessary for the award of a qualification.

TQT consists of the following two elements:

- 1) the number of hours that an awarding organisation has assigned to a qualification for guided learning
- 2) an estimate of the number of hours a learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike guided learning, not under the immediate guidance or supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.

Title and level	GLH	TQT
City & Guilds Level 2 Certificate in Engineering – Manufacturing Technology	300	350
City & Guilds Level 2 Certificate in Engineering – Maintenance Technology	300	350
City & Guilds Level 2 Certificate in Engineering – Fabrication and Welding Technology	300	350
City & Guilds Level 2 Certificate in Engineering – Electrical and Electronics Technology	300	350
City & Guilds Level 2 Diploma in Engineering – Manufacturing Technology	360	420
City & Guilds Level 2 Diploma in Engineering – Maintenance Technology	360	420
City & Guilds Level 2 Diploma in Engineering – Fabrication and Welding Technology	360	420
City & Guilds Level 2 Diploma in Engineering – Electrical and Electronics Technology	360	420

2 Centre requirements

Approval

Full approval

To offer this qualification, new centres will need to gain both centre and qualification approval. Please refer to the document **Centre Approval Process: Quality Assurance Standards** for further information.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

Resource requirements

Centre staffing

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

- be occupationally competent or technically knowledgeable in the area(s) for which they are delivering training and/or have experience of providing training (this knowledge must be to the same level as the training being delivered)
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Continuing professional development (CPD)

Centres are expected to support their staff in ensuring that their knowledge remains current of the occupational area and of best practice in delivery, mentoring, training, assessment and quality assurance, and that it takes account of any national or legislative developments.

Quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance. All external quality assurance processes reflect the minimum requirements for verified and moderated assessments, as detailed in the Centre Assessment Standards Scrutiny (CASS), section H2 of Ofqual's General Conditions. For more information on both CASS and City & Guilds Quality Assurance processes visit: the [What is CASS?](#) and [Quality Assurance Standards](#) documents on the City & Guilds website.

Standards and rigorous quality assurance are maintained by the use of:

- Internal quality assurance
- City & Guilds external quality assurance.

In order to carry out the quality assurance role, Internal Quality Assurers must

- have appropriate teaching and vocational knowledge and expertise
- have experience in quality management/internal quality assurance
- hold or be working towards an appropriate teaching/training/assessing qualification
- be familiar with the occupation and technical content covered within the qualification.

External quality assurance for the qualification will be provided by City & Guilds EQA process. EQAs are appointed by City & Guilds to approve centres, and to monitor the assessment and internal quality assurance carried out by centres. External quality assurance is carried out to ensure that assessment is valid and reliable, and that there is good assessment practice in centres.

The role of the EQA is to:

- provide advice and support to centre staff
- ensure the quality and consistency of assessments and marking/grading within and between centres by the use of systematic sampling
- provide feedback to centres and to City & Guilds.

Learner entry requirements

City & Guilds does not set entry requirements for these qualifications. However, centres must ensure that candidates have the potential and opportunity to gain the qualification successfully.

The nature of both the learning and assessment required for the qualification is such that learners will need basic literacy and numeracy skills: i.e. the ability to read and interpret written tasks and to write answers in a legible and understandable form in the English language. Learners will also need to be able to organise written information clearly and coherently, although they will not be assessed for spelling or grammatical accuracy unless this is part of the assessment criteria.

Age restrictions

There is no age restriction for this qualification unless this is a legal requirement of the process or the environment.

Access arrangements and reasonable adjustments

City & Guilds has considered the design of this qualification and its assessments in order to best support accessibility and inclusion for all learners. We understand however that individuals have diverse learning needs and may require reasonable adjustments to fully participate. Reasonable adjustments, such as additional time or alternative formats, may be provided to accommodate learners with disabilities and support fair access to assessment.

Access arrangements are adjustments that allow candidates with disabilities, special educational needs, and temporary injuries to access the assessment and demonstrate their skills and knowledge without changing the demands of the assessment. These arrangements must be made before assessment takes place.

The Equality Act 2010 requires City & Guilds to make reasonable adjustments where a disabled person would be at a substantial disadvantage in undertaking an assessment.

It is the responsibility of the centre to ensure at the start of a programme of learning that candidates will be able to access the requirements of the qualification.

Please refer to the JCQ access arrangements and reasonable adjustments and Access arrangements - when and how applications need to be made to City & Guilds for more information. Both are available on the **[City & Guilds website](#)**

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.

Inclusion and diversity

City & Guilds is committed to improving inclusion and diversity within the way we work and how we deliver our purpose which is to help people and organisations develop the skills they need for growth.

More information and guidance to support centres in supporting inclusion and diversity through the delivery of City & Guilds qualifications can be found here:

[Inclusion and diversity | City & Guilds \(cityandguilds.com\)](https://www.cityandguilds.com)

Sustainability

City & Guilds are committed to net zero. Our ambition is to reduce our carbon emissions by at least 50% before 2030 and develop environmentally responsible operations to achieve net zero by 2040 or sooner if we can. City & Guilds is committed to supporting qualifications that support our customers to consider sustainability and their environmental footprint.

More information and guidance to support centres in developing sustainable practices through the delivery of City & Guilds qualifications can be found here:

[Our Pathway to Net Zero | City & Guilds \(cityandguilds.com\)](https://www.cityandguilds.com)

Centres should consider their own carbon footprint when delivering this qualification and consider reasonable and practical ways of delivering this qualification with sustainability in mind. This could include:

- reviewing purchasing and procurement processes (such as buying in bulk to reduce the amount of travel time and energy, considering and investing in the use of components that can be reused, instead of the use of disposable or single use consumables)
- reusing components wherever possible
- waste procedures (ensuring that waste is minimised, recycling of components is in place wherever possible)

- minimising water use and considering options for reuse/salvage as part of plumbing activities wherever possible.

Support materials

The following resources are available for this qualification:

Description	How to access
Assignment guide for centres	www.cityandguilds.com
Assignments (203-to 224)	www.cityandguilds.com
Sample question paper (101)	www.cityandguilds.com
SmartScreen	www.smartscreen.co.uk

4 Assessment

Assessment of the qualification

Candidates must:

- successfully complete 1 multiple choice assessment for each mandatory unit
- successfully complete 1 short answer paper for each 'principles of ' unit
- successfully complete 1 assignment for each chosen optional unit

City & Guilds provides the following assessments:

Unit	Title	Assessment method	Where to obtain assessment materials
2850 - 201	Working in engineering	Online multiple-choice assessment The assessment covers all of the outcomes.	www.walled-garden.com
2850-202	Principles of engineering technology	Online multiple-choice assessment The assessment covers all of the outcomes.	www.walled-garden.com
2850-203	Principles of manufacturing technology	Assignment 2850-203 The assessment includes short answer questions to verify coverage of the underpinning knowledge in the unit. City & Guilds devised assignment, internally marked, externally verified.	www.cityandguilds.com
2850-204	Machine components using milling techniques	Assignment 2850-204 The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. City & Guilds devised assignment, internally marked, externally verified.	www.cityandguilds.com
2850-205	Machine components using turning techniques	Assignment 2850-205 The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.	www.cityandguilds.com

Unit	Title	Assessment method	Where to obtain assessment materials
		City & Guilds devised assignment, internally marked, externally verified.	
2850-206	Using bench fitting techniques	<p>Assignment 2850-206</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-207	Using Computer Aided Manufacturing processes	<p>Assignment 2850-207</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-208	Principles of maintenance technology	<p>Assignment 2850-208</p> <p>The assessment includes short answer questions to verify coverage of the underpinning knowledge in the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-209	Assembling and maintaining fluid power systems	<p>Assignment 2850-209</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-210	Maintenance of mechanical devices and equipment	<p>Assignment 2850-210</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-211	Maintain electrical wiring support systems	<p>Assignment 2850-211</p> <p>The assessment covers the practical activities for all outcomes and will also</p>	www.cityandguilds.com

Unit	Title	Assessment method	Where to obtain assessment materials
		sample underpinning knowledge to verify coverage of the unit. City & Guilds devised assignment, internally marked, externally verified.	
2850-212	Principles of fabrication and welding technology	Assignment 2850-212 The assessment includes short answer questions to verify coverage of the underpinning knowledge in the unit. City & Guilds devised assignment, internally marked, externally verified.	www.cityandguilds.com
2850-213	Welding by Manual Metal Arc process	Assignment 2850-213 The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. City & Guilds devised assignment, internally marked, externally verified.	www.cityandguilds.com
2850-214	Welding by MIG process	Assignment 2850-214 The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. City & Guilds devised assignment, internally marked, externally verified.	www.cityandguilds.com
2850-215	Welding by TIG process	Assignment 2850-215 The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. City & Guilds devised assignment, internally marked, externally verified.	www.cityandguilds.com
2850-216	Welding by Oxy-Acetylene process	Assignment 2850-216 The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. City & Guilds devised assignment, internally marked, externally verified.	www.cityandguilds.com

Unit	Title	Assessment method	Where to obtain assessment materials
2850-217	Fabricating sheet metalwork	<p>Assignment 2850-217</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-218	Fabricating thick plate, bar and sections	<p>Assignment 2850-218</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-219	Fabricating pipework assemblies	<p>Assignment 2850-219</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-220	Fabricating steel work assemblies	<p>Assignment 2850-220</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-221	Principles of electrical and electronics technology	<p>Assignment 2850-221</p> <p>The assessment includes short answer questions to verify coverage of the underpinning knowledge in the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-222	Maintaining electrical equipment and systems	<p>Assignment 2850-222</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p>	www.cityandguilds.com

Unit	Title	Assessment method	Where to obtain assessment materials
		City & Guilds devised assignment, internally marked, externally verified.	
2850-223	Wiring and testing electrical circuits	<p>Assignment 2850-223</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-224	Constructing, testing and fault finding electronic circuits	<p>Assignment 2850-224</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com
2850-231	Pattern development for plate and sheet metalwork	<p>Assignment 2850-231</p> <p>The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.</p> <p>City & Guilds devised assignment, internally marked, externally verified.</p>	www.cityandguilds.com

Assessment strategy

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

- live assignments for the optional units that can be downloaded from the City & Guilds website
- sample question papers for the mandatory unit downloaded from the City & Guilds website.

Assignments (one per unit) assess practical activities. City & Guilds provides an assignment for assessors which contains all information required.

As assignments are designed to sample practical activities, it is essential that the centres ensure that candidates cover the content of the whole unit.

Assessment components are graded (Pass, Merit, Distinction). A pass is the achievement level required for the knowledge and understanding and generally represents the ability to follow instructions and procedures. Merit and distinction represent increasing levels of ability to adapt to changing circumstances and to independently resolve problems

Time constraints

The following must be applied to the assessment of this qualification:

Each assignment has specific time constraints; please refer to the individual assignments.

Centre staff should guide candidates to ensure excessive evidence gathering is avoided.

Centres finding that assignments are taking longer, should contact the external verifier for guidance

All assignments must be completed and assessed within the candidate's period of registration.

Centres should advise candidates of any internal timescales for the completion and marking of individual assignments.

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 allowed and is not sector-specific.

Test specifications

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

Graded: Pass/Merit/Distinction

Test: 2850-201	Duration: 60 minutes			
Unit	Outcome	Number of questions	Percentage %	
201	1. Know engineering health and safety requirements	17	42.5	
	2. Know effective methods of communication	8	20	
	3. Understand drawings and specification	10	25	
	4. Know about working in engineering	5	12.5	
Total		40	100%	

Graded: Pass/Merit/Distinction

Test: 2850-202	Duration: 60 minutes			
Unit	Outcome	Number of questions	Percentage %	
202	Know requirements for materials in engineering	9	22.5	
	Know properties of engineering materials	9	22.5	
	Know how to apply analytical methods to engineering mathematical applications	11	27.5	
	Know how to apply analytical methods to engineering science applications	11	27.5	
Total		40	100%	

5 Units

Structure of the units

These units each have the following:

- City & Guilds reference number
- title
- level
- guided learning hours (GLH)
- credit value
- unit aim
- assessment type
- learning outcomes, which are comprised of a number of assessment criteria
- range statements
- notes for guidance.

Guidance for delivery of the units

These qualifications comprise a number of **units**. A unit describes what is expected of a competent person in particular aspects of their job.

Each **unit** is divided into **learning outcomes** which describe in further detail the skills and knowledge that a candidate should possess.

Each **learning outcome** has a set of **assessment criteria** (performance and knowledge and understanding) which specify the desired criteria that must be satisfied before an individual can be said to have performed to the agreed standard.

Range statements define the breadth or scope of a learning outcome and its assessment criteria by setting out the various circumstances in which they are to be applied.

Unit 201

Working in engineering

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Online multiple choice assessment
UAN Number:	H/503/0174
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA.
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 1: Working Safely in an Engineering Environment, Unit 2: Working Efficiently and Effectively in Engineering, Unit 3: Using and Communicating Technical Information
Aim:	<p>This unit will encourage candidates to find out about working in engineering. It will cover the underpinning basic skills and knowledge needed to function in engineering or manufacturing sectors.</p> <p>It will cover the need to recognise and use safe working practices, consideration of the environment and working effectively as a part of a team. It includes the methods of communication that engineers use in their everyday.</p>

Learning outcomes

There are **four** learning outcomes to this unit. The learner will:

1. Know engineering health and safety requirements
2. Know effective methods of communication
3. Understand drawings and specifications
4. Know about working in engineering

Unit 201

Working in engineering

Outcome 1

Know engineering health and safety requirements

Assessment Criteria

The learner will can:

1. state **health and safety regulations** applicable to engineering operations
2. state **employers' responsibilities** to ensure health and safety in the workplace
3. state the **safe working practices** that should be adhered to in the workplace
4. name the policies and procedures used to ensure effective health and safety **implementation**
5. describe the essential health and safety requirements for the **protection of operators and bystanders**
6. state the types and classification of health and safety **signs** that are used in an engineering/manufacturing environment
7. define the **roles, responsibilities and powers** of personnel with responsibility for health and safety
8. describe the **human and environmental conditions** that lead to accidents in the workplace and the means of controlling them
9. describe how to carry out a **risk assessment** and name potential hazards which may be identified
10. define what is meant by a **dangerous occurrence**
11. describe methods of **fire** prevention and control
12. state procedures used to make a **hazardous area** safe before starting work

Range

Health and safety regulations: Health and Safety at Work etc. Act, Control of Substances Hazardous to Health Regulations, Personal Protective Equipment at Work Regulations, Reporting of Injuries, Diseases and Dangerous Occurrences Regulations, *Manual Handling Operations Regulations*, Lifting Operations and Lifting Equipment Regulations, The Control of Noise at Work Regulations

Employers' responsibilities: a safe place of work, safe plant and a safe working environment equipment, safe methods of handling, storing and transporting goods and materials, reporting of accidents, information, instruction, training and supervision of employees

Safe working practices: be alert, maintain personal hygiene, protect yourself and other people, emergency procedures, report all hazards

Implementation: safety policies, codes of practice, safe systems of work

Protection of operators and bystanders: Personal Protective Equipment (PPE), Respiratory Protective Equipment (RPE), designated safe areas, first aid treatment: location of facilities, location of qualified first aiders

Signs: warning, prohibition, mandatory, information, fire

Roles, responsibilities and powers: health and safety advisors, health and safety representatives, health and safety executive inspectors

Human and environmental conditions: causes of accidents, accident prevention measures

Risk assessments: slippery or uneven surfaces, spillages, scrap or waste material, flammable materials, faulty or missing machine guards, faulty electrical connections or

damaged cables, dust and fumes, contaminants and irritants, materials handling and transportation

Fire: conditions required for extinction, fire prevention, (fire procedures, fire drills, fire fighting equipment for different types of fires extinguishers, automatic systems, e.g. sprinklers]

Hazardous area: using barriers and/or tapes, placing warning signs in appropriate positions, informing any persons who may be affected, isolating power or pressure sources, obtaining official clearance, safety checks

Additional Guidance

Human and environmental conditions: causes of accidents (human error, lack of due care, improper behavior and dress, lack of training, lack of supervision and/or experience tiredness/fatigue, intoxication, unguarded or faulty machinery or tools, inadequate ventilation, poor housekeeping, dirty, overcrowded and badly-lit workplaces), accident prevention measures (eliminate the hazard, replace the hazard with something less dangerous, guard the hazard, personal protection, health and safety education and publicity)

Hazardous area: using barriers and/or tapes, placing warning signs in appropriate positions, informing any persons who may be affected, isolating power or pressure sources, obtaining official clearance (Permit to Work), safety checks (ensuring work area is free from hazards, any required safety procedures are implemented, any necessary Personal Protective Equipment is in a usable condition, tools and equipment are in a safe and usable condition).

Unit 201

Working in engineering

Outcome 2

Know effective methods of communication

Assessment Criteria

The learner can:

1. state the **communication systems** used in the workplace
2. state the **roles** and responsibilities of key departments and personnel within an engineering organisation
3. name a range of **sources** of engineering information
4. describe the **correct approach** to take when seeking advice and guidance and name **sources of support**
5. state the importance of maintaining good customer relationships

Range

Communication systems: verbal, written, drawings, electronic, signs

Roles: departments, finance/purchasing, manufacturing/production, quality assurance/control, inspection, despatch, maintenance, human resources, personnel, managers, engineers, supervisors, trainers, inspectors, safety officers, personnel staff, unions

Sources: BS EN standards, instruction manuals, technical handbooks, tables, charts, graphs, data sheets, textbooks, reference materials, computer based, Internet, Intranet, technical information

Correct approach: stating the problem clearly and succinctly, listening to the response attentively, seeking clarification on points not fully understood

Sources of support: mentor, trainer, supervisor

Additional Guidance

Communication systems: verbal (instruction, advice), written (instructions, work requests), drawings, electronic, signs

Sources: BS EN standards, instruction manuals, technical handbooks, tables, charts, graphs, data sheets, textbooks, reference materials, computer based, Internet, Intranet, technical information (sketches, drawings, diagrams, test and inspection reports, planning documents and schedules, design brief)

Unit 201

Working in engineering

Outcome 3

Understand drawings and specifications

Assessment Criteria

The learner can:

1. describe the purpose of technical drawings and specifications
2. interpret technical drawings using **current standards**
3. interpret the **essential information** found on drawings
4. describe the purpose of **standards** in engineering
5. describe the use of **specifications and quality systems**
6. interpret standard **conventions** used on technical drawings
7. interpret and apply other **features** associated with technical information

Range

Technical drawings and specifications: characteristics of a product, shape, size, material, features; provide additional product information, materials, manufacturing or installation data, special processes/equipment requirements

Current standards: projections: orthographic, isometric, oblique, assembly, schematic, exploded views, sketches

Essential information: projection, scale, dimensions, issue number, author, tolerances, symbols, notes, materials, batch requirements, parts list

Standards: communicates technical information/data, produced in universal language for all stakeholders, provides the basis for quality assurance

Specifications and quality systems:

Quality: assurance, quality control, inspection, quality circles

Conformance/fitness for purpose: specifications: customer requirements, reference of standards, safety requirements, quality records, traceability, corrective action procedures

Conventions: lines, hatching, symbols, views, layout

Features: detailed drawings, manufacturing process(s), product make up (number of components), sequence of operations (operations sheet), quality control requirements, storage and dispatch requirements, use of graphs, tables and charts

Unit 201

Working in engineering

Outcome 4

Know about working in engineering

Assessment Criteria

The learner can:

1. describe policies related to **employment rights** and responsibilities
2. describe how to **work effectively** within an engineering workplace
3. state the **reasons** why there may be **conflict** situations in the workplace and how to **avoid** them
4. state the roles and responsibilities of **team members**
5. describe how to **work effectively** within a team

Range

Employment rights: procedures for requesting/recording time off work for: illness, medical/dental reasons, holidays, family reasons

Work effectively:

Behaviours , observation of rules, regulations and procedures, conduct within the workplace, relationships with colleagues, supervisors and managers, respect for company property

Observing safety policies and regulations

Conduct expected: when dealing with: customers, visitors, inspectors.

Conflict:

Reasons for: difficulties or situations that can arise due to: differences of opinion, unpopular team leader decisions, working within time constraints, team member aspirations and/or ambitions, individual skill levels, team member personalities.

Avoid conflict situations by, enquiring politely, timeliness when seeking advice or assistance, avoiding conflict and knowing when to withdraw from the situation, listening carefully, following reasonable requests from supervisors, offering help when colleagues are in need of assistance.

Team members: team leaders, team members

Working effectively: personal development, participation in group discussions and decision making: suggesting solutions to problems, how to give and receive constructive criticism, when to be assertive, when to concede to individual or group pressure

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Online multiple choice assessment
UAN Number:	R/503/0204
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA.
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 1: Working Safely in an Engineering Environment, Unit 2: Working Efficiently and Effectively in Engineering, Unit 3: Using and Communicating Technical Information
Aim:	This unit is concerned with the basic principles of mathematics and science, along with the materials technology that underpin engineering applications. It covers common applied engineering calculations and materials selection in terms of types, common forms of supply, properties and methods of changing their properties.

Learning outcomes

There are **four** learning outcomes to this unit. The learner will

1. Know requirements for materials in engineering
2. Know properties of engineering materials
3. Know how to apply analytical methods to engineering mathematical applications
4. Know how to apply analytical methods to engineering science applications

Unit 202

Principles of engineering technology

Outcome 1

Know requirements for materials in engineering

Assessment Criteria

The learner can:

1. state the range of **materials** used in common engineering applications
2. state the **forms of supply** of materials
3. state how to **identify materials** by their physical properties

Range

Select materials: ferrous metals: carbon steels, stainless steels, cast iron; non-ferrous metals: aluminium and aluminium alloys, copper and copper alloys; non-metallic materials: plastics, composites, rubber

Forms of supply: bar, plate, sheet, coated sheet, pipe and tube, castings, forgings, extrusions

Identify materials: colour, appearance, density

Additional Guidance

Select materials: ferrous metals: carbon steels (low, medium, high), stainless steels (austenitic, ferritic, martensitic), cast iron; non-ferrous metals: aluminium and aluminium alloys, copper and copper alloys (brass, bronze); non-metallic materials: plastics (thermoplastic, thermosetting), composites (glass fibre, carbon fibre, aramid fibre) rubber

Forms of supply: bar (flat, round, square, hexagonal), plate, sheet, coated sheet (tin plate, galvanised, plasticized), pipe and tube, castings, forgings, extrusions

Unit 202

Principles of engineering technology

Outcome 2

Know properties of engineering materials

Assessment Criteria

The learner can:

1. state the **physical properties** of materials
2. define what is meant by **mechanical properties** of materials
3. state the **mechanical properties** of materials
4. describe methods of **modifying properties** of materials

Range

Physical properties: melting points of metals, density, colour, magnetism, corrosion resistance, conductivity, insulation

Mechanical properties: tensile strength, toughness, hardness, elasticity, ductility, malleability

Modifying properties: effects of cold working; heat treatment: annealing, normalising, hardening and tempering

Unit 202

Principles of engineering technology

Outcome 3

Know how to apply analytical methods to engineering science applications

Assessment Criteria

The learner can:

1. apply appropriate **degree of accuracy** to express numbers
2. describe tolerance in terms of limits of size
3. calculate the **areas of basic shapes**
4. calculate the areas of **compound shapes**
5. calculate the **surface areas** of regular shaped solids
6. calculate the **volumes** of regular shaped solids
7. calculate the value of **angles in a triangle**
8. apply **Pythagoras' Theorem** to right-angled triangle problems
9. interpret straight line graphs using given data
10. apply multiple prefix symbols appropriately

Range

Degree of accuracy: decimals places, significant figures, fractions as a decimal quantity

Areas of basic shapes: square, rectangle, triangle, circle

Compound shapes: involving: squares, rectangles, triangles, circles, semi-circles, quadrants of a circle

Surface areas: cube, rectangular prism, cylinder (curved surface area only)

Volumes: cube, rectangular prism, cylinder

Angles in a triangle: right-angled, isosceles, equilateral

Unit 202

Principles of engineering technology

Outcome 4

Know how to apply analytical methods to engineering science applications

Assessment Criteria

The learner can:

1. calculate the value of a **force**
2. define **work done** by a simple machine
3. calculate **power** used
4. calculate **energy** used
5. calculate the **efficiency** of a machine
6. calculate the turning **moment of a force**
7. calculate the **relative density** of engineering materials
8. apply **Ohm's law** to determine simple electrical circuit problems
9. calculate the strength of engineering materials
- 10. calculate pressure at depth**
11. apply multiple prefix symbols appropriately

Range

Force: definition, solve problems using formulae

Work done: definition, solve problems using formulae

Power: mechanical power, electrical power

Energy: mechanical energy, electrical energy

Efficiency: mechanical (power, energy), electrical (power, energy)

Moment of a force: levers, torque

Relative density: relative to water

Ohm's law: of the form $V = IR$

Strength of engineering materials: yield stress, tensile stress, percentage elongation, force/extension graph, stress/strain graph

Pressure at depth: ρgh

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Short answer question paper
UAN Number:	K/503/0175
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 65: General Machining, Fitting and Assembly Applications.
Aim:	This unit is concerned with the methods of manufacture. It includes the range of functions found in manufacturing organisations and will provide the candidate with the knowledge to plan the manufacturing production of routine engineering components by the most economic manufacturing method(s).

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Know the functions within a manufacturing organisation
2. Know how to select suitable materials and components to manufacture products
3. Know how to plan production from a given specification

Unit 203

Principles of manufacturing technology

Outcome 1

Know the functions within a manufacturing organisation

Assessment Criteria

The learner can:

1. describe the function of **departments** in the production process
2. classify the different types of manufacturing **organisations**
3. describe the different **scales of production** in manufacturing operations
4. state the differences between types of **equipment** used for manufacture

Range

Departments: design, planning, stores, purchasing, quality, maintenance, sales, manufacturing

Organisations: light, medium and heavy engineering; mechanical, automotive, tools and equipment, aerospace, electrical, electronic, plant supplies, process industries, maintenance, installation, commissioning, fabrication and welding

Scales of production: jobbing, small batch, repeated batch, mass/flow production

Equipment: general purpose, dedicated, computerised

Unit 203

Principles of manufacturing technology

Outcome 2

Know how to select suitable materials and components to manufacture products

Assessment Criteria

The learner can:

1. classify **materials** by their **properties**
2. classify the **forms of supply** of materials
3. distinguish between types of **mechanical fastenings and joining techniques**
4. describe the selection criteria for **economic production**

Range

Materials: ferrous metals non-ferrous metals, plastics, composite (carbides, oxides, borides)

Properties: plasticity, elasticity, ductility, malleability, toughness, hardness, tensile strength, compressive strength, shear strength, corrosion resistance, density

Forms of supply: sheet, wire, bar, tube, extrusion, casting, forgings, moulding, granules

Mechanical fastenings and joining techniques: non permanent, permanent

Economic production: costs , availability of materials and components, fitness for purpose, production methods

Additional Guidance

Materials: ferrous metals (low medium and high carbon, stainless steels, cast iron), non-ferrous metals (copper, aluminium, brass, bronze), plastics (thermosetting, thermoplastic). Thermosetting (acrylics, polystyrene, polyvinyl chloride (PVC), polypropylene (PP), polythene)

Mechanical fastenings and joining techniques: non permanent (nuts, bolts, studs, screws, pins, keys), permanent (welded, soldered, brazed, riveted, adhesives, compression joints)

Economic production: costs (capital, overheads, breakeven, inflation), availability of materials and components, fitness for purpose, production methods (including ease of production)

Unit 203

Principles of manufacturing technology

Outcome 3

Know how to plan production from a given specification

Assessment Criteria

The learner can

1. estimate the **production requirements** to manufacture routine components
2. describe the **information requirements** to produce components to the specification
3. estimate the production **costs** to manufacture routine components
4. illustrate production planning using a flowchart or similar

Range

Production requirements: materials, processes, production sequence quality control, tools and equipment, inspection procedures, health and safety requirements

Information requirements: detailed drawings, quantities, specifications, third party suppliers, materials, processing methods

Costs: direct, indirect costs

Additional Guidance

Costs: direct (material, direct labour, production time), indirect costs (overheads: heating, lighting, machine depreciation, scrap, rework, downtime, advertising, indirect labour, administration, security, human resources, safety, holidays, marketing)

Unit 204

Machine components using milling techniques

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	Y/503/0205
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA.
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: Unit 012 Preparing and using milling machines.
Aim:	This unit is concerned with the underlying process in setting special holding devices prior to carrying out milling operations. The candidate will be able set and operate milling machines. They will be able to select the appropriate automatic feed and cutters to achieve the desired outcome. The candidate will be able to select and set cutters for straddle milling.

Learning outcomes

There are **four** learning outcomes to this unit. The learner will:

1. Know how to plan and prepare for milling activities
2. Be able to determine requirements for milling operations
3. Be able to perform milling operations to produce parts
4. Be able to perform milling operations

Unit 204 Machine components using milling techniques

Outcome 1 Know how to plan and prepare for milling activities

Assessment Criteria

The learner can:

1. describe **health and safety precautions** specific to operating lathes
2. describe the setting of work **datum**
3. define classes of fit
4. describe the accuracy and range, of precision **measuring equipment** and gauges
5. classify types and applications of **coolants and cutting oils**
6. classify **cutting tool materials** and their application
7. define the factors that affect **cutting speeds and feeds**
8. describe methods of **mounting tools**, their position and benefits
9. describe **workholding** and setting devices

Range

Health and safety precautions: emergency stop procedures, use of guards, operating procedures, moving parts, removal of swarf

Datum: faces, centres

Classes of fit: clearance

Measuring equipment: micrometers, vernier, dial test indicator (DTI), gauges, surface finish

Coolants and cutting oils: oils, compounds, synthetic

Cutting tool materials: high speed steel (HSS), carbide tips

Cutting speeds and feeds: cutting tool material/material being cut, surface finish required, type of cutting operation, power output of the machine, use of coolant, determine spindle speeds

Mounting tools: arbor (standard, short, stub); chucks (auto lock, jacobs); collets (pull [friction] positive grip, auto-lock)

Workholding: machine vice (fixed jaw, swivel and universal), direct clamping, fixtures, angle plates, vee blocks, equipment used when setting workholding devices: squares, protractors (adjustable, vernier), dial test indicators (plunger, lever), levels

Additional information

Measuring equipment: micrometers (external, internal, depth), vernier (calliper, depth, protractor, digital), dial test indicator (DTI), gauges (plug, blocks, thread, radius/profile, bore/hole), surface finish (comparison plates), how to check that measuring equipment is within current calibration dates

Cutting tool materials: high speed steel (HSS), carbide tips (methods of holding the tip, number of cutting edges, shapes)

Unit 204 Machine components using milling techniques

Outcome 2 Be able to determine requirements for milling operations

Assessment Criteria

The learner can:

1. describe how to check milling **cutters** for appropriate operations
2. check milling **cutters** for appropriate operations
3. select and secure to machine spindle cutter holding equipment
4. describe **cutter nomenclature and cutter/workpiece movement**
5. **calculate** spindle speeds for individual cutters
6. explain the types and applications of **arbor mounted cutters**
7. explain the types and applications of **collet held cutters**

Range

Cutters: vertical mounted: end mills, slot drills, tee slot, dovetail, flycutter; mounted: side and face, staggered tooth, slitting saw, angular, slab mill, helical mill, form, shell end mills

Cutter nomenclature and cutter/workpiece movement: milling cutters, twist drills, up-cut milling, down-cut milling

Calculate: spindle speeds for different materials and cutter diameters; cutting speeds for materials to be machined (carbon steels, cast iron, aluminium alloys, brass, cutting tool material, high speed steel, carbides)

Arbor mounted cutters: side and face, cylindrical cutters (slab mill), saws, angular cutters, concave and convex cutters, radius, form cutters, fluting cutters; parts and types of arbors, stub arbors and methods of mounting (construction, mounting procedures, setting cutters, support brackets, knee braces)

Collet held cutters: end mill, slot drill, fly cutters, tee slot, woodruff key and dovetail cutters; shank styles: screwed, straight, flatted; operation and application of collet chucks (types of locking devices, ease of changeability)

Additional information

Cutters: vertical mounted: end mills (4 and 2 flute), slot drills (2 and 3 flute, bull nose), tee slot, dovetail, fly cutter; horizontal (arbour and spindle) mounted: side and face, staggered tooth, slitting saw, angular (single, double), slab mill (light duty, heavy duty), helical mill, form, shell end mills

Unit 204 Machine components using milling techniques

Outcome 3 Be able to perform milling operations to produce parts

Assessment Criteria

The learner can:

1. interpret engineering **drawings**
2. select and set **workholding devices** square and central to cutter and set adjustable angle plate to a prescribe angle
3. machine slots and angles, to within specified dimensions and **measure** accuracy to ± 0.2 mm, angular $\pm 1^\circ$, surface finish $1.6 \mu\text{m}$
4. machine holes and pockets square to surfaces and **measure** accuracy
5. **apply health and safety precautions specific** to operating milling machines

Range

Drawings: orthographic and auxiliary views (dimensions (functional, non-functional), tolerance (linear, angular), scale, datum (face, point))

Workholding devices: clamps, machine vice, angle plate (fixed and adjustable), methods of securing work, setting aid(dial test indicators)

Measure: micrometers (external and depth) vernier (callipers and protractor)

Unit 204 Machine components using milling techniques

Outcome 4 Be able to perform milling operations

Assessment Criteria

The learner can:

1. use simple indexing **calculations** to determine number of turns and number of holes on a specified indexing plate
2. **mill holes, slots and flat angled surfaces**
3. select and use appropriate **measuring equipment** to equate with set tolerances
4. **restore the work area** using the correct procedures for the disposal of waste

Range

Calculations: simple indexing (pitch circle diameter [PCD], angular rotation)

Mill holes, slots and flat angled surfaces: vertical mill, depth of holes machined within depth slot drill, angles and flat surfaces end mill.

Measuring equipment: micrometer (0 – 25, 25-50 and 50-11 mm): external, depth, vernier callipers (digital) and protractor, surface texture gauges (tactual method)

Additional Guidance

Restore the work area: removing swarf, correct disposal of waste materials (segregate, label, dispose), implications of failing to do so, waste materials (metallic, plastics, paper and textiles), procedure on completion of machining (return tools, cutters and inspection equipment; remove work and cutter holding equipment)

Unit 205

Machine components using turning techniques

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	M/503/0176
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 11: Preparing and Using Lathes for Turning Operations
Aim:	<p>This unit covers a broad range of turning activities that are required in the engineering and manufacturing sectors. It covers skills and knowledge needed to produce turned components in different materials, using appropriate tools and equipment, and inspection techniques to achieve the required tolerances and conforming to specifications, whilst complying with health and safety legislation and regulations.</p> <p>This unit is concerned with the underlying process in producing components that require shafts of various lengths and shapes (including boring and reaming).</p>

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Know how to plan and prepare for turning activities
2. Be able to turn parallel and tapered shafts
3. Be able to offset turn, external and internal diameters

Unit 205 Machine components using turning techniques

Outcome 1 Know how to plan and prepare for turning activities

Assessment Criteria

The learner can:

1. describe **health and safety precautions** specific to operating lathes
2. describe the setting of work **datum**
3. define **classes of fit**
4. describe the accuracy and range of precision **measuring equipment** and gauges
5. classify types and applications of **coolants and cutting oils**
6. classify **cutting tool materials** and their application
7. define the factors that affect **cutting speeds and feeds**
8. describe methods of **mounting tools**, state their position and benefits
9. describe **workholding devices**

Range

Health and safety precautions: emergency stop procedures, use of guards, operating procedures, moving parts, removal of swarf

Datum: faces, centres

Classes of fit: clearance, interference

Measuring equipment: micrometers (external, internal, depth), vernier (calliper, depth, protractor, digital), dial test indicator (DTI), gauges (plug, blocks, thread, radius/profile, bore/hole), surface finish (comparison plates), how to check that measuring equipment is within current calibration dates

Coolants and cutting oils: oils, compounds, synthetic

Cutting tool materials: high speed steel (HSS), carbide tips

Cutting speeds and feeds: cutting tool material/material being cut, surface finish required, type of cutting operation, power output of the machine, use of coolant

Mounting tools: four way, quick change, tailstock

Workholding devices: chuck (three jaw self centring, including soft jaws), collet, four jaw independent, face plate, steadies (fixed, travelling), catch plate and carriers

Unit 205

Machine components using turning techniques

Outcome 2

Be able to turn parallel and tapered shafts

Assessment Criteria

The learner can:

1. select and use **equipment** for turning between centres
2. machine **parallel shafts** within set tolerance
3. check **surface finish** is within specification
4. generate **tapers** using a range of equipment
5. use a range of **cutting tools and materials**
6. operate equipment safely
7. check dimensions and record accuracy achieved

Range

Equipment: dead, live and running, centres, catch plate, carriers, taper turning attachment, micrometers, vernier calliper and protractors

Parallel shafts: setting centres parallel, diameters to be concentric, run out to be within tolerance (± 0.1 mm)

Surface finish: all surfaces to be within $5\mu\text{m}$, compare texture with comparison gauges

Tapers: compound slide, offset tailstock, taper turning attachment, morse/shallow tapers

Cutting tools and materials: standards shape tools, form tip tools, ferrous and non-ferrous

Unit 205 Machine components using turning techniques

Outcome 3 Be able to offset turn, external and internal diameters

Assessment Criteria

The learner can:

1. select and use **work holding devices**
2. offset components prior to machining
3. **mark centres** on non-circular parts
4. **bore and ream** holes within set **tolerances**
5. reset parts true to allow for further machining
6. operate equipment safely
7. check dimensions and record accuracy achieved
8. **restore the work area** using the correct procedure for the disposal of waste

Range

Work holding devices: four jaw chuck, self-centring chuck, face plate, between centres, clamps, setting (scribe circle and pin), wobble bar, balancing (four jaw chuck, face plate)

Mark centres: vernier height gauge, surface plate/table, vee blocks, angle plate, centre drill, drilling machine

Bore and ream: boring bars (solid, tip, insert), drills and reamers (morse taper shank, expanding, chucking, floating), sleeves (tailstock)

Tolerances: dial test indicator (DTI), micrometer (internal, external, depth) vernier calliper (digital)

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 206

Using bench fitting techniques

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	T/503/0177
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA.
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 5: Producing Components using Hand Fitting Techniques
Aim:	This unit covers a broad range of fitting activities that are required in the engineering and manufacturing sectors. It covers skills and knowledge needed to produce components for assembly using appropriate tools, different materials and inspection techniques to achieve the required tolerances and conforming to specifications, whilst complying with health and safety legislation and regulations.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

1. Know how to plan and prepare for bench fitting activities
2. Be able to apply bench fitting techniques to produce component parts

Unit 206

Using bench fitting techniques

Outcome 1

Know how to plan and prepare for bench fitting activities

Assessment Criteria

The learner can:

1. state how to use **safe working practices** and procedures for maintenance activities
2. describe the **hazards** associated with bench fitting activities
3. extract information from **engineering drawings**

Range

Safe working practices: wearing appropriate protective clothing and equipment (overalls, safety footwear, eye protection, hearing protection, use of barrier cream), maintaining a clean and tidy work area, preparing the work area, leaving the work area in a safe and clean condition, risk assessments

Hazards: handling of coolants and cutting oils/compounds, misuses of tools, use of damaged or badly maintained tools

Engineering drawings: dimensional, geometrical, materials, limits

Unit 206

Using bench fitting techniques

Outcome 2

Be able to apply bench fitting techniques to produce component parts

Assessment Criteria

The learner can:

1. select **tools and equipment** to undertake a bench fitting activity
2. use **safe working practices** and procedures during maintenance activities
3. check **portable machines and equipment** for safe operation
4. **produce and assemble component parts** using safe working practice
5. check component for **accuracy and quality**
6. **restore the work area** using the correct procedures for the **disposal of waste**

Range

Tools and equipment: marking out, punches surface plate/table, angle plate parallels and vee blocks, hand tools, measuring instruments, protractor, micrometers, verniers, dial test indicators, surface finish, cutting and shaping, drills, taps and dies, reamers, forms of power supply, powered hand tools, forming equipment

Safe working practices: wearing appropriate protective clothing and equipment (overalls, safety footwear, eye protection, hearing protection, use of barrier cream), maintaining a clean and tidy work area, preparing the work area, leaving the work area in a safe and clean condition, risk assessments

Portable machines and equipment: emergency stop procedures, use of guards and interlocking devices, operating procedures, moving parts, removal of swarf, setting, checking and operating off-hand grinding machines (gap between rest and wheel, wheel imperfections, changing the wheel), angle grinder (position of guards, wheel selection, changing the wheel)

Produce and assemble component parts: setting of work datums, use charts to obtain drill diameters for clearance and tapping hole, assemble component parts in the correct sequence and without damage

Accuracy and quality: inspection, quality control, compliance records.

Dispose of waste: legal requirements for the disposal of waste and the implications of failure to comply, materials (metallic materials, plastics, textiles, paper and card), procedures (segregate, label, dispose)

Additional Guidance

Tools and equipment: marking out (scribers, scribing block, punches [centre and dot], surface plate/table, angle plate parallels and vee blocks) hand tools (files, screwdrivers, hammers and mallets, pin punches, spanners (open-ended, socket sets, ring, torque wrenches), measuring instruments (rules, inside and outside calipers, protractor, micrometers (external, depth), verniers (height gauge, protractor, callipers), gauges (feeler, blocks/slip, radius, thread) dial test indicators, surface finish (comparison plates, tactile machines), cutting and shaping (saws [hand, mechanical], drills (high speed steel [HSS] carbide tips drill speed tables, cutting speed formula [cutting speed = $\pi dN/1000$]), taps (spiral flute, straight flute [taper, second, bottoming], use of charts for selecting tapping sizes) and dies (circular split, rectangular, pipe), reamers, forms of power supply (230V, 110V, pneumatic, battery), powered hand tools (drills, screwdrivers, angle grinders, saws), forming equipment (bench folders, fly press).

Produce and assemble component parts: setting of work datums (faces, lines, centres, corners, edges), marking out (datum and centre lines, circles and radial lines, squares and rectangles, linear hole positions, witness mark), use of types of hole (drilled, flat bottom, countersunk, counterbored, spotface), screw fittings (bolts, screws, hexagon, countersink and caphead)

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 207

Using Computer Aided Manufacturing processes

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	D/503/0206
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 14: Preparing and Proving CNC Machine Tool Programs; Unit 15: Preparing and Using CNC Turning Machines; Unit 16: Preparing and Using CNC Milling Machines; Unit 17: Preparing and Using CNC Machining Centres
Aim:	This unit is designed to enable candidates to produce standard components using computer aided manufacturing techniques. It includes the production of a component and suitable files to produce such components. It will also cover the relevant health and safety procedures required.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will

1. Be able to use a computer to produce a suitable program to enable the production of a component
2. Be able to manufacture a standard component using the appropriate machine tool

Unit 207 Using Computer Aided Manufacturing processes

Outcome 1 Be able to use a computer to produce a suitable program to enable the production of a component

Assessment Criteria

The learner can:

1. select the **hardware requirements** of a computer system
2. **check** that equipment is safe for use and correctly set up
3. describe the **health and safety requirements** relating to the use of workstations and VDU equipment
4. describe good **housekeeping** arrangements
5. produce an appropriate **drawing** for manufacture to current standards
6. save the drawing using appropriate drawing **exchange format**
7. import file into a Computer Aided Manufacturing (CAM) package
8. produce a suitable program file to enable machining

Range

Hardware requirements: CPU, monitor, keyboard, mouse, printer, scanner, hard drive

Check: visual off-load checks

Health and safety requirements: lighting, seating, sitting and positioning of equipment, dangers of trailing leads, safe and tidy work area, screen filters

Housekeeping: organisation of files into folders, closing down equipment correctly, using storage media: hard disk drive, CD ROM, DVD ROM, USB removable storage, the Internet

Drawing: orthographic (1st and 3rd angle), isometric, procedure for creating a new drawing, setting-up, scales and sheet size, types of lines, layers

Exchange format: .dxf, .iges

Unit 207 Using Computer Aided Manufacturing processes

Outcome 2 Be able to manufacture a standard component using the appropriate machine tool

Assessment Criteria

The learner can:

1. prepare for computer numerically controlled (**CNC**) machining
2. **set-up** and use a **part program**
3. machine standard components to specification
4. **check components** against specification
5. **restore the work area** using the correct procedures for the **disposal of waste**

Range

CNC machining: lathes (two axis, turning centres), milling machines (vertical, horizontal), machining centres,

Set-up: machine vice, grid plate, rotary tables, pallets, chucks, steadies, override switches, guarding, selection of speeds and feeds, tools/cutters

Part program: use of absolute and incremental co-ordinates, canned cycles, sub-routines

Check components: during manufacture, on completion, use of measuring equipment (vernier calipers, micrometers)

Disposal of waste: legal requirements for the disposal of waste and the implications of failure to comply, materials (metallic materials, plastics, textiles, paper and card), procedures (segregate, label, dispose)

Additional Guidance

Set-up: machine vice, grid plate, rotary tables, pallets, chucks (3 jaw self-centring, 4 jaw, collet) steadies (two point, three point), override switches, guarding (fixed, interlocking), selection of speeds and feeds (use of tables, $\text{rpm} = 1000S/\pi D$, $\text{feed} = \text{rpm} \times \text{number of teeth} \times \text{feed per tooth}$), tools/cutters (using bar and slip, using cutting tool, probe, high speed steel, carbide, ceramic, geometry [top rake, front rake, clearance])

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	D/503/0187
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 68: General Maintenance Engineering Applications.
Aim:	<p>This unit identifies the basic principles and commonly used processes that relate to maintenance activities. It covers routine maintenance requirements, components, tools and equipment that are commonly used and the ways in which they may be applied.</p> <p>Learners are provided with an overview of a wide range of engineering maintenance activities, terminology and practices that are needed as part of routine maintenance work.</p>

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Understand how to prepare for maintenance activities using safe and effective working practices
2. Know how to select working methods, tools and equipment
3. Know how to use dismantling/assembly techniques for components/systems

Unit 208

Principles of maintenance technology

Outcome 1

Understand how to prepare for maintenance activities using safe and effective working practices

Assessment Criteria

The learner can:

1. describe **safe working practices** and health and safety requirements
2. describe the **hazards** associated with maintenance activities
3. describe **sources of information** used during maintenance activities
4. describe types of maintenance activities
5. **describe** the factors to be **considered when planning** a maintenance activity
6. describe the procedures for **cleaning work areas** following a spillage or leakage
7. describe maintenance **diagnostic and fault location techniques** and **aids** used

Range

Safe working practices: Health & Safety Law, wearing appropriate protective clothing and equipment, maintaining a clean and tidy work area, use of barriers and/or tapes, post warning signs, informing personnel of maintenance activities, system isolation procedures for power and pressure sources, permit-to work procedures, preparing the work area, leaving the work area in a safe and clean condition

Hazards: handling of oils and grease, misuses of tools, use of damaged or badly maintained tools, not following laid-down maintenance procedures

Information sources: drawings, charts, tables, manufacturers' instructions, service manuals, drawings (orthographic, isometric, exploded views), technical specifications, signs (mandatory, warning, prohibited, emergency)

Maintenance activities: routine servicing schedules, planned / preventive maintenance, repair / replacement following breakdowns, monitoring and performance tests

Planning: tools and equipment requirements, materials and replacement parts, importance of minimising downtime to avoid production loss, site conditions, component location, provision of services (electricity, water, drainage)

Cleaning work areas: approved waste disposal methods, absorbent substances, use of detergents and solvents

Diagnostic and fault location techniques: evaluation using sensory information, diagnostic techniques, fault location techniques

Aids: manuals, flow charts, troubleshooting guides, maintenance records, barcodes, catalogue numbers

Additional Guidance

Diagnostic and fault location techniques: evaluation using sensory information (sight, sound, smell, touch), diagnostic techniques (fault reports, visual checks, measurement, movement and alignment checks, testing), fault location techniques (half-split, input-to-output, function testing, unit substitution, equipment self-diagnostics)

Mechanical system such as compressed air, steam, fuel oil etc. but not combustible gas or highly flammable hydrocarbon fuel. Can also cover domestic or industrial Electrical systems but limited to low or medium voltages.

Unit 208

Principles of maintenance technology

Outcome 2

Know how to select working methods, tools and equipment

Assessment Criteria

The learner can:

1. describe how to set-up **access equipment** for safe working
2. describe safe **lifting techniques**
3. state how to move **heavy equipment** across a flat surface
4. describe types of **tools and equipment** and how they are used
5. describe how to **perform measurement and alignment** using **equipment**
6. describe how to replace **life determined** items
7. describe the methods of applying **lubricants** and reasons for applying them

Range

Access equipment: ladders, scaffolding, platforms, mobile hoists

Lifting techniques: chains, rope and wire slings, hooks, shackles, eye bolts, methods of sling attachment to prevent damage to sling / machinery (protective padding, wooden blocks) estimation of approximate weight, use of manufacturers data, centre of gravity of load, angle of splay between two leg sling chains not to exceed 120°, never exceed the safe working load [SWL], inspection records for lifting equipment are current, lifting equipment (screw and hydraulic jacks, overhead gantry cranes, mobile cranes, jib cranes, derricks, fork lift trucks, tripods, shackles, pulley blocks)

Heavy equipment: rollers and skates, crowbars, pull-lifts, lubricated plates

Tools and equipment: torque/impact wrenches, pipe wrenches, pipe cutting and threading, spanners and socket sets, drifts and wedges, extractors, feeler gauges, screw drivers, pliers, wire cutter/strippers

Perform: measure using calibrated equipment and the importance of calibration

Equipment: Use of; rules/tapes, micrometers, vernier instruments, ammeters, voltmeters, ohmmeters, insulation resistance tester, multi-meters, straight edges, squares, feeler gauges, plumb line, spirit level, piano wire, optical instruments, lasers, checks for accuracy

Life determined: high tensile bolts and washers, nylon insert nuts, locking devices, split pins, seals and gaskets

Also includes

Bearings, slideway materials, belt and chain drives (including drive pulleys and sprockets, braking media, filters, springs, shock absorbing components, mechanical seals)

Lubricants: friction between moving parts, wear, generation of heat, force required to overcome friction, methods of reduction (oils [mineral, synthetic, animal and vegetable] greases, copper compound, graphite), application (total loss, re-circulatory, splash, grease guns and nipples), reasons for oil deterioration (excessive heat, oxidation, contamination, breakdown of structure, poor storage conditions)

Unit 208

Principles of maintenance technology

Outcome 3

Know how to use dismantling/assembly techniques for components/systems

Assessment Criteria

The learner can:

1. describe how to **dismantle** an engineering device or system
2. describe how to **re-assemble** an engineering device or system
3. describe how to **restore the work area** using the correct procedures for the disposal of waste
4. state what would be covered in a **report** completed following a maintenance activity

Range

Dismantle: procedure for isolation and locking off a device/system, sequence of operations used to dismantle a device/system, proof marking, correct storage procedures for removed parts, release of pressure/force, extraction

to include: (bearing extractors, hub pullers), diodes/transistors, fuses, printed circuit boards, mandrel presses, drifts, alignment, studs, bolts, screws, pins and dowels, keys, bearings and shafts, gears, couplings, springs, seals and gaskets, circlips, seals, gaskets, rivets; removal and refitting of: seals, gaskets, packings, grommets

Re-assemble: laying out components parts in logical sequence to aid re-assembly, tensioning, dimensional accuracy and clearance of component, components to discard and replace, fitting of mating parts, need for the use of shims or packing, type and use of mechanical/electrical securing devices, tighten fastenings correctly

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work.

Report: including: identification of equipment; type of maintenance undertaken, repairs carried out, details of replaced parts and consumables, time taken, any outstanding maintenance issues. Any improved or unusual operating conditions as a result of maintenance

Can include the process of cancellation of work permits and removal of tag outs

Additional information

Re-assemble: laying out components parts in logical sequence to aid re-assembly) tensioning (belts, chains), dimensional accuracy and clearance of component (internal / external micrometers, vernier height gauges, dial test indicator, protractor, feeler gauges), components to discard and replace (high tensile bolts and washers, nylon insert nuts, locking devices, split pins, seals and gaskets), fitting of mating parts (filing, scraping locating, cleaning) need for the use of shims or packing, type and use of mechanical/electrical locking devices, tighten fastenings correctly (correct torque applied, correct tightening sequence)

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Report: parts beginning to show signs of wear or deterioration, that were not replaced, but would need attention when next maintained

Unit 209

Assembling and maintaining fluid power systems

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	H/503/0188
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA.
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Units: 20: Assembling and Testing Fluid Power Systems, 21: Maintaining Fluid Power Equipment
Aim:	<p>This unit identifies the basic principles and commonly used components that are for assembly and maintenance of fluid power systems. It covers the assembly, testing and maintenance of fluid systems. It further deals with assembly techniques, in order to assemble the various components that will include rigid and flexible pipework, hoses, valves, actuators, cylinders regulators and sensors.</p> <p>Assembly activities include making checks and adjustments to ensure components are correctly positioned and aligned, are dimensionally accurate and secure, pipework free from ripples, creases and damage, joints are checked for security, with threaded devices tightened correctly.</p> <p>Routine maintenance activities will involve gathering information from fault reports, using fault finding techniques, measuring, inspection and operation of equipment. As well as dismantle, remove and replace/repair faulty units/components, reassembly and test system.</p>

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Know how to prepare for routine maintenance activities and dismantle devices and equipment
2. Be able to apply testing/fault finding techniques
3. Be able to dismantle, remove and replace/repair, re-assemble and test systems conform to specification

Unit 209

Assembling and maintaining fluid power systems

Outcome 1

Know how to prepare for routine maintenance activities and dismantle devices and equipment

Assessment Criteria

The learner can:

1. describe the **hazards** associated with fluid systems maintenance activities
2. produce a **plan** for an assembly/maintenance activity for a fluid power circuit
3. extract **information from sources**

Range

Hazards: handling of oils and grease (toxicity, harmful effects to skin and body) misuses of tools, use of damaged or badly maintained tools, not following laid-down maintenance procedures, stored energy/force, handling of compressed air (harmful effects to skin and body)

Plan: description of task, location(s), date and times (commencement, completion, handover), parts and consumables to be used, test data requirements, checks to be made, permits to work required, tools and equipment requirements, isolation/barrier requirements, sequence of operations for dismantle/re-assemble components, provision for spillages

Information sources: charts (seals and gaskets, lubrication and screw threads, etc), Internet, catalogues

Additional Guidance

Information sources: drawings, charts, circuit and physical layouts, specifications, manufacturers manuals, maintenance reports, compilation of material/component list from information sources, current symbols used in hydraulic systems (valves – pressure, flow control, directional control, actuators, accumulators, pumps, filters, reservoirs, gauges, hoses and connectors), current symbols used in pneumatic systems (valves: pressure control – regulating and relief, flow control – restrictors and by-pass form, directional control – rotary and spool, quick exhaust; actuators: linear – single and double acting, cylinders, rotary; accumulators, pressure intensifiers, filters, silencers, gauges, pipework connecting methods – rigid, flexible and push-in)

Unit 209

Assembling and maintaining fluid power systems

Outcome 2

Be able to apply testing/fault finding techniques

Assessment Criteria

The learner can:

1. assess fluid power system for **common faults**
2. carry out **fluid power testing**
3. identify and rectify **leaks/faults**
4. complete relevant **test/maintenance records/documentation**

Range

Common faults: ensure all pipes/components are secure, moving parts are chocked or parked, evaluation using sensory information, diagnostic techniques, fault location techniques, diagnostic aids

Fluid power testing: connect and use suitable calibrated test/diagnostic equipment to circuit to test and/or investigate problem, importance of correct calibration of test equipment, handling/application of measuring/test equipment, static tests, dynamic test

Leaks/faults:

- hydraulic:
 - connecting hydraulic pumps and power packs to circuit
 - filling hydraulic system with fluid
 - bleeding air from system
 - applying test pressures in incremental stages
 - check for leaks
 - take test readings
 - adjust components to give required operating conditions
 - re-run of tests to confirm that system performs to specification
 - check for:
 - no open ends
 - valves in test position/status
 - moving parts in test position/status
 - pipe/components fitted to specification
 - clamps/brackets position and fitted correctly
 - bleed vents accessible
 - equipment/components which may damaged/faulty are removed
 - equipment:
 - pump/pressure source
 - connections
 - leak detection fluids
 - smoke candles
 - determine when to repair or replace faulty units
- pneumatic:
 - applying test pressures in incremental stages

- check for leaks
- take test readings
- adjust components to give required operating conditions
- re-run of tests to confirm that system performs to specification
- check for:
 - all connections have been completed
 - all components are secure
 - moving parts are 'parked'
- equipment:
 - pump/pressure source
 - connections
 - leak detection fluids
 - calibrated pressure gauge
- determine when to repair or replace faulty units

Test/maintenance records/documentation: description of work undertaken, location(s), date and times (commencement, completion, handover), parts and consumables used, test data, movement of parts, noise and vibration levels, temperature, adjustment required, permit to work reference.

Additional Guidance

Common faults: ensure all pipes/components are secure, moving parts are chocked or parked, evaluation using sensory information (sight, sound, smell, touch), diagnostic techniques (fault reports, visual checks, measurement, movement and alignment checks, testing), fault location techniques (half-split, input-to-output, function testing, unit substitution, equipment self-diagnostics), diagnostic aids (manuals, flow charts, troubleshooting guides, maintenance records)

Fluid power testing: connect and use suitable calibrated test/diagnostic equipment to circuit to test and/or investigate problem, importance of correct calibration of test equipment, handling/application of measuring/test equipment (measuring instruments, pressure and flow indicators, self-diagnostic equipment), static tests (guarantee pressure tightness of a system under set conditions, locate leaks and faults in a system), dynamic test (ensure correct operation of system components, ensure system performs to specification)

Unit 209

Assembling and maintaining fluid power systems

Outcome 3

Be able to dismantle, remove and replace/repair, re-assemble and test systems conform to specification

Assessment Criteria

The learner can:

1. **use safe working practices** and procedures for maintenance activities
2. **select tools and equipment** to undertake a maintenance operation
3. **dismantle, clean** and **inspect** faulty components in fluid power systems
4. **re-assemble** fluid power systems
5. prepare a report following maintenance activities
6. **restore the work area** using the correct procedures for the disposal of waste

Range

Safe working practices: wearing appropriate protective clothing and equipment, maintaining a clean and tidy work area, use of barriers and/or tapes, post warning signs, informing personnel of maintenance activities, system isolation procedures for power and pressure sources, permit-to-work procedures, preparing the work area, leaving the work area in a safe and clean condition

Tools and equipment: spanners (open-ended, socket sets, ring), torque wrenches, screwdrivers, allen keys, fastening devices for hydraulic equipment (nuts, bolts, studs, screws, locking devices)

Dismantle: release pressure, proof marking, extraction, label and store safely parts that have been removed

Clean: dust (blow, vacuum), dirt (brushing, vacuum), grease (degreasing agents, solvents, steam, health and safety considerations)

Inspect: checking that components are fit for purpose, damage, distortion, leaks (pipes and hose connections, cylinders and valves, corrosion)

Re-assemble cut pipe to length, fittings, hand bending methods, screwed fittings, flanged fittings, push in fittings, leak free joints (gaskets, jointing and sealing compounds, seals), securing components and pipe (clamps, brackets), install flexible hose between rigid and moving components; hydraulic: valves (pressure, flow, directional control), actuators (single and double acting cylinders, rotary), accumulators, filters, strainers and lubricators, pumps, gauges, pipes, hoses and connectors (rigid and flexible)

Report: importance of completing a maintenance documentation following the maintenance activities, reporting defect (tools, equipment, components)

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 210

Maintenance of mechanical devices and equipment

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	K/503/0189
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA.
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 19: Maintaining Mechanical Devices and Equipment
Aim:	This unit identifies the basic principles and commonly used processes that are required to maintain mechanical devices and equipment. It covers basic maintenance requirements, routine inspection, lubrication and service of mechanical devices and equipment. It further deals with dismantling and re-assembly of equipment and the replacement of 'life determined' items. Devices and equipment to be covered include bearings and shafts, linkages, drives, couplings, valves, brakes, pumps and gearboxes.

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Be able to prepare for routine maintenance activities and dismantle devices and equipment
2. Be able to apply fault finding techniques
3. Be able to re-assemble mechanical devices and equipment

Unit 210 Maintenance of mechanical devices and equipment

Outcome 1 Be able to prepare for routine maintenance activities and dismantle devices and equipment

Assessment Criteria

The learner can:

1. follow **safe working practices** and procedures for maintenance activities
2. describe the **hazards** associated with maintenance activities
3. produce a **plan** for a maintenance activity for a mechanical device
4. extract **information from sources**
5. select **tools and equipment** to undertake a maintenance operation
6. select appropriate **cleaning technique(s)**
7. disassemble mechanical devices and equipment

Range

Safe working practices: wearing appropriate protective clothing and equipment, maintaining a clean and tidy work area, use of barriers and/or tapes, post warning signs, informing personnel of maintenance activities, system isolation procedures for power and pressure sources, permit-to-work procedures, preparing the work area, leaving the work area in a safe and clean condition, types of goods

Hazards: handling of oils and grease, misuses of tools, use of damaged or badly maintained tools, not following laid-down maintenance procedures

Plan: description of task, location(s), date and times (commencement, completion, handover), parts and consumables to be used, test data requirements, checks to be made, permits to work required, tools and equipment requirements, isolation/barrier requirements, sequence of operations for dismantle/re-assemble components

Information sources: drawings, charts, tables, manufacturers instructions, service manuals, drawings (orthographic, isometric, exploded views), job instructions

Tools and equipment: spanners, hammers and mallets, screwdrivers, pliers and grips, chisels, punches, drifts and wedges, nut splitters, stud extractors, measuring instruments (, equipment checks, lifting equipment, estimation of approximate weight, use of manufacturers data, centre of gravity of load, angle of splay between two leg sling chains not to exceed 120°, never exceed the safe working load [SWL], inspection records for lifting equipment are current), methods of moving heavy equipment across flat surfaces

Cleaning techniques: dust (blow, vacuum), dirt (brushing, vacuum), grease (degreasing agents, solvents, steam, health and safety considerations)

Disassemble a mechanical devices and equipment: proof marking (aid re-assembly), correct storage procedures for removed parts, release of pressure/force, extraction (bearing extractors, hub pullers), mandrel presses, drifts, alignment, studs, bolts, screws, pins and dowels, keys, bearings and shafts, gears, couplings, springs, seals and gaskets, circlips, seals, gaskets

Additional Guidance

Tools and equipment: spanners (open-ended, socket sets, ring), hammers and mallets, screwdrivers, pliers and grips, chisels, punches, drifts and wedges, nut splitters, stud extractors, measuring instruments (rules, tapes, micrometers, vernier height gauge and

calipers, feeler gauges, dial test indicators), equipment checks (free from damage or defect, in a safe and usable condition, within calibration, configured correctly for the intended purpose), lifting equipment (screw and hydraulic jacks, overhead gantry cranes, mobile cranes, jib cranes, derricks, fork lift trucks, tripods, shackles, pulley blocks, estimation of approximate weight, use of manufacturers data, centre of gravity of load, angle of splay between two leg sling chains not to exceed 120° , never exceed the safe working load [SWL], inspection records for lifting equipment are current), methods of moving heavy equipment across flat surfaces (rollers, skates, crowbars, pull-lifts, lubricated plates)

Unit 210 Maintenance of mechanical devices and equipment

Outcome 2 Be able to apply fault finding techniques

Assessment Criteria

The learner can:

1. **assess devices** and equipment for **common faults**
2. identify **wear/damage** in component parts
3. resolve **problems encountered** during maintaining mechanical devices/equipment

Range

Assess devices evaluation using sensory information (sight, sound, smell, touch), diagnostic techniques (fault reports, visual checks, measurement, movement and alignment checks, testing), fault location techniques (half-split, input-to-output, function testing, unit substitution, equipment self-diagnostics), diagnostic aids (manuals, flow charts, troubleshooting guides, maintenance records)

Wear/damage: bearings and shafts, linkages, drive belts and chains, couplings, clutches, brakes, gearboxes, seals and gaskets, metal fractures, surface cracking, corrosion, excessive movement/clearance, leakage from seals and gaskets, excessive temperature of bearings, breaks and drives, vibration, overheating, out of balance, missing parts, loose fittings and connections

Problems encountered: fastenings damaged during dismantling, components not easily parted, correct tools not available, unavailability of spares

Unit 210

Maintenance of mechanical devices and equipment

Outcome 3

Be able to re-assemble mechanical devices and equipment

Assessment Criteria

The learner can:

1. **re-assemble mechanical devices and equipment**
2. **restore the work area** using the correct procedures for the disposal of waste
3. prepare a **report** following maintenance activities

Range

Re-assemble mechanical devices and equipment: laying out components parts in logical sequence to aid re-assembly, tensioning, dimensional accuracy and clearance of component, components to discard and replace, fitting of mating parts may require filing or scraping, need for the use of shims or packing, type and use of locking devices, tighten fastenings correctly, lubrication requirements for a device/system

Additional Guidance

Re-assemble mechanical devices and equipment: laying out components parts in logical sequence to aid re-assembly) tensioning (belts, chains), dimensional accuracy and clearance of component (internal / external micrometers, vernier height gauges, dial test indicator, protractor, feeler gauges), components to discard and replace (high tensile bolts and washers, nylon insert nuts, locking devices, split pins, seals and gaskets), fitting of mating parts may require filing or scraping, need for the use of shims or packing, type and use of locking devices, tighten fastenings correctly (correct torque applied, correct tightening sequence), lubrication requirements for a device/system (types of oil and grease, methods of application)

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Report: importance of completing a maintenance documentation following maintenance activities

Unit 211

Maintaining electrical wiring support systems

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	D/503/0190
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA.
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 1: Working Safely in an Engineering Environment, Unit 2: Working Efficiently and Effectively in Engineering, Unit 3: Using and Communicating Technical Information.
Aim:	The unit covers the skills required to carry out the installation/maintenance of electric wiring support systems, including conduit, trunking and traywork systems.

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Be able to plan and prepare for electrical wiring support systems
2. Be able to install and repair electrical support systems
3. Be able to commission the system

Unit 211 **Maintaining electrical wiring support systems**

Outcome 1 Be able to plan and prepare for electrical wiring support systems

Assessment Criteria

The learner can:

1. apply **health and safety** requirements and safe working practices
2. **obtain information** for the installation/maintenance activities
3. develop a **work plan**
4. carry out inspection of **installation** and list system/component specifications
5. **select tools and equipment**

Range

Health and Safety: **Health and Safety** at Work etc. Act, IEE wiring regulations, Electricity at Work Regulations, safe isolation procedures

Obtain information: manufacturer's data, plans, drawings

Work plan: to include risk assessment and method statements

Installation: inspection of installation and record component specifications

Select tools and equipment: test, cutting, forming, assembly/mounting/attachment

Unit 211

Maintaining electrical wiring support systems

Outcome 2

Be able to install and repair electrical support systems

Assessment Criteria

The learner can:

1. carry out inspection of support systems in line with an agreed work plan
2. identify **support systems requirements**
3. identify **faulty or defective components** for replacement
4. **isolate** systems/components
5. select new **components** to conform to specification and dimension accuracy
6. **install** support systems
7. check for faulty or defective **components**
8. replace/repair components using appropriate techniques
9. **restore the work area** using the correct procedures for the disposal of waste

Range

Support systems requirements: cable enclosures/support system components (bends/elbows boxes (such as circular or square, terminal or multi branch), horizontal runs vertical drops, straight connectors/couplings, tee pieces, reducers, conversion units and adaptors, cross-over units)

Faulty or defective components: checking for level and alignment, checking that all connections are secure, checking that sufficient supports are used and that they are correctly spaced, checking that correct outlets are used (sockets, switches, light fittings, wire junction and inspection fittings)

Isolate: isolation and lock-off procedure (electrical isolation, locking off switchgear, removal of fuses, placing of maintenance warning notices, proving that isolation has been achieved and secured)

Components: metal and plastic conduit, metal and plastic trunking, traywork, accessories (switch gear, containment, fuse gear)

Install: marking out the locations, positioning and securing trunking, traywork and conduit using mechanical fixings, drilling and preparing holes for the trunking, traywork or conduit, leveling and alignment of the wiring enclosures and components

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage

Unit 211 **Maintaining electrical wiring support systems**

Outcome 3 Be able to commission the system

Assessment Criteria

The learner can:

1. carry out final **visual inspection** to ensure compliance with specifications
2. carry out **safety checks** to ensure system is safe to energise
3. complete **maintenance records** accurately and legibly

Range

Visual inspection: containment systems to comply with BS 7671/ manufacturers data.

Safety checks: covers in place, safety devices commissioned and personnel notified.

Maintenance records: reorder parts

Unit 212

Principles of fabrication and welding technology

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	H/503/0191
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Welding and Fabrication units.
Aim:	This unit is concerned with the technology that underpins fabrication and welding processes. The unit covers the basic principles of welding, fabrication materials, weld symbols and terminology, distortion, weld defects, heat affects of welding, forming allowances and non-destructive and workshop testing.

Learning outcomes

There are **four** learning outcomes to this unit. The learner will:

1. Understand the basic principles of welding
2. Know how to be able to select and apply welding terminology and symbols
3. Understand the effects of welding
4. Know how to identify common metals used in fabrication and determine forming allowances

Unit 212

Principles of fabrication and welding technology

Outcome 1

Understand the basic principles of welding

Assessment Criteria

The learner can:

1. describe the effects of **electricity** in welding
2. describe the influence of **electrode coverings**
3. describe the influence of shielding gases/gas mixtures
4. describe the effects of welding **flame conditions**

Range

Electricity: arc voltage, welding current, types of current (alternating current [ac], direct current [dc]), 'arc blow' (influence of joint geometry, influence of type of current, methods of avoidance)

Electrode coverings: rutile, basic, cellulosic, iron powder, effects of electrode coverings, composition of electrode coverings

Shielding gases/gas mixtures: tungsten-inert gas [TIG] welding, metal inert gas/metal active gas [MIG/MAG], effects of shielding gases

Flame conditions: geometry of oxy-acetylene gas welding flame (inner cone, outer envelope, hottest region of flame), different flame types and their applications (neutral, oxidising, reducing (carburising))

Additional Guidance

Electrode coverings: rutile, basic, cellulosic, iron powder, effects of electrode coverings (facilitates arc striking, stabilises and directs the arc, assists control of the size and frequency of filler metal globules/droplets, filler metal from atmospheric contamination during transfer, provides appropriate weld contour, prevents rapid cooling of weld metal (thermal blanket effect), provides a flux for the molten pool to remove oxides and impurities, supplies additional metal to weld pool)

Shielding gases/gas mixtures: tungsten-inert gas [TIG] welding (argon, helium, Ar/H₂ for stainless steels), metal inert gas/metal active gas [MIG/MAG] welding: (carbon steels, aluminum, stainless steel), effects of shielding gases (protection from gases in the atmosphere (composition of air), mode of metal transfer, penetration, weld bead profile, speed of welding, wetting/undercutting tendency)

Unit 212 Principles of fabrication and welding technology

Outcome 2 Know how to be able to select and apply welding terminology and symbols

Assessment Criteria

The learner can:

1. describe the **features of a welded joint**
2. define types of **welded joints** to current standards
3. describe how to **select joint** preparations for welding **applications**

Range

Features of a welded joint: face, toes, root. HAZ (heat affected zone), convex fillet profile, concave fillet profile, mitred fillet profile, leg, throat, root face, root gap, bevel angle, included angle, weld width, fusion zone (depth of fusion), excess weld metal, penetration, fusion line (boundary). Reinforcement and butt weld profile

Welded joints: welding symbols (application: arrow line, reference line, identification line, symbol) types of joint (butt, tee, lap, corner), types of welded preparation (square butt (open), square butt (closed), flanged butt, single-vee butt, double-vee butt, fillet, spot, seam, projection, edge). Single bevel joint, double bevel joint

Select joint: joint access, material thickness, welding process, distortion control

Applications: is related to the effect the weld joint would have on the use of the product.

Welded joints: welding symbols (application: arrow line, reference line, identification line, symbol) types of joint (butt, tee, lap, corner), types of welded preparation (square butt (open), square butt (closed), flanged butt, single-vee butt, double-vee butt, fillet, spot, seam, projection, edge)

Unit 212 Principles of fabrication and welding technology

Outcome 3 Understand the effects of welding

Assessment Criteria

The learner can:

1. describes **sources of heat** for welding and their effect
2. describe the effects of **heat distribution** due to welding
3. describe the **distortion** effects of heat and method of distortion control
4. classify **weld defects** and their possible **causes**
5. describe methods of non-destructive testing (**NDT**) weld surfaces
6. describe methods of **workshop testing** welds

Range

Sources of heat: methods of heat production (electric arc, electrical resistance, flame combustion, friction) temperature (methods of measurement, infra-red, pyrometer, temperature indicating crayons), means of heat transfer/loss (conduction, convection, radiation)

Heat distribution: effects on the structure of the weld metal, effects on the structure of the parent metal

Distortion: causes, types, methods of control

Weld defects: types

Causes: types of operator error, other causes

NDT: visual examination (applications, equipment, advantages, disadvantages), dye penetrant (test procedure, application, advantages, disadvantages), magnetic particle (magnetic flow [types of magnet horseshoe, yoke]; current flow [types of magnetisation – prods; test procedure, applications, advantages, disadvantages])

Workshop testing: bend tests (root, face and side), fracture (nick break), macro examination, cupping test (ductility)

Additional Guidance

Distortion: causes (uneven expansion and contraction, degree of restraint), types (longitudinal, transverse, angular), methods of control (presetting, pre-bending, weld sequencing, skip welding, back-stepping, tack welding, joint design, chills, restraint [clamping, jigs, back-to-back assembly])

Weld defects: types (cracks, lack of fusion [side wall, root, inter-pass], porosity isolated pore, piping, craters, slag inclusions, tungsten inclusions, lack of penetration, excessive penetration, undercut, excessive weld metal, underfil, concavity, overlap, burn-through), possible causes

Unit 212 Principles of fabrication and welding technology

Outcome 4 Know how to identify common metals used in fabrication and determine forming allowances

Assessment Criteria

The learner can:

1. describe the range of common **metals** used in fabrication and their forms of supply
2. select materials against **criteria**
3. determine the **bending and rolling allowances** for fabricated forms from information supplied

Range

Metals: carbon steels, stainless steels (austenitic, martensitic, ferritic), galvanised steel, aluminium/aluminium alloys, forms of supply

Criteria:, appearance, corrosion resistance, heat treatment of carbon steels, cost, mass, weldability, formability, machinability, strength to weight ratio

Bending and rolling allowances: purpose, thin sheet, thick plate, neutral line, pipe bends, 'U' bends, right-angle bends, circular forms, cylinders, methods to avoid 'flats' when rolling

Additional Guidance

Metals: extrusions for aluminium, low-carbon steel, austenitic stainless steels, galvanised steel, aluminium/aluminium alloys, forms of supply (sheet, plate, structural sections [equal leg angle, unequal leg angle, hollow sections: square, rectangular, round (tubular); pipe), criteria for the selection (strength, weight [mass], appearance, corrosion resistance, malleability, ductility), heat treatment of carbon steels (annealing, normalising, hardening, tempering)

Unit 213

Welding by Manual Metal Arc process

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	K/503/0192
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 27: Preparing and Using Manual Metal Arc Welding Equipment
Aim:	<p>This unit is to enable manual metal arc (MMA) welding skills to be developed to meet the defect acceptance requirements of BS 4872 part 1 in steel or stainless steel within its scope.</p> <p>The applied knowledge topics include: health and safety hazards and methods of avoiding them, preparation, electrical requirements, consumables, welding techniques, welding positions, distortion control and rectification, BS 4872 part 1 requirements and non-destructive and workshop testing.</p>

Learning outcomes

There are **four** learning outcomes to this unit. The learner will

1. Know safe working practices associated with manual metal arc welding
2. Know how to prepare manual metal arc equipment and materials for welding
3. Be able to produce standard welded joints safely using manual metal arc welding
4. Be able to visually check welds for defects

Unit 213

Welding by Manual Metal Arc process

Outcome 1

Know safe working practices associated with manual metal arc welding

Assessment Criteria

The learner can:

1. identify Personal Protective Equipment (**PPE**) used in relation to welding process
2. describe the use of Personal Protective Equipment (PPE) in manual metal arc (MMA) welding
3. describe the hazards from:
 - a. **welding fume**
 - b. **electricity**
 - c. **arc radiation**
 - d. **hot metal/slag/sparks**

Range

PPE: headshield, filter lens, cover lens, light reactive filters, gauntlets, protective footwear, eye protection, flame retardant overalls, leather apron, scull cap, leather jacket, factors render PPE provided as protection against the above ineffective or unsafe

Welding fume: types of fume (visible [particulate], invisible [gaseous], carbon monoxide [CO], oxides of nitrogen, nitrous oxide [NO], nitrogen dioxide [NO₂], use of extraction (background, local, natural ventilation [e.g. on-site], air-fed headshields, respirator

Electricity: shock hazards (use of electrical insulation [condition, correct size, correct connection, tightness of connection] welding lead, welding return, welding earth); fire, burns

Arc radiation: visible light, infra-red, ultra-violet, PPE (types, purpose), screening (types, purpose), warnings (verbal, notices)

Hot metal/slag/sparks: means of avoiding hazards (identification of hazard, use of tools [tongs, etc], use of PPE

Unit 213

Welding by Manual Metal Arc process

Outcome 2

Know how to prepare manual metal arc equipment and materials for welding

Assessment Criteria

The learner can:

1. describe types of **welding equipment**
2. describe welding **leads**
3. identify **electrode holders**
4. describe types of **return clamps**
5. describe the function and safe use of equipment used for **preparing and finishing** materials welded joints
6. describe how to prepare materials and equipment for safe welding operations

Range

Welding equipment: alternating current (a.c.) (transformer), direct current (d.c.) (transformer/rectifier, inverter, engine driven generators)

Leads: welding, return, earth

Electrode holders: fully insulated, partially insulated

Return clamps: types

Preparing and finishing: grinders (angle, mini, safe use), linishers, files, flame cutting, chipping hammer, wire brushes, hammer and chisel

Unit 213

Welding by Manual Metal Arc process

Outcome 3

Be able to produce standard welded joints safely using manual metal arc welding

Assessment Criteria

The learner can:

1. select types of **electrodes**
2. describe electrode **storage requirements**
3. select types of **welding current and polarity**
4. **apply electrode sizes to material thickness and types of joint**
5. apply **welding current ranges** to electrode sizes
6. differentiate between **welding voltages**
7. operate manual metal arc welding equipment safely
8. apply EN ISO 6947 **welding positions**
9. apply **welding techniques** in accordance with **BS 4872 part 1**.
10. apply **post welding activities**
11. describe appropriate **assembly and distortion control methods**
12. state methods of **distortion rectification**
13. use welding consumables safely
14. produce standard carbon steel or stainless steel welded joints in the EN ISO 6947 positions, minimum 5 mm thick, minimum 150 mm long using single or multiple-run welds as appropriate
15. restore the work area using the correct procedures for the disposal of waste

Range

Electrodes: cellulosic, rutile, basic, applications.

Storage requirements: temperature, humidity.

Welding current and polarity: alternating (a.c.), direct (d.c.) (electrode positive, electrode negative).

Apply electrode sizes to material thickness and types of joint: Ø2.5, Ø3.2, Ø4.0 mm; 3 mm to 10 mm thickness; butt, tee, lap, corner.

Welding current ranges to electrode sizes: Ø2.5, Ø3.2, Ø4.0 mm

Welding voltages: open circuit voltage, arc voltage.

Welding positions: flat – EN ISO 6947 PA position, horizontal/vertical – EN ISO 6947 PB position, horizontal – EN ISO 6947 PC position, vertical upwards – EN ISO 6947 PF position

Welding techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, single – run, multiple-run

BS 4872 part 1: test type, joint set-up, test piece dimensions, assessment of weld quality, destructive testing

Post welding activities: cleaning, slag removal, spatter removal, wiring brushing, removal of excess weld metal where required

Assembly and distortion control methods: clamping, alignment jigs, run on/off plates, tack welds

Distortion rectification: mechanical, thermal

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage.

Unit 213

Welding by Manual Metal Arc process

Outcome 4

Be able to visually check welds for defects

Assessment Criteria

The learner can:

1. describe **weld flaws**
2. describe **assessment criteria**
3. describe **visual assessment** techniques
4. describe **non-destructive testing** techniques
5. describe workshop **destructive testing** methods
6. perform visual checks to find weld defects
7. check weld against criteria based upon BS 4872 part 1

Range

Weld flaws: lack of continuity, even or irregular weld profile, incorrect weld size or profile, undercutting, overlap, inclusions, porosity, surface cracks, internal cracks, lack of fusion (root, side wall, inter-run), lack of penetration

Assessment criteria: qualitative (defect levels, appearance), quantitative (extent, size, dimensional accuracy)

Visual assessment: use of magnification, use of weld gauges [fillet, universal], use of illumination to aid assessment

Non-destructive testing: dye penetrant (applications, procedure, limitations) magnetic particle (techniques [current flow, magnetic flow, procedures, applications, limitations).

Destructive testing: macroscopic examination (purpose, preparation of specimen, examination of specimen) nick-break test (purpose, preparation of specimen, breaking of specimen, examination of specimen) bend tests (types [face, root, side], purpose, preparation of specimen, bending of specimen, former sizes, former arrangements, bend radius, angle of bend, examination of specimen)

Unit 214

Welding by MIG process

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	M/503/0193
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA.
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 29: Preparing and Using Manual MIG, MAG and Other Continuous Wire Welding Equipment.
Aim:	<p>This unit is to enable metal inert gas (MIG) welding skills to be developed to meet the defect acceptance requirements of BS 4872 part 1.</p> <p>The applied knowledge topics include: health and safety hazards and methods of avoiding them, preparation, electrical requirements, consumables, welding techniques, welding positions, distortion control and rectification, BS 4872 part 1 requirements and non-destructive and workshop testing.</p>

Learning outcomes

There are **four** outcomes to this unit. The learner will:

1. Know safe working practices associated with MIG welding
2. Know how to prepare MIG equipment and materials for welding
3. Be able to produce standard welded joints safely using MIG welding
4. Be able to visually check welds for defects

Unit 214

Welding by MIG process

Outcome 1

Know safe working practices associated with MIG welding

Assessment Criteria

The learner can:

1. identify Personal Protective Equipment (**PPE**) use in relation to welding process
2. describe the use of Personal Protective Equipment (**PPE**) in MIG welding
3. describe the hazards from:
 - a. **welding fume**
 - b. **electricity**
 - c. **arc radiation**
 - d. **hot metal/sparks**

Range

PPE: headshield, filter lens, cover lens, light reactive filters, gauntlets, protective footwear, eye protection, flame retardant overalls, leather apron, scull cap, leather jacket, factors render PPE provided as protection against the above ineffective or unsafe

Welding fume: types of fume (visible [particulate], invisible [gaseous]: ozone (O₃), carbon monoxide [CO], oxides of nitrogen, nitrous oxide [NO], nitrogen dioxide [NO₂], use of extraction (background, local, natural ventilation [e.g. on-site], air-fed headshields, respirator

Electricity: shock hazards (use of electrical insulation [condition, correct size, correct connection, tightness of connection] welding lead, welding return, welding earth); fire, burns

Arc radiation: visible light, infra-red, ultra-violet, PPE (types, purpose), screening (types, purpose), warnings (verbal, notices)

Hot metal/sparks: means of avoiding hazards (identification of hazard, use of tools [tongs, etc], use of PPE

Unit 214

Welding by MIG process

Outcome 2

Know how to prepare MIG equipment and materials for welding

Assessment Criteria

The learner can:

1. describe types of **welding equipment**
2. describe welding **leads**
3. identify **guns/torches**
4. describe types of return clamps
5. describe the function and safe use of equipment used for **preparing and finishing** materials welded joints
6. describe how to prepare materials and equipment for safe welding operations

Range

Welding equipment: direct current (d.c.) (transformer/rectifier, inverter, engine driven generators)

Leads: welding (water cooled, air cooled, construction of lead, supplies to gun/torch), return, earth

Guns/torches: goose neck, pistol, push, pull, push-pull, reel-on-gun, water cooled, air cooled

Preparing and finishing: grinders (angle, mini, safe use), linishers, files, flame cutting, chipping hammer, wire brushes, hammer and chisel

Unit 214

Welding by MIG process

Outcome 3

Be able to produce standard welded joints safely using MIG welding

Assessment Criteria

The learner can:

1. select types of **electrodes**
2. describe electrode **storage requirements**
3. select types of **welding current and polarity**
4. apply **electrode sizes to material thickness and types of joint**
5. relate arc voltage and wire feed speed ranges to electrode sizes
6. differentiate between **welding voltages**
7. classify **shielding gases** for welding
8. operate MIG welding equipment safely
9. apply EN ISO 6947 **welding positions**
10. apply **welding techniques** in accordance with **BS 4872 part 1**.
11. **apply post welding activities**
12. describe **appropriate assembly and distortion control methods**
13. state methods of **distortion rectification**
14. use welding consumables safely
15. produce standard carbon steel or stainless steel welded joints in the EN ISO 6947 positions, minimum 5 mm thick, minimum 150 mm long using single or multiple-run welds as appropriate.
16. **restore the work area** using the correct procedures for the disposal of waste

Range

Electrodes: solid wires (copper coated, uncoated, reel sizes), cored wire (flux cored, iron cored, self-shielded)

Storage requirements: temperature, humidity

Welding current and polarity: direct (d.c.) (electrode positive)

Electrode sizes to material thickness and types of joint: Ø2.5, Ø3.2, Ø4.0 mm; 3 mm to 10 mm thickness; butt, tee, lap, corner

Arc voltage and wire feed speed ranges to electrode sizes: Ø0.8, Ø1.0, Ø1.2 mm

Welding voltages: open circuit voltage, arc voltage

Shielding gases: inert (argon, helium, argon/helium mixtures) active (carbon dioxide [CO₂], argon/oxygen [O₂], argon/CO₂, argon/O₂/CO₂, argon/helium/O₂/CO₂), applications

Welding positions: flat – EN ISO 6947 PA position, horizontal/vertical – EN ISO 6947 PB position, horizontal – EN ISO 6947 PC position, vertical upwards – EN ISO 6947 PF position

Welding techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, single – run, multiple-run

BS 4872 part 1: test type, joint set-up, test piece dimensions, assessment of weld quality, destructive testing

Post welding activities: cleaning, slag removal, spatter removal, wiring brushing, removal of excess weld metal where required

Assembly and distortion control methods: clamping, alignment jigs, run on/off plates, tack welds

Distortion rectification: mechanical, thermal

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage

Unit 214

Welding by MIG process

Outcome 4

Be able to visually check welds for defects

Assessment Criteria

The learner can:

1. describe **weld flaws**
2. describe **assessment criteria**
3. describe **visual assessment** techniques
4. describe **non-destructive testing** techniques
5. describe workshop **destructive testing** methods
6. perform visual checks to find weld defects in accordance with BS 4872 part 1

Range

Weld flaws: lack of continuity, even or irregular weld profile, incorrect weld size or profile, undercutting, overlap, inclusions, porosity, surface cracks, internal cracks, lack of fusion (root, side wall, inter-run), lack of penetration

Assessment criteria: qualitative (defect levels, appearance), quantitative (extent, size, dimensional accuracy)

Visual assessment: use of magnification, use of weld gauges [fillet, universal], use of illumination to aid assessment

Non-destructive testing: dye penetrant (applications, procedure, limitations) magnetic particle (techniques [current flow, magnetic flow, procedures, applications, limitations)

Destructive testing: macroscopic examination (purpose, preparation of specimen, examination of specimen) nick-break test (purpose, preparation of specimen, breaking of specimen, examination of specimen) bend tests (types [face, root, side], purpose, preparation of specimen, bending of specimen, former sizes, former arrangements, bend radius, angle of bend, examination of specimen)

Unit 215

Welding by TIG process

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	T/503/0194
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 28: Preparing and Using Manual TIG or Plasma-arc Welding Equipment.
Aim:	<p>This unit is to enable tungsten inert gas (TIG) welding skills to be developed to meet the defect acceptance requirements of BS 4872 part 1 in steel or stainless steel and part 2: Aluminium/aluminium alloys within their scopes.</p> <p>The applied knowledge topics include: health and safety hazards and methods of avoiding them, preparation, electrical requirements, consumables, welding techniques, welding positions, distortion control and rectification, BS 4872 requirements and non-destructive and workshop testing.</p>

Learning outcomes

There are **four** learning outcomes to this unit. The learner will:

1. Know safe working practices associated with TIG welding
2. Know how to prepare TIG equipment and materials for welding
3. Be able to produce standard welded joints safely using TIG welding
4. Be able to visually check welds for defects

Unit 215

Welding by TIG process

Outcome 1

Know safe working practices associated with TIG welding

Assessment Criteria

The learner can:

1. identify Personal Protective Equipment (**PPE**) used in relation to welding process
2. describe the use of Personal Protective Equipment (**PPE**) in TIG welding
3. describe the hazards from:
 - a. **welding fume**
 - b. **electricity**
 - c. **arc radiation**
 - d. **hot metal**

Range

PPE: headshield, filter lens, cover lens, light reactive filters, gauntlets, protective footwear, eye protection, flame retardant overalls, scull cap, factors render PPE provided as protection against the above ineffective or unsafe

Welding fume: types of fume (visible [particulate], invisible [gaseous]: ozone (O₃), oxides of nitrogen, nitrous oxide [NO], nitrogen dioxide [NO₂], use of extraction (background, local, natural ventilation [e.g. on-site]), air-fed headshields, respirator

Electricity: shock hazards (use of electrical insulation [condition, correct size, correct connection, tightness of connection] welding lead, welding return, welding earth); fire, burns

Arc radiation: visible light, infra-red, ultra-violet, PPE (types, purpose), screening (types, purpose), warnings (verbal, notices)

Hot metal: means of avoiding hazards (identification of hazard, use of tools [tongs, etc], use of PPE

Unit 215

Welding by TIG process

Outcome 2

Know how to prepare TIG equipment and materials for welding

Assessment Criteria

The learner can:

1. describe types of **welding equipment**
2. describe welding **leads**
3. identify guns/torches
4. describe types of return clamps
5. describe the function and safe use of equipment used for **preparing and finishing** materials welded joints
6. prepare materials and equipment for safe welding operations

Range

Welding equipment: direct current (d.c.) (transformer/rectifier, inverter, engine driven generators, a.c./d.c. converters)

Leads: welding (water cooled, air cooled, construction of lead, supplies to gun/torch), return, earth

Guns/torches: water cooled, air cooled, pencil

Preparing and finishing: grinders (angle, mini, safe use), finishers, files, wire brushes

Unit 215

Welding by TIG process

Outcome 3

Be able to produce standard welded joints safely using TIG welding

Assessment Criteria

The learner can:

1. select types of **electrodes**
2. select **filler wires**
3. describe filler wire **storage requirements**
4. select types of **welding current and polarity**
5. relate electrode sizes to material thickness and types of joint and types of current
6. relate welding current ranges to electrode sizes
7. differentiate between **welding voltages**
8. classify **shielding gases** for welding
9. operate TIG welding equipment safely
10. apply EN ISO 6947 **welding positions**
11. apply **welding techniques** in accordance with **BS 4872** part 1 and **BS 4872** part 2
- 12. apply post welding activities**
13. describe appropriate **assembly and distortion control methods**
14. state methods of **distortion rectification**
15. produce standard carbon steel or stainless steel welded joints in the EN ISO 6947 positions, less than 5 mm thick, minimum 150 mm long using single or multiple-run welds as appropriate
16. **restore the work area** using the correct procedures for the disposal of waste

Range

Electrodes: thoriated, zirconiated, ceriated, lanthanated, applications, identification, sizes (\varnothing 1.6, \varnothing 2.4, \varnothing 3.2 mm)

Filler wires: copper coated steel, uncoated, common sizes (\varnothing 1.6, \varnothing 2.4, \varnothing 3.2 mm)

Storage requirements: temperature, humidity

Welding current and polarity: direct (d.c.) (electrode negative: heat distribution, reasons for d.c.), alternating (a.c.) (heat distribution, reasons for a.c.)

Welding voltages: open circuit voltage, arc voltage

Shielding gases: inert (argon, helium, argon/helium mixtures) active (argon/hydrogen [H₂]), applications

Welding positions: flat – EN ISO 6947 PA position, horizontal/vertical – EN ISO 6947 PB position, horizontal – EN ISO 6947 PC position, vertical upwards – EN ISO 6947 PF position

Welding techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, single – run, multiple-run

BS 4872: test type, joint set-up, test piece dimensions, assessment of weld quality, destructive testing

Post welding activities: cleaning, slag removal, spatter removal, wiring brushing, removal of excess weld metal where required

Assembly and distortion control methods: clamping, alignment jigs, run on/off plates, tack welds

Distortion rectification: mechanical, thermal

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage.

Unit 215

Welding by TIG process

Outcome 4

Be able to visually check welds for defects

Assessment Criteria

The learner can:

1. describe **weld flaws**
2. describe **assessment criteria**
3. describe **visual assessment** techniques
4. describe **non-destructive testing** techniques
5. describe workshop **destructive testing** methods
6. perform visual checks to find weld defects against criteria based upon BS 4872

Range

Weld flaws: lack of continuity, even or irregular weld profile, incorrect weld size or profile, undercutting, overlap, inclusions, porosity, surface cracks, internal cracks, lack of fusion (root, side wall, inter-run), lack of penetration

Assessment criteria: qualitative (defect levels, appearance), quantitative (extent, size, dimensional accuracy)

Visual assessment: use of magnification, use of weld gauges [fillet, universal], use of illumination to aid assessment

Non-destructive testing: dye penetrant (applications, procedure, limitations) magnetic particle (techniques [current flow, magnetic flow, procedures, applications, limitations)

Destructive testing: macroscopic examination (purpose, preparation of specimen, examination of specimen) nick-break test (purpose, preparation of specimen, breaking of specimen, examination of specimen) bend tests (types [face, root, side], purpose, preparation of specimen, bending of specimen, former sizes, former arrangements, bend radius, angle of bend, examination of specimen)

Unit 216

Welding by Oxy-Acetylene process

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	A/503/0195
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 30: Preparing and Using Manual Gas Welding Equipment.
Aim:	<p>This unit is to enable oxy-acetylene (gas) welding skills to be developed to meet the defect acceptance requirements of BS 4872 part 1 in steel within its scope.</p> <p>The applied knowledge topics include: health and safety hazards and methods of avoiding them, preparation, electrical requirements, consumables, welding techniques, welding positions, distortion control and rectification, BS 4872 part 1 requirements and non-destructive and workshop testing.</p>

Learning outcomes

There are **four** learning outcomes to this unit. The learner will

1. Know safe working practices associated with oxy-acetylene welding
2. Be able to prepare oxy-acetylene equipment and materials for welding
3. Be able to produce standard welded joints safely using oxy-acetylene welding
4. Be able to visually check welds for defects

Unit 216

Welding by Oxy-Acetylene process

Outcome 1

Know safe working practices associated with oxy-acetylene welding

Assessment Criteria

The learner can:

1. identify Personal Protective Equipment (**PPE**) in relation to welding process
2. describe the use of Personal Protective Equipment (**PPE**) in oxy-acetylene welding
3. state the **hazards** from:
 - a. **welding fume**
 - b. **hot metal**

Range

PPE: goggles, filter lens, cover lens, gloves, protective footwear, eye protection, flame retardant overalls, leather apron, scull cap, leather jacket, factors render PPE provided as protection against the above ineffective or unsafe

Welding fume: types of fume (visible [particulate], invisible [gaseous]: carbon monoxide [CO], carbon dioxide [CO₂], use of extraction (background, local, natural ventilation [e.g. on-site], respirator

Hot metal: means of avoiding hazards (identification of hazard, use of tools [tongs, etc], use of PPE

Hazards: sources of combustion, compressed gas cylinders (safe: storage conditions. handling/moving, use)

Unit 216

Welding by Oxy-Acetylene process

Outcome 2

Be able to prepare oxy-acetylene equipment and materials for welding

Assessment Criteria

The learner can:

1. describe the set-up of the **welding equipment**
2. describe function of **components** of oxy-acetylene welding equipment
3. select welding **variables**
4. select **flame condition**
5. prepare materials and equipment for safe welding operations

Range

Welding equipment: cylinders, pressure regulators, flashback arrestors, hoses, hose check-valves, hose connectors, blowpipe/torch, nozzles

Components: cylinders (oxygen, acetylene, colour coding), pressure regulators (types: single-stage, two-stage), flashback arrestors, hoses, hose check-valves, hose connectors, blowpipe/torch, nozzles (sizes, selection), use of left hand and right hand threaded connections (identification)

Variables: gas pressures, nozzle size, welding technique (leftward)

Flame condition: neutral, oxidising, carburising/reducing, parts of the flame (inner cone, outer envelope, hottest point, typical flame temperature)

Unit 216

Welding by Oxy-Acetylene process

Outcome 3

Be able to produce standard welded joints safely using oxy-acetylene welding

Assessment Criteria

The learner can:

1. select **filler rods**
2. describe filler rod **storage requirements**
3. classify **gases** for welding
4. relate nozzle sizes and joint thicknesses
5. relate filler rod sizes and joint thicknesses
6. relate gas pressures and joint thicknesses
7. operate oxy-acetylene welding equipment safely
8. apply EN ISO 6947 **welding positions**
9. apply **welding techniques** in accordance with apply **BS 4872 part 1**.
10. produce standard carbon steel or stainless steel welded joints in the EN ISO 6947 positions, 1.0 to 3.0 mm thick, minimum 150 mm long using single or multiple-run welds as appropriate
11. apply **post welding activities**
12. describe appropriate **assembly and distortion control methods**
13. state methods of **distortion rectification**
14. **restore the work area** using the correct procedures for the disposal of waste

Range

Filler rods: copper coated steel (function of coating), common sizes (Ø1.6, Ø2.4, Ø3.2 mm)

Storage requirements: temperature, humidity

Gases: oxygen and acetylene (cylinder colours, hose colours, hazards associated with their use and how to avoid them)

Welding positions: flat – EN ISO 6947 PA position, horizontal/vertical – EN ISO 6947 PB position, horizontal – EN ISO 6947 PC position, vertical upwards – EN ISO 6947 PF position

Welding techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, single – run, multiple-run

BS 4872 part 1: test type, joint set-up, test piece dimensions, assessment of weld quality, destructive testing

Post welding activities: cleaning, slag removal, spatter removal, wiring brushing, removal of excess weld metal where required

Assembly and distortion control methods: clamping, alignment jigs, run on/off plates, tack welds

Distortion rectification: mechanical, thermal

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage.

Unit 216

Welding by Oxy-Acetylene process

Outcome 4

Be able to visually check welds for defects

Assessment Criteria

The learner can:

1. describe **weld flaws**
2. describe **assessment criteria**
3. describe **visual assessment** techniques
4. describe **non-destructive testing** techniques
5. describe workshop **destructive testing** methods
6. perform visual checks on to find weld defects against criteria based upon BS 4872 part 1

Range

Weld flaws: lack of continuity, even or irregular weld profile, incorrect weld size or profile, undercutting, overlap, inclusions, porosity, surface cracks, internal cracks, lack of fusion (root, side wall, inter-run), lack of penetration

Assessment criteria: qualitative (defect levels, appearance), quantitative (extent, size, dimensional accuracy)

Visual assessment: use of magnification, use of weld gauges [fillet, universal], use of illumination to aid assessment

Non-destructive testing: dye penetrant (applications, procedure, limitations) magnetic particle (techniques [current flow, magnetic flow, procedures, applications, limitations)

Destructive testing: macroscopic examination (purpose, preparation of specimen, examination of specimen) nick-break test (purpose, preparation of specimen, breaking of specimen, examination of specimen) bend tests (types [face, root, side], purpose, preparation of specimen, bending of specimen, former sizes, former arrangements, bend radius, angle of bend, examination of specimen)

Unit 217

Fabricating sheet metalwork

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	F/503/0196
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 22: Producing Sheet Metal Components and Assemblies
Aim:	<p>This unit is concerned with the underlying process technology associated with the fabrication of sheet metal products, in terms of cutting, forming, assembly and joining of sheet metal.</p> <p>It covers the health and safety considerations associated with cutting, forming, assembly and joining of sheet metal.</p>

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Be able to prepare equipment and tools for sheet metal cutting
2. Be able to use equipment, tools and materials for sheet metal forming
3. Be able to produce fabrications using sheet metalwork assembly techniques

Unit 217

Fabricating sheet metalwork

Outcome 1

Be able to prepare equipment and tools for sheet metal cutting

Assessment Criteria

The learner can:

1. prepare **equipment** and **tools** for a cutting operation
2. prepare **materials** for a cutting operation

Range

Equipment: drills (bench, pillar, portable), rotary shears (portable, nibblers [shear type, punch type], guillotines (treadle, mechanical, back stops, front stops, guards), fly press, power punch, portable angle grinders/sanders, health and safety considerations

Tools: hand shears (straight, left hand, right hand, universal), bench shears (hand-lever) tinman's hand-level punch, health and safety considerations

Materials: methods of marking out, use of datums (line, edge, centre point), avoiding damage to surface coatings, minimal wastage, health and safety considerations

Unit 217

Fabricating sheet metalwork

Outcome 2

Be able to use equipment, tools and materials for sheet metal forming

Assessment Criteria

The learner can:

1. use **equipment** and **tools** for a **forming** operation
2. use **stiffening techniques** to strengthen materials
3. operate equipment safely

Range

Equipment: jennys (tooling) rolling machines (pyramid type, pinch type, slip rolls, hand-operated), folding machines (box and pan, universal swing-beam), fly press (tooling: dies, forming tools), health and safety considerations

Tools: hammers, planishing hammers, mallets, wooden blocks, range of bench stakes

Forming: forms (square, rectangular, cylindrical, cones, boxed), hand forming techniques (hollowing, raising, planishing, flanging, 'split and weld' methods, health and safety considerations

Stiffening techniques: swaging, beading, wired edges [including false], folds, flanging, reinforcement, diamond break, health and safety considerations

Unit 217

Fabricating sheet metalwork

Outcome 3

Be able to produce fabrications using sheet metalwork assembly techniques

Assessment Criteria

The learner can:

1. use of sheet metalwork **assembly** and **joining techniques** to produce fabrications to the required shape/geometry within ± 3.0 mm
2. produce fabrications that have secure and firm joints and are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs
3. produce fabricated assemblies safely
4. **restore the work area** using the correct procedures for the disposal of waste

Range

Assembly: holding methods, clamping, distortion control methods

Joining techniques:

- non self-secured joints
- self-secured joints, mechanical joining methods
- soldering techniques, cleaning the soldered joint
- brazing techniques, cleaning the joint, types of brazing alloys, types of flux, heat sources
- resistance welding
- MIG welding equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires, shielding gases used for the welding of carbon steels, PERSONAL PROTECTIVE EQUIPMENT (PPE), fume removal
- TIG welding equipment/consumables: direct current [d.c.] electrode negative, methods of arc ignition, welding torches, tungsten electrodes for the welding of steels, electrode sizes, filler wire sizes, shielding gas used for the welding of carbon steels: argon, Personal Protective Equipment (PPE)

Additional Guidance

Joining techniques:

- non self-secured joints (lap, corner, butt, tee, joggled lap, flanged butt, lock seam, bottom seam [internal lap, external lap])
- self-secured joints (grooved seam, panned down, slip joint, allowances); mechanical joining methods (solid riveting, hollow riveting, threaded fastenings)
- soldering techniques (preparing the joint, cleaning the joint, types of soft solder, types of flux, types of soldered iron, heat sources [electrical, flame], cleaning the soldered joint)
- brazing techniques (preparing the joint, cleaning the joint, types of brazing alloys, types of flux, heat sources [flame, gas mixtures], cleaning the brazed joint)
- resistance welding (spot, seam, the electrodes available for spot welding, electrode functions (gripping, exertion of force, passage of high current) electrode material, electrode tip geometry (domed end, truncated cone)
- MIG welding (equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires [$\text{\O}0.6$ mm, $\text{\O}0.8$ mm], shielding gases

used for the welding of carbon steels: carbon dioxide [CO₂], argon / CO₂, argon/oxygen/CO₂), Personal Protective Equipment (PPE), fume removal)

- TIG welding (equipment/consumables: direct current [d.c.] electrode negative, methods of arc ignition, welding torches, tungsten electrodes for the welding of steels: [thoriated, ceriated, lanthanated], electrode sizes [Ø1.6 mm, Ø2.4 mm], filler wire sizes [Ø1.6 mm, Ø2.4 mm], shielding gas used for the welding of carbon steels: argon, Personal Protective Equipment (PPE))

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 218

Fabricating thick plate, bar and sections

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	J/503/0197
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 23: Producing Platework Components and Assemblies
Aim:	<p>This unit is concerned with the underlying process technology associated with the fabrication of thick plate bar and rolled sections, in terms of: cutting, forming, assembly and joining of thick plate bar and rolled sections fabrication.</p> <p>It covers health and safety hazards associated with cutting (including oxy-fuel gas), forming, assembly and joining of thick plate bar and rolled sections fabrication.</p>

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Be able to prepare equipment, tools and materials for cutting of thick plate, bar and rolled sections
2. Be able to use equipment and tools for thick plate, bar and rolled sections
3. Be able to produce fabrications using thick plate and rolled bar sections joining techniques

Unit 218

Fabricating thick plate, bar and sections

Outcome 1

Be able to prepare equipment, tools and materials for cutting of thick plate, bar and rolled sections

Assessment Criteria

The learner can:

1. prepare **equipment** for a cutting operation
2. prepare **materials** for a cutting operation
3. operate equipment safely

Range

Equipment:

- drills
- rotary shears
- guillotines
- power punch
- cutting-off wheel machines
- oxy-fuel gas cutting: process, equipment, safe storage conditions, hazards from hot metal/sparks, types of gasses, cylinders types and identification, flashback arrestors, hose types and identification, connector types and identification, hose check valves, cutting torch, flashback arrestors, cutting nozzles guides, portable track cutting machines
- grinders
- lifting equipment, wall and overhead mounted travelling cranes, fork lift trucks, pallets and pallet truck, block and tackle, pull/lift lever hoist, engine hoist, chains, ropes, slings, shackles, lifting eyes, friction clamps, welded lugs, lifting capacity

Materials: methods of marking out, use of datums (line, edge, centre point), avoiding damage to surface coatings, minimal wastage, health and safety considerations

Additional Guidance

Equipment:

- drills (bench, pillar, portable)
- rotary shears (portable, nibblers [shear type, punch type])
- guillotines (mechanical, back stops, front stops, guards)
- power punch
- cutting-off wheel machines
- oxy-fuel gas cutting (process, equipment (recognise the hazards from compressed gas cylinders [safe: storage conditions, handling/moving, use, start-up and shut down procedures, dealing with a backfire/flashback], hazards from hot metal/sparks, types of gasses, cylinders types and identification, flashback arrestors, hose types and identification, connector types and identification, hose check valves [protectors], cutting torch, flashback arrestors, cutting nozzles [types, gouging], guides [bevel, circle, radius bar], portable track cutting machines)
- grinders (portable angle grinders/sanders, bench, pedestal)

- lifting equipment (common forms of injury, use lifting aids [straps, bars, harnesses], wall and overhead mounted travelling cranes, fork lift trucks, pallets and pallet truck, block and tackle, pull/lift lever hoist, engine hoist, chains, ropes, slings, shackles, lifting eyes, friction clamps, welded lugs, lifting capacity [safe working load {SWL}])

Unit 218

Fabricating thick plate, bar and sections

Outcome 2

Be able to use equipment and tools for thick plate, bar and rolled sections

Assessment Criteria

The learner can:

1. use equipment for **forming** thick plate, bar and rolled sections
2. use equipment for **assembling** thick plate, bar and rolled sections to the required shape/geometry within ± 3.0 mm
3. operate equipment safely
4. produce fabricated assemblies safely

Range

Forming: hot and cold bending (principles – application of heat, hand methods [clamps, vices, levers], bench mounted machines [types, applications], bench bending around a former, fly press [principles, tooling], brake press [principles, tooling], springback [principle, allowances], ‘split and weld’ methods, health and safety considerations

Assembling: work holding (clamps, pins, plate dogs, wedges, tack welding), work alignment (strong backs, clamping dogs, wedges, draw-bolts and cleats, bridge pieces, toggle clamps, alignment jigs), distortion control (tack welding, presetting, weld sequencing)

Unit 218

Fabricating thick plate, bar and sections

Outcome 3

Be able to produce fabrications using thick plate and rolled bar sections joining techniques

Assessment Criteria

The learner can:

1. use thick plate **joining techniques** to produce fabrications to the required shape/geometry within ± 3.0 mm
2. produce fabrications that have secure and firm joints and are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs
3. join fabricated assemblies safely
4. **restore the work area** using the correct procedure for the disposal of waste

Range

Joining techniques:

- solid rivets
- bolts and nuts
- screwed fastenings types of screwed fastening, cap/cheese head, round head, countersunk, self-tapping, use of hank bushes, use of taps and dies
- use of welded joints
- manual metal arc (MMA) welding equipment/consumables, techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, Personal Protective Equipment (PPE), fume removal
- MIG welding equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires shielding gases used for the welding of carbon steels: carbon dioxide [CO₂], argon/CO₂, argon/oxygen/CO₂), Personal Protective Equipment (PPE), fume removal

Additional Guidance

Joining techniques:

- solid rivets (single lap, double lap, single strap, double strap; types of rivet head: flat, countersunk, round [or snap], pan, mushroom, applications; riveting defects; causes of joint failure [tearing of metal, crushing of metal, splitting of metal, shearing of rivet; allowances; sources of pressure: hammers, pneumatic, hydraulic)
- bolts and nuts (types of bolts: black, turned, high-strength friction-grip, cap/cheese head; types of nuts: hexagonal, split, self-locking, wing, castellated, domed; use of washers: flat, taper, spring; defects in bolted connections; use of podging spanners and drifts; allowances)
- screwed fastenings (types of screwed fastening, cap/cheese head, round head, countersunk, self-tapping, use of hank bushes, use of taps and dies
- use of welded joints (lap, corner, butt, tee)
- manual metal arc (MMA) welding (equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads [welding, return, earth], electrode holders, return clamps, chipping hammer, wire brushes, electrode sizes [$\varnothing 2.5$, 3.2 $\varnothing 4.0$ mm] techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, Personal Protective Equipment (PPE), fume removal)

- MIG welding (equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires [Ø0.6 mm, Ø0.8 mm], shielding gases used for the welding of carbon steels: carbon dioxide [CO₂], argon/CO₂, argon/oxygen/CO₂), Personal Protective Equipment (PPE), fume removal)

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 219

Fabricating pipework assemblies

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	L/503/0198
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 7: Forming and Assembling Pipework Systems.
Aim:	This unit is concerned with the underlying process technology associated with the fabrication of pipework assemblies, in terms of: cutting, forming, assembly and joining of thick plate bar and rolled sections fabrication. It covers health and safety hazards associated with cutting (including oxy-fuel gas), forming, assembly and joining of pipework assemblies. The joining methods include non-thermal techniques: mechanical – bolting, screwed and thermal: soldering, MMA, MIG and TIG welding.

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Be able to prepare equipment, tools and materials for cutting pipework
2. Be able to use equipment and tools for fabricating pipework
3. Be able to produce and test fabricated pipework assemblies using joining techniques

Unit 219

Fabricating pipework assemblies

Outcome 1

Be able to prepare equipment, tools and materials for cutting pipework

Assessment Criteria

The learner can:

1. prepare **equipment** and **tools** for a cutting operation
2. prepare **materials** for a cutting operation
3. operate equipment safely

Range

Equipment and tools:

- drills (bench, pillar, portable)
- cutting-off wheel machines
- hand-held rotary pipe cutters
- machine rotary pipe cutters
- bandsaw
- oxy-fuel gas cutting process, equipment, recognise the hazards from compressed gas cylinders, hazards from hot metal/sparks, types of gasses, cylinders types and identification, flashback arrestors, hose types and identification, connector types and identification, hose check valves, cutting torch, flashback arrestors, cutting nozzles, orbital pipe cutting machines)
- grinders
- lifting equipment, wall and overhead mounted travelling cranes, fork lift trucks, pallets and pallet truck, block and tackle, pull/lift lever hoist, engine hoist, chains, ropes, slings, shackles, lifting eyes, friction clamps, welded lugs, lifting capacity

Materials:

- graphical representation of pipework block plans and plant layout, plant equipment and positions, piping assembly drawings, isometric sub-assemblies; symbols for pipelines, joints, welds, equipment and components
- methods of marking out, use of datums, avoiding damage to surface coatings, minimal wastage
- forms of supply : copper: solid drawn, annealed; carbon steel: hot finished seamless, cold finished seamless, electric resistance welded; galvanised steel; austenitic stainless steel; plastic; sizes fittings: welded, soldered, plastic socket
- health and safety considerations

Additional Guidance

Equipment and tools:

- drills (bench, pillar, portable)
- cutting-off wheel machines
- hand-held rotary pipe cutters
- machine rotary pipe cutters
- bandsaw
- oxy-fuel gas cutting (process, equipment (recognise the hazards from compressed gas cylinders [safe: storage conditions, handling/moving, use, start-up and shut down procedures, dealing with a backfire/flashback], hazards from hot metal/sparks, types of gasses, cylinders types and identification, flashback arrestors, hose types and identification, connector types and identification, hose check valves [protectors], cutting torch, flashback arrestors, cutting nozzles, orbital pipe cutting machines)
- grinders (portable angle grinders/sanders, internal grinding)
- lifting equipment (common forms of injury, use lifting aids [straps, bars, harnesses], wall and overhead mounted travelling cranes, fork lift trucks, pallets and pallet truck, block and tackle, pull/lift lever hoist, engine hoist, chains, ropes, slings, shackles, lifting eyes, friction clamps, welded lugs, lifting capacity [safe working load {SWL}])

Materials:

- graphical representation of pipework (block plans and plant layout, plant equipment and positions, piping assembly drawings, isometric sub-assemblies; symbols for pipelines, joints, welds, equipment and components)
- methods of marking out, use of datums (line, edge, centre point), avoiding damage to surface coatings, minimal wastage
- forms of supply (copper: solid drawn, annealed; carbon steel: hot finished seamless, cold finished seamless, electric resistance welded; galvanised steel; austenitic stainless steel; plastic; sizes [outside diameter, inside diameter, wall thickness, nominal bore])
- fittings (welded: butt, fillet, slip-on flanges, socket welded; screwed; friction [compression]; soldered [pre-applied, plain soldered]; plastic socket)
- health and safety considerations

Unit 219

Fabricating pipework assemblies

Outcome 2

Be able to use equipment and tools for fabricating pipework

Assessment Criteria

The learner can:

1. use equipment for **forming** pipework
2. use equipment for **assembling** pipework to the required specification within ± 3.0 mm
3. operate equipment safely
4. produce fabricated pipework assemblies safely

Range

Forming:

- hot bending (principles – application of heat, wire templates, control of pipe deformation [sand packing], use of pin blocks [pins, dogs])
- cold bending (hand methods [types, applications], machines methods [types, applications], wire templates, control of pipe deformation, springback [principle, allowances])
- health and safety considerations

Assembling:

- branches (equal, unequal, set-on, lateral, straight to elbow), trunions (equal, unequal, set-on, straight to elbow)
- fittings (elbows, tees, reducers [eccentric, concentric], flanges [weld-neck, slip-on, screwed, blanks], unions, couplings, weldolets, elbowlets, lateralets, end caps)
- work holding (full-scale setting out, pipe vice, pipe clamps, pin blocks, vee blocks, wedges, tack welding)
- work alignment (wedges, podger spanners, square, spirit level)
- distortion control (tack welding, presetting, weld sequencing)

Unit 219

Fabricating pipework assemblies

Outcome 3

Be able to produce and test fabricated pipework assemblies using joining techniques

Assessment Criteria

The learner can:

1. use pipework **joining techniques** to produce fabrications to the required specification within ± 3.0 mm
2. join fabricated assemblies safely
3. produce pipework fabrications that have secure and firm joints and are free from excessive tooling marks, deformation, cracking, or leaks
4. **test pipework** to prove joint effectiveness
5. **restore the work area** using the correct procedures for the disposal of waste

Range

Joining techniques:

- bolts and nuts, use of washers, use of jointing compounds, use of podging spanners and drifts, allowances, methods of freeing or disconnecting seized bolted joints, dispelling scales and corrosion, sawing / chiselling, solvents application of heat
- use of gaskets
- use of seals
- use of spanners
- screwed connections
- compression joints, push-fit fitting connection
- cemented/glued fitting connections
- soldered
- use of welded joints
- manual metal arc (MMA) welding (equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads electrode holders, return clamps, chipping hammer, wire brushes, electrode sizes techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, Personal Protective Equipment (PPE), fume removal
- MIG welding equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires, shielding gases used for the welding of carbon steels: carbon dioxide [CO₂], argon/CO₂, argon/oxygen/CO₂), Personal Protective Equipment (PPE), fume removal
- TIG welding (equipment/consumables: direct current [d.c.] electrode negative, methods of arc ignition, welding torches, tungsten electrodes for the welding of steels, electrode sizes filler wire sizes, shielding gas used for the welding of carbon steels: argon, Personal Protective Equipment (PPE)
- health and safety considerations

Test pipework: hydrostatic, pneumatic and vacuum (principle, test media, test pressure, test method, methods of detecting leakage, safety factors)

Additional Guidance

Joining techniques

- bolts and nuts (types of bolts: black, turned, high-strength friction-grip, cap/cheese head; types of nuts: hexagonal, split, self-locking, wing, castellated, domed; use of washers: flat, taper, spring; defects in bolted connections, use of jointing compounds [grease, copper]; use of podging spanners and drifts; allowances; methods of freeing or disconnecting seized bolted joints [shock loading {impact}, dispelling scales and corrosion, sawing / chiselling, solvents application of heat.
- use of gaskets
- use of seals
- use of spanners (adjustable, ring, combination, podging, socket)
- screwed connections (thread types, methods of pipe thread cutting, threading allowances, jointing compounds, sealing tapes, methods of tightening)
- compression joints (types, principle, allowances, methods of preparation, methods of tightening)
- push-fit fitting connection (advantages and disadvantages)
- cemented/glued fitting connections (methods of joint preparation, types of adhesive, joining methods, safety precautions [ventilation, away from sources of ignition, avoiding skin contact], checking of joints)
- soldered (types, pre-applied solder, plain soldered [types of solder, types of flux, techniques])
- use of welded joints (lap, corner, butt, tee)
- manual metal arc (MMA) welding (equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads [welding, return, earth], electrode holders, return clamps, chipping hammer, wire brushes, electrode sizes [Ø2.5, 3.2 Ø 4.0 mm] techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, PPE, fume removal)
- MIG welding (equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires [Ø0.6 mm, Ø0.8 mm], shielding gases used for the welding of carbon steels: carbon dioxide [CO₂], argon/CO₂, argon/oxygen/CO₂), PPE, fume removal)
- TIG welding (equipment/consumables: direct current [d.c.] electrode negative, methods of arc ignition, welding torches, tungsten electrodes for the welding of steels: [thoriated, ceriated, lanthanated], electrode sizes [Ø1.6 mm, Ø2.4 mm], filler wire sizes [Ø1.6 mm, Ø2.4 mm], shielding gas used for the welding of carbon steels: argon, PPE)

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 220

Fabricating steel work assemblies

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	R/503/0199
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 66: General Fabrication and Welding Applications
Aim:	This unit is concerned with the underlying process technology associated with the fabrication of steelwork assemblies, in terms of: cutting, assembly and joining of thick plate bar and rolled sections fabrication. It covers health and safety hazards associated with cutting (including oxy-fuel gas), assembly and joining of steelwork assemblies. The joining methods include non-thermal techniques: mechanical – bolting and thermal: MMA and MIG welding.

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Be able to prepare equipment and materials for cutting steelwork
2. Be able to use equipment for fabricating steelwork
3. Be able to produce fabricated steelwork assemblies using joining techniques

Unit 220

Fabricating steel work assemblies

Outcome 1

Be able to prepare equipment and materials for cutting steelwork

Assessment Criteria

The learner can:

1. prepare **equipment** and **tools** for a cutting operation
2. prepare **materials** for a cutting operation
3. operate equipment safely

Range

Equipment and tools:

- drills
- rotary shears
- guillotines power punch
- cutting-off wheel machines
- oxy-fuel gas cutting, process, equipment, recognise the hazards from compressed gas cylinders, safe: storage conditions, hazards from hot metal/sparks, types of gasses, cylinders types and identification, flashback arrestors, hose types and identification, connector types and identification, hose check valves, cutting torch, flashback arrestors, cutting nozzles, guides
- grinders
- lifting equipment
- health and safety considerations

Materials:

- methods of marking out, use of datums, avoiding damage to surface coatings, minimal wastage
- forms of supply, rolled steel equal angle, rolled steel unequal angle, rolled steel joist, universal beam, universal column, tee bar, castellated beam, structural hollow sections, rolled steel channel, galvanised
- health and safety considerations

Additional Guidance

Equipment and tools:

- drills (bench, pillar, portable)
- rotary shears (portable, nibblers [shear type, punch type])
- guillotines (mechanical, back stops, front stops, guards)
- power punch
- cutting-off wheel machines
- oxy-fuel gas cutting (process, equipment, recognise the hazards from compressed gas cylinders [safe: storage conditions, handling/moving, use, start-up and shut down procedures, dealing with a backfire/flashback], hazards from hot metal/sparks, types of gasses, cylinders types and identification, flashback arrestors, hose types and identification, connector types and identification, hose check valves (protectors), cutting torch, flashback arrestors, cutting nozzles [types, gouging], guides [bevel, circle, radius bar], portable track cutting machines)

- grinders (portable angle grinders/sanders, bench, pedestal)
- lifting equipment (common forms of injury, use lifting aids [straps, bars, harnesses], wall and overhead mounted travelling cranes, fork lift trucks, pallets and pallet truck, block and tackle, pull/lift lever hoist, engine hoist, chains, ropes, slings, shackles, lifting eyes, friction clamps, welded lugs, lifting capacity [safe working load [SWL]])
- health and safety considerations

Materials:

- methods of marking out, use of datums (line, edge, centre point), avoiding damage to surface coatings, minimal wastage
- forms of supply (sheet and plate [anti-slip platform and tread materials], rolled steel equal angle, rolled steel unequal angle, rolled steel joist [RSJ], universal beam, universal column, tee bar, castellated beam, structural hollow sections [square, rectangular, round], rolled steel channel, galvanised
- health and safety considerations

Unit 220

Fabricating steel work assemblies

Outcome 2

Be able to use equipment for fabricating steelwork

Assessment Criteria

The learner can:

1. describe **steelwork assemblies**
2. use equipment for **assembling** steelwork to the required specification within ± 3.0 mm
3. operate equipment safely
4. produce fabricated steelwork assemblies safely

Range

Steelwork assemblies:

- for access (platforms, decking, walkways, stairways, hooped ladders, handrailing)
- for support (saddles, brackets, cleats, frameworks, bracings, ties)
- for security (gates, guards, barriers, fencing, cages, compounds)
- connections (splices, splice plates, gusset plates, end cleats, flange cleats, web cleats, contact surfaces, packers, shims, fish plates, knees, apexes)

Assembling: work holding (clamps, pins, plate dogs, wedges, tack welding), work alignment (strong backs, clamping dogs, wedges, draw-bolts and cleats, bridge pieces, toggle clamps, alignment jigs, crowbar, podger spanner), distortion control (tack welding, presetting, weld sequencing)

Unit 220

Fabricating steel work assemblies

Outcome 3

Be able to produce fabricated steelwork assemblies using joining techniques

Assessment Criteria

The learner can:

1. use steelwork **joining techniques** to produce fabrications to the required specification within ± 3.0 mm
2. join fabricated assemblies safely
3. produce steelwork fabrications that have secure and firm joints and are free from excessive tooling marks, deformation, cracking, or leaks
4. **restore the work area** using the correct procedure for the disposal of waste

Range

Joining techniques:

- bolts and nuts, fitted; types of nuts: hexagonal, split, self-locking, wing, castellated, domed, use of washers: flat, taper, spring, load indicating, nylon; defects in bolted connections, use of jointing compounds, use of podging spanners and drifts, allowances; methods of freeing or disconnecting seized bolted joints, dispelling scales and corrosion, sawing/chiselling, solvents application of heat
- use of spanners
- allowances
- use of welded joints
- manual metal arc (MMA) welding equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads, electrode holders, return clamps, chipping hammer, wire brushes, electrode sizes techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, Personal Protective Equipment (PPE), fume removal
- MIG welding equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires, shielding gases used for the welding of carbon steels: carbon dioxide [CO₂], argon/CO₂, argon/oxygen/CO₂), Personal Protective Equipment (PPE), fume removal
- health and safety considerations

Additional Guidance

Joining techniques:

- bolts and nuts (types of bolts: black, turned, high-strength friction-grip, high tensile, load indicating, fitted; types of nuts: hexagonal, split, self-locking, wing, castellated, domed; use of washers: flat, taper, spring, load indicating, nylon; defects in bolted connections, use of jointing compounds [grease, copper]; use of podging spanners and drifts; allowances
- use of spanners (adjustable, ring, combination, podging, socket, ratchet, torque, impact)
- allowances (back marks)
- use of welded joints (lap, corner, butt, tee)
- manual metal arc (MMA) welding (equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads [welding, return, earth], electrode holders, return

clamps, chipping hammer, wire brushes, electrode sizes [$\text{Ø}2.5$, $3.2 \text{ Ø } 4.0$ mm]
techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, PPE, fume removal)

- MIG welding (equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires [$\text{Ø}0.6$ mm, $\text{Ø}0.8$ mm], shielding gases used for the welding of carbon steels: carbon dioxide [CO_2], argon/ CO_2 , argon/oxygen/ CO_2), PPE, fume removal)
- health and safety considerations

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 221

Principles of electrical and electronics technology

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	A/503/0200
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 033 Wiring and testing electrical equipment and circuits and Unit 036 Assembling and testing electronic circuits
Aim:	This unit is concerned with Electrical and Electronic Technology required for working with lighting, heating and power circuits. The learner will have a basic understanding of units, terminology and applications associated with Electrical and Electronics technology.

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Know the basic units used in electrotechnology
2. Know the application of electrotechnology
3. Be able to identify the characteristics of an electrical circuit

Unit 221 Principles of electrical and electronics technology

Outcome 1 Know the basic units used in electrotechnology

Assessment Criteria

The learner can:

1. state the **basic units** used in electrotechnology
2. carry out electrical calculations

Range

Basic Units: S.I. Units and derived units including multiples and sub-multiples for length, area and volume, force, energy, power, pressure & stress, electrical potential, charge & flux, magnetic flux, flux densit, electrical resistance, capacitance, inductance, frequency, temperature, current

Electrical calculations: basic electron theory, Ohms' Law, resistivity, resistors in series and parallel/ current, voltage and resistance in parallel circuits, power, calculation of power ratings for common components and equipment, energy as power x time

Unit 221

Principles of electrical and electronics technology

Outcome 2

Know the application of electrotechnology

Assessment Criteria

The learner can

1. describe the function of **electrical components**
2. describe the **application** of electrical components

Range

Electrical components: magnets, solenoids, relays, resistors, capacitors (polarised, paper, polyethylene, air, mica). AC and DC motors / generators. Transformers (basic construction of single phase transformers, core types, core, shell and toroidal, laminations and ferrite cores, double wound and auto-transformers), Diodes, Zener diodes, LEDs, bi-polar transistors. Light Dependent Resistors (LDRs) Thermistors Commercially available sockets and plugs (phono, din, edge, 'D' co-axial)

Application: AC and DC generation. Motors, motor drive control DC or AC. Basic lighting, lighting control, LED drive circuitry. Light detection systems using an LDR. Environmental control, temperature etc. Alarms, security systems. Basic transistor switching circuits. Basic transistor amplifier circuits. Voltage transformation systems. Connection methods

Additional Guidance

Electrical components: Sine wave (peak, average and RMS values). Transformers (basic construction of single phase transformers, core types, core, shell and toroidal, laminations and ferrite cores, double wound and auto-transformers), semi-conductor materials, diode types and uses, bi-polar transistors, use as switching devices and amplifiers, light dependent resistors, light emitting diodes, connection methods, safe practice, soldering, crimping, IDC, commercially available sockets and plugs (phono, din, edge, 'D' co-axial)

Unit 221

Principles of electrical and electronics technology

Outcome 3

Be able to identify the characteristics of an electrical circuit

Assessment Criteria

The learner can:

1. determine the current and voltage distribution in series and parallel circuits
2. describe the **magnetic fields** for bar magnets in various configurations
3. determine the polarity of a **solenoid**
4. describe the construction of a typical **capacitor**
5. describe a **sine wave** as displayed on an oscilloscope
6. determine the input and output voltage of double wound **transformers**
7. describe and construct a simple **bridge rectifier** circuit and its function

Additional Guidance

Magnetic fields: Sketch magnetic fields for single bar magnets, N-N, S-S and N-S combinations

Solenoid: Sketch magnetic field and determine polarity

Capacitor: construction of typical capacitor, polarised and air capacitors

Sine wave: Sketch a sine wave and indicate peak, average and root mean square values.

Transformers: Turns ratios. Primary and secondary voltage relationships

Bridge rectifier: Circuit sketches of a simple bridge rectifier. Output waveforms, with and without smoothing

Unit 222

Maintaining electrical equipment and systems

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	F/503/0201
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 037 Maintaining electrical equipment/systems
Aim:	The unit is concerned with the process and equipment essential for the maintenance of electrical engineering equipment up to 400v. The learner will be able to prepare and carry out maintenance on a range of electrical systems and equipment.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

1. Be able to prepare for maintaining electrical systems/equipment
2. Be able to carry out the maintenance of electrical systems/equipment

Unit 222 **Maintaining electrical equipment and systems**

Outcome 1 Be able to prepare for maintaining electrical systems/equipment

Assessment Criteria

The learner can:

1. gather, read and interpret manufacturers **maintenance instructions**.
2. determine a suitable sequence of **testing operations**
3. devise suitable methods for the **security of components**
4. obtain **test equipment** and tools required to carry out maintenance activities

Range

Maintenance instructions: manuals, catalogues, block diagrams, test schedules, safety & job instructions. Equipment and system specifications, BS 7671 Wiring Regulations, Guidance Notes 3, Electricity at Work regulations

Testing operations: Test sequence as BS 7671 or GN 3, logical fault finding sequence, risk assessment, work plans

Security of components: storage and labelling of components and disconnected conductors.

Test equipment: low reading ohmmeters, insulation resistance testers, RCD tester, open and short circuit testing, resistance faults, mechanical and component faults.

Tools: screwdrivers, pliers, side cutters, cable strippers, spanners, hammers, saws, files, drills, battery and power tools, torches and hand lamps, soldering irons, cable terminating equipment

Unit 222 **Maintaining electrical equipment and systems**

Outcome 2 Be able to carry out the maintenance of electrical systems/equipment

Assessment Criteria

The learner can:

1. **prepare** for maintenance activity
2. use **Personal Protective Equipment (PPE)**
3. identify **hazards** and minimise their risk
4. carry out **maintenance**
5. carry out **tests** to ensure the fault has been rectified and the equipment performs within specification
6. **restore the work area** using the correct procedures for the disposal of waste

Range

Prepare: risk assessment, method statement, perform safety checks on area and equipment.

Personal Protective Equipment (PPE): boots, overalls, gloves, goggles/glasses, ear defenders, dust masks, hard hats

Hazards: electric shock, burns, oils spills, chemicals, dust, falls, rotating equipment, fire, slips. Use of access equipment, stored energy, UPS systems

Maintenance: remove and store covers and casings, identify and mark disconnected components and cabling, replacement items to meet specifications

Tests: safe isolation procedure, identify correct test points, visual inspection, logical sequence for fault finding

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 223

Wiring and testing electrical circuits

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	J/503/0202
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 1: Working Safely in an Engineering Environment, Unit 2: Working Efficiently and Effectively in Engineering, Unit 3: Using and Communicating Technical Information
Aim:	he unit is concerned with the process and equipment essential to the wiring and testing of electrical circuits connected to a 230/400v installation.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

1. Be able to assemble components and prepare for wiring and testing of electrical circuits
2. Be able to carry out the wiring of electrical circuits

Unit 223

Wiring and testing electrical circuits

Outcome 1

Be able to assemble components and prepare for wiring and testing of electrical circuits

Assessment Criteria

The learner can:

1. read and interpret **safety instructions**
2. plan for the **installation of circuits**
3. select the **wiring system** suitable for the environment, utilisation and building
4. compile a requisition of items; cables, supporting systems and fixing methods required.
5. check the **tools, equipment and components** are safe and suitable for their intended use
6. determine **termination, fixing and earthing methods**
7. select suitable **test instruments** and ensure safety in use

Range

Safety instructions: manufacturers' instructions, Health and Safety at Work etc. Act Electricity at Work Regulations, GS38

Plan for the installation of circuits: risk assessment, method statement, circuit and wiring diagrams

Wiring system: standard circuits as listed in BS 7671, cable types including single and multicore (twin & CPC) armoured and fire resistant cables, accessories, components, wiring systems & fixings appropriate to single phase domestic/commercial installations

Tools, equipment and components: selection of tools and plant appropriate to small domestic/commercial installations, screwdrivers, pliers, side cutters, drills, stripping tools, power tools

Termination, fixing and earthing: wood and machine screws, wall plugs, anchors, plasterboard fixings, cable clips, screw, pressure, crimp/compression terminations, earth clamps and terminations

Test instruments: low resistance ohmmeter, insulation resistance test instrument, voltage indicator to GS 38

Unit 223

Wiring and testing electrical circuits

Outcome 2

Be able to carry out the wiring of electrical circuits

Assessment Criteria

The learner can:

1. install **wiring systems**
2. install lighting, power and control **circuits** and components to industry standards
3. **test** circuits to current IEE Wiring Regulations
4. **restore the work area** using the correct procedures for the disposal of waste

Range

Wiring systems: PVC and metal conduit and trunking, metal tray, basket, PVC single and multicore, steel wire armoured, FP200

Circuits: 1-way, 2- way and intermediate lighting circuits, ring final and radial power circuits, Control circuits

Tests: continuity of protective conductors, insulation resistance and polarity tests, replacing any faulty components/items as identified by tests, functional tests

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work

Unit 224

Constructing, testing and fault finding electronic circuits

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	L/503/0203
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Relationship between the unit and relevant national standards	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 036 Assembling and testing electronic circuits
Aim:	<p>This unit is concerned with the processes and equipment essential to building and testing electronic circuits. The topics covered will enable the candidate to collect, read and interpret information, plan and prepare for electronics activities, and state how to identify electronic components.</p> <p>The candidate will also be able to perform circuit and diagnostic checks, and make simple deductions from the results of these checks.</p>

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. Be able to prepare for building and testing of electronic circuits
2. Be able to test, fault find and repair electronic equipment
3. Be able to construct new, and identify faults on existing, electronic equipment

Unit 224

Constructing, testing and fault finding electronic circuits

Outcome 1

Be able to prepare for building and testing of electronic circuits

Assessment Criteria

The learner can:

1. define **units of measurement** and their multiples and sub-multiples for electrical quantities and components
2. describe the **V, I and R relationships** for simple dc circuits
3. identify **electronic components** and their circuit symbols, values and **ratings**
4. identify **semiconductor components**, and their circuit symbols
5. state typical applications for **primary and secondary cells**
6. state typical applications for **input and output devices**
7. identify **heat sinks**, and explain their function
8. select and use information from **common sources** used in the electronics industry
9. describe the basic **function of components** within a circuit
10. describe how to plan **work activities** listing **tools and components** required
11. identify **potential hazards** relating to a given task and **safety measures** that could be applied

Range

Units of measurement: ampere, volt, ohm, Watt, coulomb, Farad, Henry, pico, nano, micro, milli, Kilo, Mega, Giga, Tera, resistor colour code (4 band)

V, I and R relationships: series resistor circuits, parallel resistor circuits, series / parallel resistor circuits, Ohms Law, EMF, potential difference

Electronic components:

- resistors – carbon film, carbon composition, metal oxide, wirewound, surface mount, variable, fusible
- capacitors – ceramic, paper, polypropylene, mica, electrolytic, tantalum, surface mount, variable
- inductors – air core, ferrite core, iron core
- transformers – power, rf
- switches – single pole, double pole, relay
- fuses – mains, quick blow, anti-surge, time delay, solid state
- indicating devices – filament lamp, LED, panel mounting devices

Ratings: resistor power, resistor tolerance, capacitor voltage, filament lamp power

Semiconductor components: signal diode, power diode, bridge rectifier (encapsulated), zener diode, LED, photo diode, bi-polar transistor, unijunction transistor, photo transistor, MOSFET, opto-coupler, integrated circuits

Primary and secondary cells: zinc carbon, zinc chloride, silver oxide, lithium, nickel cadmium, nickel metal hydride, lead acid

Input and output devices: transducers, transformers, sensors, actuators, stepper motors, display devices

Heat sinks: convection cooled, fan cooled, water cooled, heat sink compound

Common sources: circuit diagrams, block diagrams, layout diagrams, equipment reference manuals, data sheets, practical tests

Function of components: resistors, capacitors, inductors, switches, fuses, diodes, transistors, transducers, transformers, sensors, actuators, stepper motors, display devices

Work activities: building, testing, repairing

Tools and components: screwdrivers, pliers, cutters, spanners, clamps, soldering tools, de-soldering tools, extraction / insertion tools, solvent cleaners, all components listed in range statements above

Potential hazards: using hand tools, soldering equipment, solder splash, solvents, high voltages,

Safety measures: isolation transformers, RCD protection, rubber matting, anti-static wrist / ankle straps / clothing, solder fume extraction

Unit 224 **Constructing, testing and fault finding electronic circuits**

Outcome 2 Be able to test, fault find and repair electronic equipment

Assessment Criteria

The learner can:

1. describe **preparatory activities** necessary prior to testing electronic equipment
2. identify **test instruments**, and their applications
3. describe methods for **connection / disconnection** of connectors and test probes
4. state common components / items that can reveal fault conditions through **visual inspection**
5. state **terminology** used in fault diagnosis
6. identify and describe **typical faults** in electronic equipment
7. apply **typical fault diagnosis techniques**
8. describe **common factors** that determine the method of repair
9. describe **methods for recording** symptoms, faults, and action taken

Range

Preparatory activities: safety checks, test instrument calibration check, setting up of test instruments, removal of equipment covers / casings, mains supply isolation, cleaning of modules / components

Test instruments: multimeter, insulation resistance tester, continuity tester, oscilloscope, storage scope, signal generator, signal injector, variable dc power supply

Connection/disconnection: test probes, instrument sensors, risk of arcing, risk of shorting, risk of circuit loading

Visual inspection:

- fluid components – pipework, air / fluid lines, couplings, seals, sensors
- electrical components – instrument needles, cables, connectors
- electronic components – printed circuit boards, component / wiring positioning, component values, spillage, burning / scorching, blown fuses
- mechanical components – damaged / overheated equipment housings, physical damage, presence of foreign bodies

Terminology: symptom, fault, cause

Typical faults: leaking – pipework, air lines, fluid lines, couplings, seals, damaged or faulty – sensors, instrument needles, electrical cables, electrical connectors, printed circuit boards – breaks, spillages, burnt/charred components, reduced or no functionality

Fault diagnosis techniques: input to output checks, half split method, injection and sampling, circuit/component isolation, component/unit substitution, use of symptom(s) to determine nature of fault, correct selection of instrument, identification of test points, connection methods for test instruments, application of circuit / layout diagrams, comparison of actual readings to specified readings, interpretation of results

Common factors: time versus cost of module/unit, serviceability of module/unit, availability of individual components, possibility of damage to other components / modules

Methods for recording: paper based, electronic

Unit 224 **Constructing, testing and fault finding electronic circuits**

Outcome 3 Be able to construct new, and identify faults on existing, electronic equipment

Assessment Criteria

The learner can:

1. state briefly the function of **electronic components** in circuits
2. describe methods for connecting/orientating **electronic components** in circuits
3. identify common **connection and termination devices** employed in electronic circuits
4. use correct **assembly methods** for circuit boards
5. describe component **insertion methods**
6. use correct methods for **preparing/fixing wiring and cables**
7. describe methods for avoidance of **static damage to components / circuit boards** whilst handling
8. list the applications for different **types of solder**
9. identify different types of **soldering/de-soldering equipment**
10. apply **effective soldering practices**
11. describe methods for the **removal of devices** from circuit boards
12. describe the **values of a.c. waveshapes**
13. use **test instruments** to take measurements on electronic circuits
14. relate test results to **values** given on circuit information
15. explain the importance of verifying **PSU** (power supply) **functionality** during fault finding
16. **restore equipment** to safe working order following repair / investigation
17. follow good working practices throughout the construction / fault location process.
18. **restore work area** using the correct procedure for the disposal of waste

Range

electronic components:

- resistors – carbon film, carbon composition, metal oxide, wirewound, surface mount, variable, fusible
- capacitors – ceramic, paper, polypropylene, mica, electrolytic, tantalum, surface mount, variable
- inductors – air core, ferrite core, iron core
- transformers – power, rf,
- switches – single pole, double pole, relay
- fuses – mains, quick blow, anti-surge, time delay, solid state
- indicating devices – filament lamp, LED, panel mounting devices
- semiconductors – signal diode, power diode, bridge rectifier
- (encapsulated), zener diode, LED, photo diode, bi-polar transistor,
- unijunction transistor, photo transistor, MOSFET, opto-coupler,
- integrated circuits
- wiring – wire links, jumper links, cables, connectors

Connection and termination devices: plug and socket, crimp, solder pin, terminal screw

Assembly methods: component orientation, component mounting, avoidance of component damage, routing and grouping of wiring, marking of flying leads / connectors, cable ties and clamps

Insertion methods: manual insertion methods, automated insertion methods

Preparing / fixing wiring and cables: selection of wires / cables, stripping, tinning, termination, dressing, avoidance of electronic interference, avoidance of mechanical damage

Static damage to components / circuit boards: anti-static wrist / ankle straps, use of conductive mats, use of conductive bags / containers, equipotential bonding of work area, component / board transportation, static warning labels

Types of solder: rosin free, autosol (high speed), low residue no clean, hydro flux

Soldering / de-soldering equipment: 230 V a.c. high wattage iron, low voltage iron, gas iron, hot air gun, flow solder process, de-soldering pump, solder wick

Effective soldering practices: component handling, solder selection, cleaning of joint areas, mechanically and electrically sound joints, sufficient solder application, joints free of splatter, short circuits and spikes

Removal of devices: PCB – single sided, double sided, multi-layer components – discrete, multi-pin, surface mount

Values of a.c. waveshapes: periodic time, frequency, peak to peak, peak, average, RMS (root mean squared)

Test instruments: multimeter, oscilloscope, function generator

Values: d.c. voltages, d.c. currents, resistance, a.c. waveshapes,

PSU functionality: output voltage(s), ability to deliver required load current(s), effects of overload trip circuits / devices

Additional Guidance

Restore equipment: all connectors re-made, all safety components / devices correctly installed, all cables / wiring harnesses correctly fixed, equipment free of foreign bodies, all covers re-fitted and correctly secured

Restore work area: work area is tidy and free of hazards, safe working practices are observed, work area is left clean and tidy, tools /test instruments are returned to safe storage

Unit 231

Pattern development for plate and sheet metalwork

Level:	2
Credit Value:	7
GLH:	60
Assessment type:	Assignment
UAN Number:	K/505/2726
Support of the unit by a sector or other appropriate body	This unit is endorsed by SEMTA
Aim:	<p>Learners will develop the skills to undertake a broad range of pattern development techniques used extensively within the fabrication and welding sector including parallel line, radial line and triangulation methods. Learners will also develop the knowledge and skills to select the most suitable methods and techniques and produce patterns and templates that address common practical situations in the workplace.</p> <p>Although many organisations now use computer programmes to produce patterns, a thorough understanding of the underpinning principles will support learners. Opportunities to link this unit to 2850-217 fabricating sheet metalwork exist especially the drawing of the pattern required for the unit assignment.</p>

Learning outcomes

There are **four** learning outcomes to this unit. The learner will:

1. Be able to use geometric drawing methods to support pattern development techniques
2. Be able to determine lines of intersection
3. Be able to develop patterns using various pattern development methods
4. Understand the benefits and use of templates for plate and sheet metal work

Unit 231 **Pattern development for plate and sheet metalwork**

Outcome 1 Be able to use geometric drawing methods to support pattern development techniques

Assessment Criteria

The learner can:

1. use **geometric drawing methods**
2. construct **triangles** from provided **data**
3. construct an ellipse using a range of **methods**
4. construct regular **polygons** based on dimensional features

Range

Geometric drawing methods: bisect a line and angle, construct parallel lines, draw perpendicular lines, divide a line into equal parts, divide a circle into 12 equal parts, construct angles

Triangles: right; equilateral; isosceles, scalene

Data: length of sides, angles

Methods: concentric circle, trammel method, oblique projection of a circle

Polygons: square, rectangles, hexagons, octagons

Additional Guidance

Geometric methods: bisect a line and angle using a compass and straight edge, construct parallel lines using a combination of 2 set squares, draw perpendicular lines using compass and straight edge; divide a line into equal parts using the parallel line method, construct 30° , 60° and 90° angles using a compass, divide a circle into 12 equal parts using a compass and using a $60^\circ/30^\circ$ set square

Triangles: construct right, equilateral, isosceles and scalene using a compass and rule,

Ellipse construction: geometric methods of construction using concentric circles and trammel methods. Oblique projection in preparation for cut faces of cylinders and conical sections.

Polygon construction (dimensional features). Geometric methods to be used dependent on length of side, distance across flats or distance across points

Unit 231 Pattern development for plate and sheet metalwork

Outcome 2 Be able to determine lines of intersection

Assessment Criteria

The learner can:

1. construct lines of intersection between **regular sections** in a **range of configurations** using projection
2. construct lines of intersection between **fabricated forms** in a **range of configurations** using the common central sphere

Range

Regular sections: round, rectangular, square

2.1 Range of configurations: intersections between branches at 90° and 45° between round to round and rectangular to rectangular sections of equal and unequal dimensions.

Fabricated forms: right cones, cylinders, rectangular sections

2.2 Range of configurations: right cones to cylinders, cylindrical branches to right cones, right cones to right cones

Additional Guidance

Projection: Intersections between on centre branches at 90° and 45° between round to round and rectangular to rectangular sections of equal and unequal dimensions.

Common central sphere: Right cones to cylinders; cylindrical branches to right cones; right cones to right cones

Unit 231 **Pattern development for plate and sheet metalwork**

Outcome 3 Be able to develop patterns using various pattern development methods

Assessment Criteria

The learner can:

1. produce patterns of **fabricated forms** using the parallel line method
2. produce patterns of **fabricated forms** using the radial line method
3. produce patterns of **fabricated forms** using the triangulation method
4. perform **calculations** to check patterns

Range

3.1 Fabricated forms: cylinders, rectangular sections, segmental bends

3.2 Fabricated forms: right cones and frusta; oblique cones and frusta;

3.3 Fabricated forms: transformers, cones

Calculations: circumference of cylinders; chord length of right cone templates

Additional Guidance

Parallel line: develop patterns of on centre branches at 90° and 45° between round to round and rectangular to rectangular sections of equal and unequal dimensions. Pattern required for the shape of the hole to be cut in the main pipe for all combinations. 90° right cylindrical segmental bends patterns having joint shortest side only.

Radial line: right cones to have top frusta both parallel and angled to the base, oblique cones frusta to be parallel to the base, base in both forms to be horizontal.

Triangulation: Square to square twisted through 45° , rectangular to round, slow tapered cones ; all examples to have base and top horizontal

Calculations: Circumference of circles, chord length of radial line patterns. Where applicable calculations should be used to check patterns produced in previous learning outcomes

Unit 231 Pattern development for plate and sheet metalwork

Outcome 4 Understand the benefits and use of templates for plate and sheet metal work

Assessment Criteria

The learner can:

1. select **template materials** to suit applications
2. explain the **factors** for selecting template materials
3. describe the **benefits** of using a template

Range

Template materials: wood, template paper, card, metal.

Factors: cost, availability, ease of production, quantity of components

Benefits: speed; accuracy; repeatability; means of checking

Links to other qualifications and frameworks in each unit

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications.

These qualifications have connections to the:

NVQ Diploma in Engineering Maintenance (City & Guilds 1788),

NVQ Diploma in Mechanical Manufacturing Engineering (City & Guilds 1712)

NVQ Diploma in Fabrication and Welding (City & Guilds 1781).

Literacy, language, numeracy and ICT skills development

These qualifications include opportunities to develop and practise many of the skills and techniques required for success in the following qualifications:

Functional Skills (England) – see www.cityandguilds.com/functionalskills

Essential Skills (Northern Ireland) – see www.cityandguilds.com/essentialskillsni

Essential Skills (Wales).

There might also be opportunities to develop skills and/or portfolio evidence if candidates are completing any Key Skills alongside these qualifications.

Appendix 2 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 **Centre document library** on **www.cityandguilds.com** or click on the links below:

Centre Handbook: Quality Assurance Standards

This document is for all approved centres and provides guidance to support their delivery of our qualifications. It includes information on:

- centre quality assurance criteria and monitoring activities
- administration and assessment systems
- centre-facing support teams at City & Guilds/ILM
- centre quality assurance roles and responsibilities.

The Centre Handbook should be used to ensure compliance with the terms and conditions of the centre contract.

Centre Assessment: Quality Assurance Standards

This document sets out the minimum common quality assurance requirements for our regulated and non-regulated qualifications that feature centre-assessed components. Specific guidance will also be included in relevant qualification handbooks and/or assessment documentation.

It incorporates our expectations for centre internal quality assurance and the external quality assurance methods we use to ensure that assessment standards are met and upheld. It also details the range of sanctions that may be put in place when centres do not comply with our requirements or actions that will be taken to align centre marking/assessment to required standards. Additionally, it provides detailed guidance on the secure and valid administration of centre assessments.

Access arrangements: When and how applications need to be made to City & Guilds

provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **Centre document library** also contains useful information on such things as:

- conducting examinations
- registering learners
- appeals and malpractice.

Useful contacts

Please visit the **Contact us** section of the City & Guilds website.

City & Guilds

City & Guilds is the global skills partner, empowering people, organisations and economies to develop the skills they need for growth. With almost 150 years of trusted expertise, we support people into work, help them develop on the job and move into the next job.

We work with Governments, employers, training providers, colleges and industry stakeholders to design and deliver high-quality training, qualifications, assessments and credentials that lead to meaningful career progression. We understand the life changing link between skills development, social mobility and success. Our solutions span critical sectors including construction, engineering, transport, energy and electrical, serving over 1 million learners annually.

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