QUALIFICATION HANDBOOK

City & Guilds Level 2 Certificate/Diploma in Engineering (IVQ) (2850-81/82/83/84 and 51/52/53/54)

March 2022 Version 3.5

City & Guilds

Qualifications at a glance

Subject area	Engineering
City & Guilds number	2850
Age group approved	All
Assessment	Online multiple-choice Assignment Dated entry written exam
Approval	Required
Support materials	Centre handbook Assessment pack Smartscreen
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	City & Guilds number	Accreditation number
Level 2 Certificate in Engineering – Manufacturing Technology	2850-81	600/0880/5
Level 2 Certificate in Engineering – Maintenance Technology	2850-82	600/0880/5
Level 2 Certificate in Engineering – Fabrication and Welding	2850-83	600/0880/5
Level 2 Certificate in Engineering – Electrical and Electronics Technology	2850-84	600/0880/5
Level 2 Diploma in Engineering – Manufacturing Technology	2850-51	600/0881/7
Level 2 Diploma in Engineering – Maintenance Technology	2850-52	600/0881/7
Level 2 Diploma in Engineering – Fabrication and Welding	2850-53	600/0881/7
Level 2 Diploma in Engineering – Electrical and Electronics Technology	2850-54	600/0881/7

Version and date	Change detail	Section
3.5 March 2022	GLH and TQT clarified and highlighted	**Qualification Structure**

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1 Introduction

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

Area	Description
Who are the qualifications for?	These qualifications are aimed at learners who: • intend to follow an Apprenticeship or Advanced Modern Apprenticeship Programmes • wish for career progression within engineering • wish to develop the skills learnt from other qualifications
What do the qualifications cover?	They allow learners with some engineering knowledge and/or experience to develop understanding and practical experience of specific engineering technologies.
What opportunities for progression are there?	They allow learners to progress into employment or to the following City & Guilds qualifications: • 2850 - Level 3 in Engineering IVQ (all pathways)
These qualification replace	1155-02 Level 2 IVQ Diploma in Engineering Skills 2565-02 Level 2 IVQ Technician Certificate in Engineering 8030-21 Level 2 IVQ Technician Certificate in Electrical and Electronic Engineering

2 Structure

To achieve the **Level 2 Certificate in Engineering –Manufacturing Technology (2850-81)**, learners must achieve **35** credits:

- **21** credits from the mandatory units plus,
- a minimum of **14** credits from the optional units.

Unit accreditation number	City & Guilds unit number	Unit title value	Credit	GLH
Mandatory				
H/503/0174	2850-201	Working in engineering	7	60
R/503/0204	2850-202	Principles of engineering technology	7	60
K/503/0175	2850-253	Principles of manufacturing technology	7	60
Optional				
Y/503/0205	2850-204	Machine components using milling techniques	7	60
M/503/0176	2850-205	Machine components using turning techniques	7	60
T/503/0177	2850-206	Using bench fitting techniques	7	60
D/503/0206	2850-207	Using computer aided manufacturing processes	7	60

To achieve the **Level 2 Certificate in Engineering – Maintenance Technology (2850-82)**, learners must achieve **35** credits:

- **21** credits from the mandatory units plus,
- a minimum of **14** credits from the optional units.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value	GLH
Mandatory				
H/503/0174	2850-201	Working in engineering	7	60
R/503/0204	2850-202	Principles of engineering technology	7	60
D/503/0187	2850-254	Principles of maintenance technology	7	60
Optional				
H/503/0188	2850-209	Assembling and maintaining fluid power systems	7	60
K/503/0189	2850-210	Maintenance of mechanical devices and equipment	7	60
D/503/0190	2850-211	Maintaining electrical wiring support systems	7	60
F/503/0201	2850-222	Maintaining electrical equipment and systems	7	60

To achieve the **Level 2 Certificate in Engineering – Fabrication and Welding Technology (2850-83)**, learners must achieve **35** credits:

- **21** credits from the mandatory units plus,
- a minimum of **14** credits from the optional units.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value	GLH
Mandatory				
H/503/0174	2850-201	Working in engineering	7	60
R/503/0204	2850-202	Principles of engineering technology	7	60
H/503/0191	2850-2554	Principles of fabrication and welding technology	7	60
Optional				
K/503/0192	2850-213	Welding by manual metal arc	7	60
M/503/0193	2850-214	Welding by MIG process	7	60
T/503/0194	2850-215	Welding by oxy-acetylene	7	60
A/503/0195	2850-216	Maintaining electrical equipment and systems	7	60
F/503/0196	2850-217	Fabricating sheet metalwork	7	60
J/503/0197	2850-218	Fabricating thick plate, bar and sections	7	60
L/503/0198	2850-219	Fabricating pipework assemblies	7	60
R/503/0199	2850-220	Fabricating steelwork assemblies	7	60

To achieve the **Level 2 Certificate in Engineering – Electrical and Electronics Technology (2850-84)**, learners must achieve **35** credits:

- **21** credits from the mandatory units plus,
- a minimum of **14** credits from the optional units.

Unit accreditation number	City & Guilds unit number	Unit title value	Credit	GLH
Mandatory				
H/503/0174	2850-201	Working in engineering	7	60
R/503/0204	2850-202	Principles of engineering technology	7	60
A/503/0200	2850-256	Principles of electrical and electronics technology	7	60
Optional				
D/503/0190	2850-211	Maintaining electrical wiring support systems	7	60
F/503/0201	2850-222	Maintaining electrical equipment and systems	7	60
J/503/0202	2850-223	Wiring and testing electrical circuits	7	60
L/503/0203	2850-224	Constructing, testing and fault finding electronic circuits	7	60

To achieve the **Level 2 Diploma in Engineering – Manufacturing Technology (2850-51)**, learners must achieve **42** credits:

- **21** credits from the mandatory units plus
- a minimum of **21** credits from the optional units.

Unit accreditation number	City & Guilds unit number	Unit title value	Credit	GLH
Mandatory				
H/503/0174	2850-201	Working in engineering	7	60
R/503/0204	2850-202	Principles of engineering technology	7	60
K/503/0175	2850-253	Principles of manufacturing technology	7	60
Optional				
Y/503/0205	2850-204	Machine components using milling techniques	7	60
M/503/0176	2850-205	Machine components using turning techniques	7	60
T/503/0177	2850-206	Using bench fitting techniques	7	60
D/503/0206	2850-207	Using computer aided manufacturing processes	7	60

To achieve the **Level 2 Diploma in Engineering – Maintenance Technology (2850-52)**, learners must achieve **42** credits:

- **21** credits from the mandatory units plus
- a minimum of **21** credits from the optional units.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value	GLH
Mandatory				
H/503/0174	2850-201	Working in engineering	7	60
R/503/0204	2850-202	Principles of engineering technology	7	60
D/503/0187	2850-254	Principles of maintenance technology	7	60
Optional				
H/503/0188	2850-209	Assembling and maintaining fluid power systems	7	60
K/503/0189	2850-210	Maintenance of mechanical devices and equipment	7	60
D/503/0190	2850-211	Maintaining electrical wiring support systems	7	60
F/503/0201	2850-222	Maintaining electrical equipment and systems	7	60

To achieve the **Level 2 Diploma in Engineering – Fabrication and Welding Technology (2850-53)**, learners must achieve **42** credits:

- **21** credits from the mandatory units plus
- a minimum of **21** credits from the optional units.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value	GLH
Mandatory				
H/503/0174	2850-201	Working in engineering	7	60
R/503/0204	2850-202	Principles of engineering technology	7	60
H/503/0191	2850-2554	Principles of fabrication and welding technology	7	60
Optional				
K/503/0192	2850-213	Welding by manual metal arc	7	60
M/503/0193	2850-214	Welding by MIG process	7	60
T/503/0194	2850-215	Welding by oxy-acetylene	7	60
A/503/0195	2850-216	Maintaining electrical equipment and systems	7	60
F/503/0196	2850-217	Fabricating sheet metalwork	7	60
J/503/0197	2850-218	Fabricating thick plate, bar and sections	7	60
L/503/0198	2850-219	Fabricating pipework assemblies	7	60
R/503/0199	2850-220	Fabricating steelwork assemblies	7	60

To achieve the **Level 2 Diploma in Engineering – Electrical and Electronics Technology (2850-54)**, learners must achieve **42** credits:

- **21** credits from the mandatory units plus
- a minimum of **21** credits from the optional units.

Unit accreditation number	City & Guilds unit number	Unit title value	Credit	GLH
Mandatory				
H/503/0174	2850-201	Working in engineering	7	60
R/503/0204	2850-202	Principles of engineering technology	7	60
A/503/0200	2850-256	Principles of electrical and electronics technology	7	60
Optional				
D/503/0190	2850-211	Maintaining electrical wiring support systems	7	60
F/503/0201	2850-222	Maintaining electrical equipment and systems	7	60
J/503/0202	2850-223	Wiring and testing electrical circuits	7	60
L/503/0203	2850-224	Constructing, testing and fault finding electronic circuits	7	60

Total Qualification Time

Total Qualification Time (TQT) is the total amount of time, in hours, expected to be spent by a Learner to achieve a qualification. It includes both guided learning hours (which are listed separately) and hours spent in preparation, study and assessment.

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

3 Centre requirements

Approval

Centres wishing to offer City & Guilds qualifications must be approved:

- new centres must apply for centre and qualification approval. Please refer to the *Centre Manual – Delivering International Qualifications* for further information. Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.
- existing City & Guilds' centres will need to get specific qualification approval to run these awards and to submit a QAP form.

City & Guilds reserves the right to suspend an approved centre, or withdraw its approval from an approved centre to conduct City & Guilds' qualifications for reasons of debt, malpractice or for any reason that maybe detrimental to the maintenance of authentic, reliable and valid qualifications or that may prejudice the name of City & Guilds.

Resource requirements

Centre staffing

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

- be occupationally competent or technically knowledgeable in the areas for which they are delivering training and/or have experience of providing training. This knowledge must be at least 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.

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

Physical Resources

Centres wishing to use this qualification must review this Handbook and ensure that they have the staff and access to sufficient equipment in the centre or workplace so that learners have the opportunity to cover all of the activities of the qualification. It is acceptable for a centre to use specifically designated areas within a centre if the learner does not have a work placement. Where facilities do not exist for realistic practical work, it is strongly recommended that centres develop links with local organisations to provide opportunities for hands on experience.

Internal quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Full information is provided in the *Centre Manual – Delivering International Qualifications*.

Centres are responsible for internal quality assurance, and City & Guilds is responsible for external quality assurance.

International standards and rigorous quality assurance are maintained by the use of:

- City & Guilds externally set and externally marked examinations for the mandatory unit
- City & Guilds activities, delivered and assessed by the centre according to externally set evidence requirements
- internal (centre) quality assurance
- City & Guilds external verification.

To meet the quality assurance criteria for this qualification, the centre must ensure that the following internal roles are undertaken:

- Assessment Manager
- Tutor/Assessor
- Internal Verifier Co-ordinator (for larger centres)
- Internal Verifier
- Examinations Secretary
- Invigilator.

Full details and guidance on the internal and external quality assurance requirements, procedures and roles, are provided in *Centre Manual – Delivering International Qualifications* together with full details of the tasks, activities and responsibilities of quality assurance staff.

In order to fully support learners, centres are required to retain original copies of the learner's assessment and internal verification records for **three** years after certification.

The following is a summary of the key roles involved in the successful implementation and assessment of the qualification. (Please refer to the *Centre Manual – Delivering International Qualifications* for further information.)

The role of the Internal Verifier (IV) is to ensure that:

- they liaise with City & Guilds personnel
- there are adequate resources, both staff and materials
- the work of all personnel contributing to the delivery and assessment of the programme is sampled by a range of methods which should include sampling the observation checklist, learner training plans and multiple choice quiz responses
- records of all sampling activities are monitored and maintained
- where several members of staff are involved in the delivery/assessment of the qualification, that there is a consistent interpretation of the requirements through standardisation activities and that these are documented
- all staff carrying out delivery and assessment are familiar with and understand the qualification requirements
- an appropriate referral policy is in place
- an appropriate appeals procedure is in place
- learner evidence is clearly organised and accessible to the Internal Verifier and Qualification Consultant
- relevant records and pro formas are completed, maintained and retained for the purposes of internal and external verification along with the record of course delivery form.

The role of the Tutor/Assessor is to:

- plan, manage, deliver and assess the qualification using the City and Guilds materials provided
- ensure availability of technical support for ICT equipment
- ensure that each learner is aware of the assessment requirements throughout their programme of learning
- provide guidance and support to learners on the assessment and evidence requirements for the qualification
- ensure that the assessment and evidence requirements have been met by the learner
- observe learners' delivered sessions
- facilitate the multiple choice quiz and mark learner responses
- complete relevant records and pro formas.

All staff should participate in appropriate Continuous Professional Development (CPD), to keep up to date with the delivery of the qualification and their role.

External quality assurance

External quality assurance for the qualifications will be provided by the usual City & Guilds external verification process and reported on using relevant documentation to provide a risk analysis of individual centre assessment and verification practice.

Continuing professional development (CPD)

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

Learner entry requirements

No specific prior qualifications, learning or experience are required for learners undertaking the qualification. However, centres will need to make an initial assessment of each learner to ensure that the level of the scheme is appropriate. The nature of both the learning and assessment required for the qualification is such that learners will need basic literacy and numeracy skills: ie 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.

There are no restrictions on entry for this award. City & Guilds recommend that learners should not enter for a qualification of the same level and the same content as that of a qualification they already hold.

Age restrictions

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

4 Delivering the qualification

Initial assessment and induction

Centres will need to make an initial assessment of each learner prior to the start of their programme to ensure they are entered for an appropriate type and level of qualification.

The initial assessment should identify:

- any specific training needs the learner has, and the support and guidance they may require when working towards their qualification. This is sometimes referred to as diagnostic testing.
- any units the learner has already completed, or credit they have accumulated which is relevant to the qualification they are about to begin.

City & Guilds recommends that centres provide an induction programme to ensure the learner fully understands the requirements of the qualification they will work towards, their responsibilities as a learner, and the responsibilities of the centre. It may be helpful to record the information on a learning contract.

All teaching and assessment for this qualification must take place in the English language.

Support materials

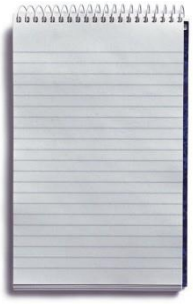
The following resources are available for this qualification:

Description	How to access
Assignment guide for centres	www.cityandguilds.com
Assignments (204-207, 209-211, 213-220, 222-224)	www.cityandguilds.com (password protected)
SmartScreen	www.smartscreen.co.uk

Recording documents

Learners and centres may decide to use a paper-based or electronic method of recording evidence.

City & Guilds endorses several ePortfolio systems, including our own, **Learning Assistant**, an easy-to-use and secure online tool to support and evidence learners' progress towards achieving qualifications. Further details are available at: **www.learningassistant.com**.



5 Assessment

The mandatory core Units 201 Working in engineering and 202 Principles of engineering technology, are assessed by a City & Guilds online multiple-choice assessment, the remaining 'Principles of' units are assessed by a dated entry written exam – the written test which will take place on fixed dates scheduled by City &Guilds. All other units are assessed by assignment which contains practical and knowledge tasks.

Assignments (one per unit) assess practical activities. City & Guilds provides an assignment guide for assessors, which contains all information required. As assignments are designed to sample practical activities, it is essential that the centres ensure that learners 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 in an IVQ 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.

Summary of assessment methods

For these qualifications, learners will be required to complete the following assessments:

- **one** online multiple-choice assessment for **each 201 and 202** mandatory unit
- **one** dated entry written exam for each 'Principles of' specialist unit
- **one** assignment for **each chosen** optional unit

Information on online assessments can be found at - http://cgcom/Provide-Training/Delivery-Success/e-volve

City & Guilds provides the following assessments:

Unit no.	Title	Assessment method	Where to obtain assessment materials
201	Working in engineering	Online multiple-choice assessment. The assessment covers all of the outcomes.	http://cgcom/Provide-Training/Delivery-Success/e-volve
202	Principles of engineering technology	Online multiple-choice assessment. The assessment covers all of the outcomes.	http://cgcom/Provide-Training/Delivery-Success/e-volve
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
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. City & Guilds devised assignment, internally marked, externally verified	www.cityandguilds.com
206	Using bench fitting techniques	Assignment 2850-206 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 no.	Title	Assessment method	Where to obtain assessment materials
207	Using computer aided manufacturing processes	Assignment 2850-207 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
209	Assembling and maintaining fluid power systems	Assignment 2850-209 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
210	Maintenance of mechanical devices and equipment	Assignment 2850-210 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
211	Maintain electrical wiring support systems	Assignment 2850-211 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 no.	Title	Assessment method	Where to obtain assessment materials
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
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
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
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 no.	Title	Assessment method	Where to obtain assessment materials
217	Fabricating sheet metalwork	Assignment 2850-217 The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. ity & Guilds devised assignment, internally marked, externally verified.	www.cityandguilds.com
218	Fabricating thick plate, bar and sections	Assignment 2850-218 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
219	Fabricating pipework assemblies	Assignment 2850-219 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
220	Fabricating steel work assemblies	Assignment 2850-220 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 no.	Title	Assessment method	Where to obtain assessment materials
222	Maintaining electrical equipment and systems	Assignment 2850-222 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
223	Wiring and testing electrical circuits	Assignment 2850-223 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
224	Constructing, testing and fault finding electronic circuits	Assignment 2850-224 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
253	Principles of manufacturing technology	Dated entry written exam paper 2850-253	www.cityandguilds.com
254	Principles of maintenance technology	Dated entry written exam paper 2850-254	www.cityandguilds.com
255	Principles of fabrication and welding technology	Dated entry written exam paper 2850-255	www.cityandguilds.com
256	Principles of electrical and electronics technology	Dated entry written exam paper 2850-256	www.cityandguilds.com

Time constraints

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

- Each assignment has specific time constraints; please refer to the individual assignments. Centre staff should guide learners to ensure excessive evidence gathering is avoided. Centres finding that assignments are taking longer, should contact the Qualification consultant for guidance.
- All assignments must be completed and assessed within the learner's period of registration. Centres should advise learners of any internal timescales for the completion and marking of individual assignments.

Assessment strategy

Test specifications for the dated entry written exam papers will be available from July 2013. Dated entry examinations will begin to take place from December 2013.

Test specifications

The test specifications for the online multiple-choice assessments are below:

Test: 2850-201 Working in engineering
Duration: 60 minutes

Outcome	No. of questions	%
1. Know engineering health and safety 2. 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**

Test: 2850-202 Principles of engineering technology
Duration: 60 minutes

Outcome	No. of questions	%
1. Know requirements for materials in engineering	9	22.5
2. Know properties of engineering materials	9	22.5
3. Know how to apply analytical methods to engineering mathematical applications	11	27.5
4. Know how to apply analytical methods to engineering science applications	11	27.5
Total	**40**	**100**

6 Units

Availability of units

These units each have the following:

- City & Guilds reference number
- Unit Accreditation Number (UAN))
- title
- level
- credit value
- guided learning hours
- endorsement by a sector or other appropriate body
- unit aim
- information on assessment
- learning outcomes which are comprised of a number of assessment criteria
- notes for guidance.

Unit 201 Working in engineering

UAN:	**H/503/0174**
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	This unit will encourage learners to find out about working in engineering. It will cover the underpinning basic skills and knowledge needed to function in engineering or manufacturing sectors. 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
Assessment	This unit will be assessed by an online multiple-choice assessment

Learning outcome
The learner will: 1. Know engineering health and safety requirements
Assessment criteria
The learner can: 1.1 state **health and safety regulations** applicable to engineering operations 1.2 state **employers' responsibilities** to ensure health and safety in the workplace 1.3 state the **safe working practices** that should be adhered to in the workplace 1.4 name the policies and procedures used to ensure effective health and safety **implementation** 1.5 describe the essential health and safety requirements for the **protection of operators and bystanders** 1.6 state the types and classification of health and safety **signs** that are used in an engineering/manufacturing environment 1.7 define the **roles, responsibilities and powers** of personnel with responsibility for health and safety 1.8 describe the **human and environmental conditions** that lead

	to accidents in the workplace and the means of controlling them
1.9	describe how to carry out a **risk assessment** and name potential hazards which may be identified
1.10	define what is meant by a dangerous occurrence
1.11	describe methods of **fire** prevention and control
1.12	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, eg 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 behaviour 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 (PPE) is in a usable condition, tools and equipment are in a safe and usable condition).

Learning outcome
The learner will: 2. Know effective methods of communication
Assessment criteria
The learner can: 2.1 state the **communication systems** used in the workplace 2.2 state the **roles** and responsibilities of key departments and personnel within an engineering organisation 2.3 name a range of **sources** of engineering information 2.4 describe the **correct approach** to take when seeking advice and guidance and name **sources of support** 2.5 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).

Learning outcome
The learner will: 3. Understand drawings and specifications
Assessment criteria
The learner can: 3.1 describe the purpose of **technical drawings and specifications** 3.2 interpret technical drawings using **current standards** 3.3 interpret the **essential information** found on drawings 3.4 describe the purpose of **standards** in engineering 3.5 describe the use of **specifications and quality systems** 3.6 interpret standard **conventions** used on technical drawings 3.7 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(es), product make up (number of components), sequence of operations (operations sheet), quality control requirements, storage and dispatch requirements, use of graphs, tables and charts.

Learning outcome
The learner will: 4. Know and understand how to provide leadership
Assessment criteria
The learner can: 4.1 describe policies related to **employment rights** and responsibilities 4.2 describe how to **work effectively** within an engineering workplace 4.3 state the **reasons why there may be conflict** situations in the workplace and how to **avoid** them 4.4 state the roles and responsibilities of **team members** 4.5 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. **Reasons why there may be conflict:** 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. **Work 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.

Unit 202 Principles of engineering technology

UAN:	R/503/0204
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
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.
Assessment:	This unit will be assessed by an online multiple-choice assessment

Learning outcome
The learner will: 1 Know requirements for materials in engineering
Assessment criteria
The learner can: 1.1 state the range of **materials** used in common engineering applications 1.2 state the **forms of supply** of materials 1.3 state how to **identify materials** by their physical properties.

Range
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
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, plasticised), pipe and tube, castings, forgings, extrusions.

Learning outcome
The learner will: 2 Know properties of engineering materials
Assessment criteria
The learner can: 2.1 state the **physical properties** of materials 2.2 define what is meant by **mechanical properties** of materials 2.3 state the **mechanical properties** of materials 2.4 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.

Learning outcome
The learner will: 3 Know how to apply analytical methods to engineering mathematical applications
Assessment criteria
The learner can: 3.1 apply appropriate **degree of accuracy** to express numbers 3.2 describe tolerance in terms of limits of size 3.3 calculate the **areas of basic shapes** 3.4 calculate the areas of **compound shapes** 3.5 calculate the **surface areas** of regular shaped solids 3.6 calculate the **volumes** of regular shaped solids 3.7 calculate the value of **angles in a triangle** 3.8 apply Pythagoras' Theorem to right-angled triangle problems 3.9 interpret straight line graphs using given data 3.10 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.

Learning outcome
The learner will: 4 Know how to apply analytical methods to engineering science applications
Assessment criteria
The learner can: 4.1 calculate the value of a **force** 4.2 define **work done** by a simple machine 4.3 calculate **power** used 4.4 calculate **energy** used 4.5 calculate the **efficiency** of a machine 4.6 calculate the turning **moment of a force** 4.7 calculate the **relative density** of engineering materials 4.8 apply **Ohm's Law** to determine simple electrical circuit problems 4.9 calculate the strength of engineering materials 4.10 calculate **pressure at depth** 4.11 [illegible]

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.

Unit 204 Machine components using milling techniques

UAN:	Y/503/0205
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	This unit is concerned with the underlying process in setting special holding devices prior to carrying out milling operations. The learner will be able to set and operate milling machines. They will be able to select the appropriate automatic feed and cutters to achieve the desired outcome. The learner will be able to select and set cutters for straddle
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Know how to plan and prepare for milling activities
Assessment criteria
The learner can: 1.1 describe **health and safety precautions** specific to operating lathes 1.2 describe the setting of work **datum** 1.3 define **classes of fit** 1.4 describe the accuracy and range, of precision **measuring equipment** and gauges 1.5 classify types and applications of **coolants and cutting oils** 1.6 classify **cutting tool materials** and their application 1.7 define the factors that affect **cutting speeds and feeds** 1.8 describe methods of **mounting tools**, their position and benefits 1.9 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 guidance

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).

Learning outcome

The learner will:

2 Be able to determine requirements for milling operations

Assessment criteria

The learner can:

2.1 describe how to check milling **cutters** for appropriate operations

2.2 check milling **cutters** for appropriate operations

2.3 select and secure to machine spindle cutter holding equipment

2.4 describe **cutter nomenclature and cutter/workpiece movement**

2.5 **calculate** spindle speeds for individual cutters

2.6 explain the types and applications of **arbor mounted cutters**

2.7 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 guidance
Cutters: vertical mounted: end mills (4 and 2 flute), slot drills (2 and 3 flute, bull nose), tee slot, dovetail, flycutter; 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.

Learning outcome	
The learner will:	
3	Be able to perform milling operations to produce parts
Assessment criteria	
The learner can:	
3.1	interpret engineering **drawings**
3.2	select and set **workholding devices** square and central to cutter and set adjustable angle plate to a prescribe angle
3.3	machine slots and angles, to within specified dimensions and **measure** accuracy to ± 0.2 mm, angular ± 1°, surface finish 1.6 µm
3.4	machine holes and pockets square to surfaces and **measure** accuracy
3.5	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).

Learning outcome
The learner will: 4 Be able to perform milling operations
Assessment criteria
The learner can: 4.1 use simple indexing **calculations** to determine number of turns and number of holes on a specified indexing plate 4.2 **mill holes, slots and flat angled surfaces** 4.3 select and use appropriate **measuring equipment** to equate with set tolerances 4.4 **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

UAN:	M/503/0176
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	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. This unit is concerned with the underlying process in producing components that require shafts of various lengths and shapes
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Know how to plan and prepare for turning activities
Assessment criteria
The learner can: 1.1 describe **health and safety precautions** specific to operating lathes 1.2 describe the setting of work **datum** 1.3 define **classes of fit** 1.4 describe the accuracy and range of precision **measuring equipment** and gauges 1.5 classify types and applications of **coolants and cutting oils** 1.6 classify **cutting tool materials** and their application 1.7 define the factors that affect **cutting speeds and feeds** 1.8 describe methods of **mounting tools**, state their position and benefits 1.9 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.

Learning outcome
The learner will: 2 Be able to turn parallel and tapered shafts
Assessment criteria
The learner can: 2.1 select and use **equipment** for turning between centres 2.2 machine **parallel shafts** within set tolerance 2.3 check **surface finish** is within specification 2.4 generate **tapers** using a range of equipment 2.5 use a range of **cutting tools and materials** 2.6 operate equipment safely 2.7 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 5µm, 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.

Learning outcome
The learner will: 3 Be able to offset turn, external and internal diameters
Assessment criteria
The learner can: 3.1 select and use **work holding devices** 3.2 offset components prior to machining 3.3 **mark centres** on non-circular parts 3.4 **bore and ream** holes within set **tolerances** 3.5 reset parts true to allow for further machining 3.6 operate equipment safely 3.7 check dimensions and record accuracy achieved 3.8 **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

UAN:	T/503/0177
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
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
Assessment	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Know how to plan and prepare for bench fitting activities
Assessment criteria
The learner can: 1.1 state how to use **safe working practices** and procedures for maintenance activities 1.2 describe the **hazards** associated with bench fitting activities 1.3 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.

Learning outcome
The learner will: 2 Be able to apply bench fitting techniques to produce component parts
Assessment criteria
The learner can: 2.1 select **tools and equipment** to undertake a bench fitting activity 2.2 use **safe working practices** and procedures during maintenance activities 2.3 check **portable machines and equipment** for safe operation 2.4 **produce and assemble component parts** using safe working practice 2.5 check component for **accuracy and quality** 2.6 **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. **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

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 = πdN/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

UAN:	D/503/0206
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	This unit is designed to enable learners 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.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to use a computer to produce a suitable program to enable the production of a component
Assessment criteria
The learner can: 1.1 select the **hardware requirements** of a computer system 1.2 **check** that equipment is safe for use and correctly set up 1.3 describe the **health and safety requirements** relating to the use of workstations and VDU equipment 1.4 describe good **housekeeping** arrangements 1.5 produce an appropriate **drawing** for manufacture to current standards 1.6 save the drawing using appropriate drawing **exchange format** 1.7 import file into a Computer Aided Manufacturing (CAM) package 1.8 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.

Learning outcome
The learner will: 2 Be able to manufacture a standard component using the appropriate machine tool
Assessment criteria
The learner can: 2.1 prepare for Computer Numerically Controlled **(CNC) machining** 2.2 **set-up** and use a **part program** 2.3 machine standard components to specification 2.4 **check components** against specification 2.5 **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, rpm = 1000S/πD, feed = rpm x number of teeth x 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.

Unit 209 Assembling and maintaining fluid power systems

UAN:	H/503/0188
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	This unit identifies the basic principles and commonly used components 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. 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. 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.
Assessment	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Know how to prepare for routine maintenance activities and dismantle devices and equipment
Assessment criteria
The learner can: 1.1 describe the **hazards** associated with fluid systems maintenance activities 1.2 produce a **plan** for an assembly/maintenance activity for a fluid power circuit 1.3 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.

Learning outcome
The learner will: 2 Be able to apply testing/fault finding techniques
Assessment criteria
The learner can: 2.1 assess fluid power system for **common faults** 2.2 carry out **fluid power testing** 2.3 identify and rectify **leaks/faults** 2.4 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 that:
  - 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).

Learning outcome
The learner will: 3 Be able to dismantle, remove and replace/repair, re-assemble and test systems conform to specification
Assessment criteria
The learner can: 3.1 use **safe working practices** and procedures for maintenance activities 3.2 select **tools and equipment** to undertake a maintenance operation 3.3 **dismantle**, **clean** and **inspect** faulty components in fluid power systems 3.4 **re-assemble** fluid power systems 3.5 prepare a **report** following maintenance activities 3.6 **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, stream, 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

UAN:	K/503/0189
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
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.
Assessment	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to prepare for routine maintenance activities and dismantle devices and equipment
Assessment criteria
The learner can: 1.1 follow **safe working practices** and procedures for maintenance activities 1.2 describe the **hazards** associated with maintenance activities 1.3 produce a **plan** for a maintenance activity for a mechanical device 1.4 extract **information from sources** 1.5 select **tools and equipment** to undertake a maintenance operation 1.6 select appropriate **cleaning techniques** 1.7 **dissemble 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: charts, tables, manufacturer's 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, stream, health and safety considerations).

Dissemble 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).

Learning outcome
The learner will: 2 Be able to apply fault finding techniques
Assessment criteria
The learner can: 2.1 **assess devices** and equipment for common faults 2.2 identify **wear/damage** in component parts 2.3 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.

Learning outcome
The learner will: 3 Be able to re-assemble mechanical devices and equipment
Assessment criteria
The learner can: 3.1 **re-assemble mechanical devices and equipment** 3.2 **restore the work area** using the correct procedures for the disposal of waste 3.3 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

UAN:	D/503/0190
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA.
Aim:	This unit covers the skills required to carry out the installation/maintenance of electric wiring support systems, including conduit, trunking and traywork systems.
Assessment	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to plan and prepare for electrical wiring support systems
Assessment criteria
The learner can: 1.1 apply **health and safety** requirements and safe working practices 1.2 **obtain information** for the installation/maintenance activities 1.3 develop a **work plan** 1.4 carry out inspection of **installation** and list system/component specifications 1.5 **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.

Learning outcome
The learner will: 2 Be able to install and repair electrical support systems
Assessment criteria
The learner can: 2.1 carry out inspection of support systems in line with an agreed work plan 2.2 identify **support systems requirements** 2.3 identify **faulty or defective components** for replacement 2.4 **isolate** systems/components 2.5 select new **components** to conform to specification and dimension accuracy 2.6 **install** support systems 2.7 check for faulty or defective **components** 2.8 replace/repair components using appropriate techniques 2.9 **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.

Learning outcome
The learner will: 3 Be able to commission the system
Assessment criteria
The learner can: 3.1 carry out final **visual inspection** to ensure compliance with specifications 3.2 carry out **safety checks** to ensure system is safe to energise 3.3 complete **maintenance records** accurately and legibly.

Range
Visual inspection: containment systems to comply with BS 7671/manufacturer's data. **Safety checks:** covers in place, safety devices commissioned and personnel notified. **Maintenance records**: reorder parts.

Unit 213 Welding by manual metal arc process

UAN:	K/503/0192
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	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. 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.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Know safe working practices associated with manual metal arc welding
Assessment criteria
The learner can: 1.1 identify Personal Protective Equipment **(PPE)** used in relation to welding process 1.2 describe the use of Personal Protective Equipment (PPE) in Manual Metal Arc (MMA) welding 1.3 describe the hazards from: • **welding fume** • **electricity** • **arc radiation** • **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 (NO_2), use of extraction (background, local, natural ventilation (eg 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.

Learning outcome
The learner will: 2 Know how to prepare manual metal arc equipment and materials for welding
Assessment criteria
The learner can: 2.1 describe types of **welding equipment** 2.2 describe welding **leads** 2.3 identify **electrode holders** 2.4 describe types of **return clamps** 2.5 describe the function and safe use of equipment used for **preparing and finishing** materials welded joints 2.6 describe how to prepare materials and equipment for safe welding operations.

Range
Welding equipment: Alternating Current (AC) (transformer), Direct Current (DC) (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.

Learning outcome
The learner will: 3 Be able to produce standard welded joints safely using manual metal arc welding
Assessment criteria
The learner can: 3.1 select types of **electrodes** 3.2 describe electrode **storage requirements** 3.3 select types of **welding current and polarity** 3.4 **apply electrode sizes to material thickness and types of joint** 3.5 apply **welding current ranges** to electrode sizes 3.6 differentiate between **welding voltages** 3.7 operate manual metal arc welding equipment safely 3.8 apply EN ISO 6947 **welding positions** 3.9 apply **welding techniques** in accordance **with BS 4872 Part 1** 3.10 apply **post welding activities** 3.11 describe appropriate **assembly and distortion control methods** 3.12 state methods of **distortion rectification** 3.13 use welding consumables safely 3.14 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 3.15 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 (AC), direct (DC) (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.

Learning outcome
The learner will: 4 Be able to visually check welds for defects
Assessment criteria
The learner can: 4.1 describe **weld flaws** 4.2 describe **assessment criteria** 4.3 describe **visual assessment** techniques 4.4 describe **non-destructive testing** techniques 4.5 describe workshop **destructive testing** methods 4.6 perform visual checks to find weld defects 4.7 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).

BSI standards can be accessed at http://shop.bsigroup.com/en/

Unit 214 Welding by MIG process

UAN:	M/503/0193
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	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. 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.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Know safe working practices associated with MIG welding
Assessment criteria
The learner can: 1.1 identify Personal Protective Equipment **(PPE)** used in relation to welding process 1.2 describe the use of Personal Protective Equipment **(PPE)** in MIG welding 1.3 describe the hazards from: • **welding fume** • **electricity** • **arc radiation** • **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 (O_3), carbon monoxide (CO), oxides of nitrogen, nitrous oxide (NO), nitrogen dioxide (NO_2), use of extraction (background, local, natural ventilation (eg 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.

Learning outcome
The learner will: 2 Know how to prepare MIG equipment and materials for welding
Assessment criteria
The learner can: 2.1 describe types of **welding equipment** 2.2 describe welding **leads** 2.3 identify **guns/torches** 2.4 describe types of return clamps 2.5 describe the function and safe use of equipment used for **preparing and finishing** materials welded joints 2.6 describe how to prepare materials and equipment for safe welding operations.

Range
Welding equipment: Direct Current (DC) (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.

Learning outcome
The learner will: 3 Be able to produce standard welded joints safely using MIG welding
Assessment criteria
The learner can: 3.1 select types of **electrodes** 3.2 describe electrode **storage requirements** 3.3 select types of **welding current and polarity** 3.4 apply **electrode sizes to material thickness and types of joint** 3.5 relate arc voltage and wire feed speed ranges to electrode sizes 3.6 differentiate between **welding voltages** 3.7 classify **shielding gases** for welding 3.8 operate MIG welding equipment safely 3.9 apply EN ISO 6947 **welding positions** 3.10 apply **welding techniques** in accordance with **BS 4872 Part 1** 3.11 apply **post welding activities** 3.12 describe appropriate **assembly and distortion control methods** 3.13 state methods of **distortion rectification** 3.14 use welding consumables safely 3.15 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 3.16 **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 (DC) (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 (CO_2), argon/oxygen (O_2), argon/CO_2, argon/O_2/CO_2, argon/helium/O_2/CO_2), 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.

Learning outcome
The learner will: 4 Be able to visually check welds for defects
Assessment criteria
The learner can: 4.1 describe **weld flaws** 4.2 describe **assessment criteria** 4.3 describe **visual assessment** techniques 4.4 describe **non-destructive testing** techniques 4.5 describe workshop **destructive testing** methods 4.6 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).

BSI standards can be accessed at http://shop.bsigroup.com/en/

Unit 215 Welding by TIG process

UAN:	T/503/0194
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	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. 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-
Assessment;	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Know safe working practices associated with TIG welding
Assessment criteria
The learner can: 1.1 identify Personal Protective Equipment **(PPE)** used in relation to welding process 1.2 describe the use of Personal Protective Equipment **(PPE)** in TIG welding 1.3 describe the hazards from: • **welding fume** • **electricity** • **arc radiation** • **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 (O_3), oxides of nitrogen, nitrous oxide (NO), nitrogen dioxide (NO_2), use of extraction (background, local, natural ventilation (eg 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.

Learning outcome
The learner will: 2 Know how to prepare TIG equipment and materials for welding
Assessment criteria
The learner can: 2.1 describe types of **welding equipment** 2.2 describe welding **leads** 2.3 identify **guns/torches** 2.4 describe types of return clamps 2.5 describe the function and safe use of equipment used for **preparing and finishing** materials welded joints 2.6 prepare materials and equipment for safe welding operations.

Range
Welding equipment: Direct Current (DC) (transformer/rectifier, inverter, engine driven generators, AC/DC 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), linishers, files, wire brushes.

Learning outcome
The learner will: 3 Be able to produce standard welded joints safely using TIG welding
Assessment criteria
The learner can: 3.1 select types of **electrodes** 3.2 select **filler wires** 3.3 describe filler wire **storage requirements** 3.4 select types of **welding current and polarity** 3.5 relate electrode sizes to material thickness and types of joint and types of current 3.6 relate welding current ranges to electrode sizes 3.7 differentiate between **welding voltages** 3.8 classify **shielding gases** for welding 3.9 operate TIG welding equipment safely 3.10 apply EN ISO 6947 **welding positions** 3.11 apply **welding techniques** in accordance with **BS 4872** Part 1 and **BS 4872** Part 2 3.12 apply **post welding activities** 3.13 describe appropriate **assembly and distortion control methods** 3.14 state methods of **distortion rectification** 3.15 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 3.16 **restore the work area** using the correct procedures for the

Range
Electrodes: thoriated, zirconiated, ceriated, lanthanated, applications, identification, sizes (Ø1.6, Ø2.4, Ø3.2 mm). **Filler wires:** copper coated steel, uncoated, common sizes (Ø1.6, Ø2.4, Ø3.2 mm). **Storage requirements**: temperature, humidity. **Welding current and polarity:** direct (DC) (electrode negative: heat distribution, reasons for DC), alternating (AC) (heat distribution, reasons for AC). **Welding voltages:** open circuit voltage, arc voltage. **Shielding gases:** inert (argon, helium, argon/helium mixtures) active (argon/hydrogen (H_2)), 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.

Learning outcome
The learner will: 4 Be able to visually check welds for defects
Assessment criteria
The learner can: 4.1 describe **weld flaws** 4.2 describe **assessment criteria** 4.3 describe **visual assessment** techniques 4.4 describe **non-destructive testing** techniques 4.5 describe workshop **destructive testing** methods 4.6 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).

BSI standards can be accessed at http://shop.bsigroup.com/en/

Unit 216 Welding by oxy-acetylene process

UAN:	A/503/0195
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	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. 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
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Know safe working practices associated with oxy-acetylene welding
Assessment criteria
The learner can: 1.1 identify Personal Protective Equipment **(PPE)** in relation to welding process 1.2 describe the use of Personal Protective Equipment **(PPE)** in oxy-acetylene welding 1.3 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. **Hazards:** sources of combustion, compressed gas cylinders (safe: storage conditions. handling/moving, use). **Welding fume:** types of fume; visible (particulate), invisible (gaseous): carbon monoxide (CO), carbon dioxide (CO_2), use of extraction (background, local, natural ventilation (eg on-site), respirator. **Hot metal:** means of avoiding hazards (identification of hazard, use of tools (tongs, etc), use of PPE.

Learning outcome
The learner will: 2 Be able to prepare oxy-acetylene equipment and materials for welding
Assessment criteria
The learner can: 2.1 describe the set-up of the **welding equipment** 2.2 describe function of **components** of oxy-acetylene welding equipment 2.3 select welding **variables** 2.4 select **flame condition** 2.5 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).

Learning outcome
The learner will: 3 Be able to produce standard welded joints safely using oxy-acetylene welding
Assessment criteria
The learner can: 3.1 select **filler rods** 3.2 describe filler rod **storage requirements** 3.3 classify **gases** for welding 3.4 relate nozzle sizes and joint thicknesses 3.5 relate filler rod sizes and joint thicknesses 3.6 relate gas pressures and joint thicknesses 3.7 operate oxy-acetylene welding equipment safely 3.8 apply EN ISO 6947 **welding positions** 3.9 apply **welding techniques** in accordance with apply **BS 4872 Part 1** 3.10 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 3.11 apply **post welding activities** 3.12 describe appropriate **assembly and distortion control methods** 3.13 state methods of **distortion rectification** 3.14 restore the work area using the correct procedures for the

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.

Learning outcome
The learner will: 4 Be able to visually check welds for defects
Assessment criteria
The learner can: 4.1 describe **weld flaws** 4.2 describe **assessment criteria** 4.3 describe **visual assessment** techniques 4.4 describe **non-destructive testing** techniques 4.5 describe workshop **destructive testing** methods 4.6 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).

BSI standards can be accessed at http://shop.bsigroup.com/en/

Unit 217 Fabricating sheet metalwork

UAN:	F/503/0196
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	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. It covers the health and safety considerations associated with cutting, forming, assembly and joining of sheet metal.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to prepare equipment and tools for sheet metal cutting
Assessment criteria
The learner can: 1.1 prepare **equipment** and **tools** for a cutting operation 1.2 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.

Learning outcome
The learner will: 2 Be able to use equipment, tools and materials for sheet metal forming
Assessment criteria
The learner can: 2.1 use **equipment** and **tools** for a **forming** operation 2.2 use **stiffening techniques** to strengthen materials 2.3 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.

Learning outcome
The learner will: 3 Be able to produce fabrications using sheet metalwork assembly techniques
Assessment criteria
The learner can: 3.1 use of sheet metalwork **assembly** and **joining techniques** to produce fabrications to the required shape/geometry within ± 3.0 mm 3.2 produce fabrications that have secure and firm joints and are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs 3.3 produce fabricated assemblies safely 3.4 **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 (DC) 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 (DC) 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 (DC) 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 (CO_2), argon / CO_2, argon/oxygen/ CO_2), Personal Protective Equipment (PPE), fume removal)
- TIG welding (equipment/consumables: Direct Current (DC) 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

UAN:	J/503/0197
Level:	2
Credit value:	7
GLH:	60
Relationship to NOS:	This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 23: Producing Platework components and Assemblies
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	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. It covers the health and safety hazards associated with cutting (including oxy-fuel gas), forming, assembly and joining of thick plate bar and rolled sections fabrication.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to prepare equipment, tools and materials for cutting of thick plate, bar and rolled sections
Assessment criteria
The learner can: 1.1 prepare **equipment** for a cutting operation 1.2 prepare **materials** for a cutting operation 1.3 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)).

Learning outcome
The learner will: 2 Be able to use equipment and tools for thick plate, bar and rolled sections
Assessment criteria
The learner can: 2.1 use equipment for **forming** thick plate, bar and rolled sections 2.2 use equipment for **assembling** thick plate, bar and rolled sections to the required shape/geometry within ± 3.0 mm 2.3 operate equipment safely 2.4 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).

Learning outcome
The learner will: 3 Be able to produce fabrications using thick plate and rolled bar sections joining techniques
Assessment criteria
The learner can: 3.1 use thick plate **joining techniques** to produce fabrications to the required shape/geometry within ± 3.0 mm 3.2 produce fabrications that have secure and firm joints and are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs 3.3 join fabricated assemblies safely 3.4 **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 (DC) electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires shielding gases used for the welding of carbon steels: carbon dioxide (CO_2), argon/CO_2, argon/oxygen/CO_2), 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 (AC) Direct Current (DC), 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, Personal Protective Equipment (PPE), fume removal)
- MIG welding (equipment/consumables: Direct Current (DC) 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 (CO_2), argon/CO_2, argon/oxygen/CO_2), 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

UAN:	L/503/0198
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
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,
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to prepare equipment, tools and materials for cutting pipework
Assessment criteria
The learner can: 1.1 prepare **equipment and tools** for a cutting operation 1.2 prepare **materials** for a cutting operation 1.3 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:

- geographical 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; galvanized 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

Learning outcome
The learner will: 2 Be able to use equipment and tools for fabricating pipework
Assessment criteria
The learner can: 2.1 use equipment for **forming** pipework 2.2 use equipment for **assembling** pipework to the required specification within ± 3.0 mm 2.3 operate equipment safely 2.4 produce fabricated pipework assemblies safely.

Range

Forming:

- hot bending (principles – application of heat, wire templates, control of pipe deformation (sand packing), use of pin block (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).

Learning outcome
The learner will: 3 Be able to produce and test fabricated pipework assemblies using joining techniques
Assessment criteria
The learner can: 3.1 use pipework **joining techniques** to produce fabrications to the required specification within ± 3.0 mm 3.2 join fabricated assemblies safely 3.3 produce pipework fabrications that have secure and firm joints and are free from excessive tooling marks, deformation, cracking, or leaks 3.4 **test pipework** to prove joint effectiveness 3.5 **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 (AC) Direct Current (DC), 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 (DC) electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires, shielding gases used for the welding of carbon steels: carbon dioxide (CO_2), argon/CO_2, argon/oxygen/CO_2), Personal Protective Equipment (PPE), fume removal
- TIG welding (equipment/consumables: Direct Current (DC) 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 (AC) Direct Current (DC), 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 (DC) 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 (CO_2), argon/CO_2, argon/oxygen/CO_2), PPE, fume removal) • TIG welding (equipment/consumables: Direct Current (DC) 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

UAN:	R/503/0199
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
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.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to prepare equipment and materials for cutting steelwork
Assessment criteria
The learner can: 1.1 prepare **equipment** and **tools** for a cutting operation 1.2 prepare **materials** for a cutting operation 1.3 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.

Learning outcome
The learner will: 2 Be able to use equipment for fabricating steelwork
Assessment criteria
The learner can: 2.1 describe **steelwork assemblies** 2.2 use equipment for **assembling** steelwork to the required specification within ± 3.0 mm 2.3 operate equipment safely 2.4 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).

Learning outcome
The learner will: 3 Be able to produce fabricated steelwork assemblies using joining techniques
Assessment criteria
The learner can: 3.1 use steelwork **joining techniques** to produce fabrications to the required specification within ± 3.0 mm 3.2 join fabricated assemblies safely 3.3 produce steelwork fabrications that have secure and firm joints and are free from excessive tooling marks, deformation, cracking, or leaks 3.4 **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 (AC) Direct Current (DC), 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 (DC) electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires, shielding gases used for the welding of carbon steels: carbon dioxide (CO_2), argon/CO_2, argon/oxygen/CO_2), 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 (AC) Direct Current (DC), 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 (DC) 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 (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 222 Maintaining electrical equipment and systems

UAN:	F/503/0201
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
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.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to prepare for maintaining electrical systems/equipment
Assessment criteria
The learner can: 1.1 gather, read and interpret manufacturer's **maintenance instructions** 1.2 determine a suitable sequence of **testing operations** 1.3 devise suitable methods for the **security of components** 1.4 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.

Learning outcome
The learner will: 2 Be able to carry out the maintenance of electrical systems/equipment
Assessment criteria
The learner can: 2.1 **prepare** for maintenance activity 2.2 use **Personal Protective Equipment (PPE)** 2.3 identify **hazards** and minimise their risk 2.4 carry out **maintenance** 2.5 carry out **tests** to ensure the fault has been rectified and the equipment performs within specification 2.6 **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

UAN:	J/503/0202
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	The unit is concerned with the process and equipment essential to the wiring and testing of electrical circuits connected to a 230/400v installation.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to assemble components and prepare for wiring and testing of electrical circuits
Assessment criteria
The learner can: 1.1 read and interpret **safety instructions** 1.2 plan for the **installation of circuits** 1.3 select the **wiring system** suitable for the environment, utilisation and building 1.4 compile a requisition of items; cables, supporting systems and fixing methods required. 1.5 check the **tools, equipment and components** are safe and suitable for their intended use 1.6 determine **termination, fixing and earthing methods** 1.7 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. **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.

Learning outcome
The learner will: 2 Be able to carry out the wiring of electrical circuits
Assessment criteria
The learner can: 2.1 install **wiring systems** 2.2 install lighting, power and control **circuits** and components to industry standards 2.3 **test** circuits to current IEE Wiring Regulations 2.4 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

UAN:	L/503/0203
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	This unit is concerned with the processes and equipment essential building and testing electronic circuits. The topics covered will enable the learner o collect, read and interpret information, plan and prepare for electronic components. The learner will also be able to perform circuit and diagnostic checks, and make simple deductions from the results of these checks.
Assessment:	This unit will be assessed by an assignment covering practical skills and underpinning knowledge.

Learning outcome
The learner will: 1 Be able to prepare for building and testing of electronic circuits
Assessment criteria
The learner can: 1.1 define **units of measurement** and their multiples and sub-multiples for electrical quantities and components 1.2 describe the **V, I and R relationships** for simple DC circuits 1.3 identify **electronic components** and their circuit symbols, values and **ratings** 1.4 identify **semiconductor components**, and their circuit symbols 1.5 state typical applications for **primary and secondary cells** 1.6 state typical applications for **input and output devices** 1.7 identify **heat sinks**, and explain their function 1.8 select and use information from **common sources** used in the electronics industry 1.9 describe the basic **function of components** within a circuit 1.10 describe how to plan **work activities** listing **tools and components** required 1.11 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.

Learning outcome
The learner will: 2 Be able to test, fault find and repair electronic equipment
Assessment criteria
The learner can: 2.1 describe **preparatory activities** necessary prior to testing electronic equipment 2.2 identify **test instruments**, and their applications 2.3 describe methods for **connection/disconnection** of connectors and test probes 2.4 state common components/items that can reveal fault conditions through **visual inspection** 2.5 state **terminology** used in fault diagnosis 2.6 identify and describe **typical faults** in electronic equipment 2.7 apply **typical fault diagnosis techniques** 2.8 describe **common factors** that determine the method of repair 2.9 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.

Learning outcome
The learner will: 3 Be able to construct new, and identify faults on existing, electronic equipment
Assessment criteria
The learner can: 3.1 state briefly the function of **electronic components** in circuits 3.2 describe methods for connecting/orientating **electronic components** in circuits 3.3 identify common **connection and termination devices** employed in electronic circuits 3.4 use correct **assembly methods** for circuit boards 3.5 describe component **insertion methods** 3.6 use correct methods for **preparing/fixing wiring and cables** 3.7 describe methods for avoidance of **static damage to components/circuit boards** whilst handling 3.8 list the applications for different **types of solder** 3.9 identify different types of **soldering/de-soldering equipment** 3.10 apply **effective soldering practices** 3.11 describe methods for the **removal of devices** from circuit boards 3.12 describe the **values of AC waveshapes** 3.13 use **test instruments** to take measurements on electronic circuits 3.14 relate test results to **values** given on circuit information 3.15 explain the importance of verifying **PSU** (power supply) **functionality** during fault finding 3.16 **restore equipment** to safe working order following repair/investigation 3.17 follow good working practices throughout the construction/fault location process. 3.18 **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 AC 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 AC waveshapes: periodic time, frequency, peak to peak, peak, average, RMS (root mean squared).

Test instruments: multimeter, oscilloscope, function generator.

Values: DC voltages, DC currents, resistance, AC 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 253 Principles of manufacturing technology

UAN:	K/503/0175
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	This unit is concerned with the methods of manufacture. It includes the range of functions found in manufacturing organisations and will provide the learner with the knowledge to plan the manufacturing production of routine engineering components by the most economic manufacturing method(s)
Assessment:	This unit will be assessed by timed question paper.

Learning outcome
The learner will: 1 Know the functions within a manufacturing organisation
Assessment criteria
The learner can: 1.1 describe the function of **departments** in the production process 1.2 classify the different types of manufacturing **organisations** 1.3 describe the different **scales of production** in manufacturing operations 1.4 state the differences between types of **equipment** used for manufacture.

Range
Departments: design, planning, stores, purchasing, quality, maintenance, sales. **Organisations:** light, medium and heavy engineering; mechanical, automotive, tools and equipment, aerospace, electrical, electronic, plant supplies, process industries, maintenance, installation and commissioning. **Scales of production:** jobbing, small batch, repeated batch, mass production. **Equipment:** general purpose, dedicated, computerised.

Learning outcome
The learner will: 2 Know how to select suitable materials and components to manufacture products
Assessment criteria
The learner can: 2.1 classify **materials** by their **properties** 2.2 classify the forms of supply of materials 2.3 distinguish between types of **mechanical fastenings and joining techniques** 2.4 describe the selection criteria for **economic production**.

Range
Range **Materials:** ferrous metals non-ferrous metals, plastics. **Properties**: plasticity, elasticity, ductility, malleability, toughness, hardness, tensile strength, compressive strength, shear strength, corrosion resistance, density. **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). **Mechanical fastenings and joining techniques:** non permanent (nuts, bolts, studs, screws, pins, springs, keys, bearings), permanent (welded, soldered, brazed, riveted). **Economic production:** costs (capital, overheads, breakeven, inflation), availability of materials and components, fitness for purpose, production methods (including ease of production).

Learning outcome
The learner will: 3 Know how to plan production from a given specification
Assessment criteria
The learner can: 3.1 estimate the **production requirements** to manufacture routine components 3.2 describe the **information requirements** to produce components to the specification 3.3 estimate the production **costs** to manufacture routine components 3.4 illustrate production planning using a flowchart or similar.

Range
Production requirements: materials, processes, production sequence, tools and equipment, speeds and feeds, inspection procedures, health and safety requirements. **Information requirements**: production drawings, quantities, specifications, third party suppliers, materials, processing methods. **Costs**: direct, indirect costs.

Additional guidance
Costs: direct (material, direct labour, production time, scrap, rework), indirect costs (overheads: heating, lighting, machine depreciation, downtime, advertising, indirect labour).

Unit 254 Principles of maintenance technology

UAN:	D/503/0187
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
Aim:	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.
Assessment:	This unit will be assessed by a timed question paper.

Learning outcome
The learner will: 1 Understand how to prepare for maintenance activities using safe and effective working practices
Assessment criteria
The learner can: 1.1 describe **safe working practices** and health and safety requirements 1.2 describe the **hazards** associated with maintenance activities 1.3 describe **sources of information** used during maintenance activities 1.4 describe types of **maintenance activities** 1.5 describe the factors to be considered when **planning** a maintenance activity 1.6 describe the procedures for **cleaning work areas** following a spillage or leakage 1.7 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. **Sources of information:** 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).

Learning outcome
The learner will: 2 Know how to select working methods, tools and equipment
Assessment criteria
The learner can: 2.1 describe how to set-up **access equipment** for safe working 2.2 describe safe **lifting techniques** 2.3 state how to move **heavy equipment** across a flat surface 2.4 describe types of **tools and equipment** and how they are used 2.5 describe how to **perform** measurement and alignment using **equipment** 2.6 describe how to replace **life determined** items 2.7 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:** cleaned, calibrate. **Equipment:** rules/tapes, micrometers, vernier instruments, ammeters, voltmeters, 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. **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).

Learning outcome
The learner will: 3 Know how to use dismantling/assembly techniques for components/systems
Assessment criteria
The learner can: 3.1 describe how to **dismantle** an engineering device or system 3.2 describe how to **re-assemble** an engineering device or system 3.3 describe how to **restore the work area** using the correct procedures for the disposal of waste 3.4 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.

Report: including: identification of equipment; type of maintenance undertaken, repairs carried out, details of replaced parts and consumables, time taken, any outstanding maintenance issues.

Additional guidance

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: including: identification of equipment; type of maintenance undertaken, repairs carried out, details of replaced parts and consumables, time taken, any outstanding maintenance issues (eg parts beginning to show signs of wear or deterioration that were not replaced, but would need attention when next maintained).

Unit 255 Principles of fabrication and welding technology

UAN:	H/503/0191
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
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.
Assessment:	This unit will be assessed by a timed question paper.

Learning outcome
The learner will: 1 Understand the basic principles of welding
Assessment criteria
The learner can: 1.1 describe the effects of **electricity** in welding 1.2 describe the influence of **electrode coverings** 1.3 describe the influence of **shielding gases/gas mixtures** 1.4 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, 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, metal inert gas/metal active gas (MIG/MAG), effects of shielding gases. **Flame conditions:** effects of combustion, 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/H_2 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).

Learning outcome
The learner will: 2 Know how to be able to select and apply welding terminology and symbols
Assessment criteria
The learner can: 2.1 describe the features of a welded joint 2.2 define types of **welded joints** to current standards 2.3 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). **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).

Learning outcome
The learner will: 3 Understand the effects of welding
Assessment criteria
The learner can: 3.1 describes **sources of heat** for welding and their effect 3.2 describe the effects of **heat distribution** due to welding 3.3 describe the **distortion** effects of heat and method of distortion control 3.4 classify **weld defects** and their possible **causes** 3.5 describe methods of Non-Destructive Testing (**NDT**) weld surfaces 3.6 describe methods of **workshop testing** welds.

Range

Sources of heat: methods of heat production (electric arc, electrical resistance, flame combustion) temperature (methods of measurement, 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, 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.

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).

Learning outcome
The learner will: 4 Know how to identify common metals used in fabrication and determine forming allowances
Assessment criteria
The learner can: 4.1 describe the range of common **metals** used in fabrication and their forms of supply 4.2 select materials against **criteria** 4.3 determine the **bending and rolling allowances** for fabricated forms from information supplied.

Range
Metals: low-carbon steel, austenitic stainless steels, galvanised steel, aluminium/aluminium alloys, forms of supply. **Criteria:** appearance, corrosion resistance, malleability, ductility, heat treatment of carbon steels. **Bending and rolling allowances:** purpose, thin sheet, thick plate, neutral line, pipe bends, 'U' bends, right-angle bends, circular forms, cylinders, presetting required to avoid 'flats' when rolling.

Additional guidance
Metals: 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 256 Principles of electrical and electronics technology

UAN:	A/503/0200
Level:	2
Credit value:	7
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA
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.
Assessment	This unit will be assessed by a timed question paper.

Learning outcome
The learner will: 1 Know the basic units used in electrotechnology
Assessment criteria
The learner can: 1.1 state the **basic units** used in electrotechnology 1.2 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.

Learning outcome
The learner will: 2 Know the application of electrotechnology
Assessment criteria
The learner can: 2.1 describe the function of **electrical components** 2.2 describe the **application** of electrical components.

Range
Electrical components: magnets, magnetic fields, solenoids, capacitors (polarised, paper, polyethylene, air, mica), applications of capacitors, series parallel connections, dangers associated with capacitors, generation of AC and DC using rotating machines, transformers, semi- conductor materials, bi-polar transistors, use as switching devices and amplifiers, connection methods. **Application:** Motors, motor control, motor start/stop relay and latching circuit, lighting, lighting control, environmental control, alarms, security systems and communications.

Additional guidance
Electrical components: magnets, magnetic fields, solenoids, capacitors (polarised, paper, polyethylene, air, mica), applications of capacitors, series parallel connections, dangers associated with capacitors, generation of AC and DC using rotating machines. Sine wave (peak, average and RMS values). 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.

Learning outcome
The learner will: 3 Be able to identify the characteristics of an electrical circuit
Assessment criteria
The learner can: 3.1 determine the current and voltage distribution in series and parallel circuits 3.2 describe the **magnetic fields** for bar magnets in various configurations 3.3 determine the polarity of a **solenoid** 3.4 describe the construction of a typical **capacitor** 3.5 describe a **sine wave** as displayed on an oscilloscope 3.6 determine the input and output voltage of double wound **transformers** 3.7 describe and construct a simple **bridge rectifier** circuit and its function.

Range
Magnetic fields: Sketch magnetic fields showing field directions for single bar magnets, N-N, S-S and N-S combinations. **Solenoid**: Sketch magnetic field showing field directions and determine polarity. **Capacitor**: construction of typical capacitors, polarized, air capacitors, paper, ceramic and silver mica. **Sine wave**: Sketch a sine wave and indicate peak, periodic times, average and root mean square values. Determine periodic time. **Transformers**: connect a double wound transformer to a load and measure relevant values. Turns ratios. Primary and secondary voltage and current relationships. **Bridge rectifier**: construct a bridge rectifier using available components. Using ELV supply and appropriate load, measure input and output parameters. Circuit sketches of a simple bridge rectifier. Output waveforms, with and without smoothing.

Appendix 1 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to **http://www.cityandguilds.com/Provide- Training/Centre-Support**.

Our Quality Assurance Requirements encompasses all of the relevant requirements of key regulatory documents

- Regulatory Arrangements for the Qualifications and Credit Framework (2008)

and sets out the criteria that centres should adhere to pre and post centre and qualification approval.

The **homepage** section of the City & Guilds website also contains useful information such on such things as:

- **Walled Garden:** how to register and certificate learners online
- **Events**: dates and information on the latest Centre events
- **Online assessment**: how to register for e-assessments.

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

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of learners
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal and External quality assurance
- Frequently asked questions.

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Useful contacts

International learners and centres General qualification information	Please contact your regional office. Details can be found at **www.cityandguilds.com** or alternatively E: **intcg@cityandguilds.com**

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