Level 2 Certificate and Diploma in Engineering (2850-20)

Qualification handbook for centres
Level 2 Certificate in Engineering 600/0880/5
Level 2 Diploma in Engineering 600/0881/7
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Level 2 Certificate and Diploma in Engineering (2850-20)

Qualification handbook for centres

Level 2 Certificate in Engineering – Manufacturing Technology (2850-20)
Level 2 Certificate in Engineering – Maintenance Technology (2850-21)
Level 2 Certificate in Engineering – Fabrication and Welding Technology (2850-22)
Level 2 Certificate in Engineering – Electrical and Electronics Technology (2850-23)
Level 2 Diploma in Engineering – Manufacturing Technology (2850-24)
Level 2 Diploma in Engineering – Maintenance Technology (2850-25)
Level 2 Diploma in Engineering – Fabrication and Welding Technology (2850-26)
Level 2 Diploma in Engineering – Electrical and Electronics Technology (2850-27)

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<td>Add unit 231 to units and update structure</td>
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1 About this document

This document contains the information that centres need to offer for the following qualification:

| Qualification titles and level                                      | Level 2 Certificate in Engineering
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<tbody>
<tr>
<td>City &amp; Guilds qualification number</td>
<td>2850-20/21/22/23/24/25/26/27</td>
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| Qualification accreditation number                                | Level 2 Certificate in Engineering - QAN 600/0880/5
|                                                                   | Level 2 Diploma in Engineering - QAN 600/0881/7                    |
| Registration and certification                                    | See Online Catalogue/Walled Garden for last dates                  |

These awards are designed to contribute towards the knowledge and understanding for the NVQ Diploma in Engineering Maintenance (City & Guilds 1788), NVQ Diploma in Mechanical Manufacturing Engineering (City & Guilds 1712) and NVQ Diploma in Fabrication and Welding (City & Guilds 1781).

These qualifications are aimed at candidates who:
- intend to follow Apprenticeship and Advanced Modern Apprenticeship programmes
- wish for career progression within engineering
- wish to develop the skills learnt from other qualifications
- require evidence towards the underpinning knowledge of the N/SVQ.

It is expected that candidates should have sufficient levels of numeracy and literacy to be able to satisfactorily complete the course of study.

1.1 Qualification structure

The following qualifications are available:

Level 2 Certificate in Engineering – Manufacturing Technology (2850-20)
Level 2 Certificate in Engineering – Maintenance Technology (2850-21)
Level 2 Certificate in Engineering – Fabrication and Welding Technology (2850-22)
Level 2 Certificate in Engineering – Electrical and Electronics Technology (2850-23)
Level 2 Diploma in Engineering – Manufacturing Technology (2850-24)
Level 2 Diploma in Engineering – Maintenance Technology (2850-25)
Level 2 Diploma in Engineering – Fabrication and Welding Technology (2850-26)
Level 2 Diploma in Engineering – Electrical and Electronics Technology (2850-27)
<table>
<thead>
<tr>
<th>City &amp; Guilds unit number</th>
<th>Title</th>
<th>Unit number</th>
<th>Credit value</th>
<th>GLH</th>
<th>Level</th>
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<td>2850 - 201</td>
<td>Working in engineering</td>
<td>H/503/0174</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 202</td>
<td>Principles of engineering technology</td>
<td>R/503/0204</td>
<td>7</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>2850 - 203</td>
<td>Principles of manufacturing technology</td>
<td>K/503/0175</td>
<td>7</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>2850 - 204</td>
<td>Machine components using milling techniques</td>
<td>Y/503/0205</td>
<td>7</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>2850 - 205</td>
<td>Machine components using turning techniques</td>
<td>M/503/0176</td>
<td>7</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>2850 - 206</td>
<td>Using bench fitting techniques</td>
<td>T/503/0177</td>
<td>7</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>2850 - 207</td>
<td>Using Computer Aided Manufacturing processes</td>
<td>D/503/0206</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 208</td>
<td>Principles of maintenance technology</td>
<td>D/503/0187</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 209</td>
<td>Assembling and maintaining fluid power systems</td>
<td>H/503/0188</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<td>2850 - 210</td>
<td>Maintenance of mechanical devices and equipment</td>
<td>K/503/0189</td>
<td>7</td>
<td>60</td>
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<td>2850 - 211</td>
<td>Maintaining electrical wiring support systems</td>
<td>D/503/0190</td>
<td>7</td>
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<tr>
<td>2850 - 212</td>
<td>Principles of fabrication and welding technology</td>
<td>H/503/0191</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<td>2850 - 213</td>
<td>Welding by Manual Metal Arc process</td>
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<td>60</td>
<td>2</td>
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<td>2850 - 214</td>
<td>Welding by MIG process</td>
<td>M/503/0193</td>
<td>7</td>
<td>60</td>
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<td>2850 - 215</td>
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<td>2850 - 216</td>
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<td>2850 - 217</td>
<td>Fabricating sheet metalwork</td>
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<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 218</td>
<td>Fabricating thick plate, bar and sections</td>
<td>J/503/0197</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<td>2850 - 219</td>
<td>Fabricating pipework assemblies</td>
<td>L/503/0198</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 220</td>
<td>Fabricating steel work assemblies</td>
<td>R/503/0199</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<td>2850 - 221</td>
<td>Principles of electrical and electronics technology</td>
<td>A/503/0200</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 222</td>
<td>Maintaining electrical equipment and systems</td>
<td>F/503/0201</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 223</td>
<td>Wiring and testing electrical circuits</td>
<td>J/503/0202</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 224</td>
<td>Constructing, testing and fault finding electronic circuits</td>
<td>L/503/0203</td>
<td>7</td>
<td>60</td>
<td>2</td>
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<tr>
<td>2850 - 231</td>
<td>Pattern development for plate and sheet metalwork</td>
<td>K/505/2726</td>
<td>7</td>
<td>56</td>
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</table>
To achieve a full **Level 2 Certificate in Engineering**, candidates must achieve 5 units with a total credit value of **35 credits** including:

**Mandatory units (14 credits)**
- Unit 201 Working in engineering (7 credits)
- Unit 202 Principles of engineering technology (7 credits)

**Plus 7 credits from their chosen pathway eg:**
- Unit 203 Principles of manufacturing technology (7 credits)
- Unit 208 Principles of maintenance technology (7 credits)
- Unit 212 Principles of fabrication and welding technology (7 credits)
- Unit 221 Principles of electrical and electronics technology (7 credits)

**Of the final 14 credits**
7 credits (one unit) must relate to their chosen technology, **plus 7 credits** (one unit) from a 'free choice' option that may or may not be from their chosen pathway.

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

**Mandatory units (14 credits)**
- Unit 201 Working in engineering (7 credits)
- Unit 202 Principles of engineering technology (7 credits)

**Plus 7 credits from their chosen pathway eg:**
- Unit 203 Principles of manufacturing technology (7 credits)
- Unit 208 Principles of maintenance technology (7 credits)
- Unit 212 Principles of fabrication and welding technology (7 credits)
- Unit 221 Principles of electrical and electronics technology (7 credits)

**Of the final 21 credits**
7 credits (one unit) must relate to their chosen technology pathway, **plus 14 credits** (two units) from a 'free choice' option that may or may not be from their chosen pathway.

### Level 2 Certificate in Engineering Rules of Combination

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Mandatory units 21 credits</th>
<th>Technology option 7 credits</th>
<th>Free option 7 credits</th>
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<td>Level 2 Certificate in Engineering – Manufacturing Technology</td>
<td>201, 202, 203</td>
<td>204-207</td>
<td>204-207, 209-211, 213-220, 222-224</td>
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<tr>
<td>Level 2 Certificate in Engineering – Maintenance Technology</td>
<td>201, 202, 208</td>
<td>209-211, 222</td>
<td>204-207, 209-211, 213-220, 222-224</td>
</tr>
<tr>
<td>Level 2 Certificate in Engineering – Electrical and Electronics Technology</td>
<td>201, 202, 221</td>
<td>211, 222-224</td>
<td>204-207, 209-211, 213-220, 222-224</td>
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Level 2 Diploma in Engineering Rules of Combination

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<tr>
<th>Pathway</th>
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<th>Free option 14 credits</th>
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</thead>
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<tr>
<td>Level 2 Diploma in Engineering – Manufacturing technology</td>
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<td>204-207</td>
<td>204-207, 209-211, 213-220, 222-224</td>
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<tr>
<td>Level 2 Diploma in Engineering – Maintenance technology</td>
<td>201, 202, 208</td>
<td>209-211, 222</td>
<td>204-207, 209-211, 213-220, 222-224</td>
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<td>Level 2 Diploma in Engineering – Fabrication and welding technology</td>
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<td>Level 2 Diploma in Engineering – Electrical and electronics technology</td>
<td>201, 202, 221</td>
<td>211, 222-224</td>
<td>204-207, 209-211, 213-220, 222-224</td>
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</tbody>
</table>

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.

<table>
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<tr>
<th>Title and level</th>
<th>GLH</th>
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<td>Level 2 Diploma in Engineering – Maintenance Technology</td>
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<td>Level 2 Diploma in Engineering – Fabrication and Welding</td>
<td>360</td>
<td>420</td>
</tr>
<tr>
<td>Level 2 Diploma in Engineering – Electrical and Electronics Technology</td>
<td>360</td>
<td>420</td>
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</table>
1.2 Opportunities for progression
The qualification provides knowledge and practical skills related to the Level 2 NVQ Diploma in Engineering Maintenance, Level 2 NVQ Diploma in Mechanical Manufacturing Engineering and Level 2 NVQ Diploma in Fabrication and Welding.

1.3 Qualification support materials
City & Guilds also provides the following publications and resources specifically for these qualifications:

<table>
<thead>
<tr>
<th>Description</th>
<th>How to access</th>
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<tbody>
<tr>
<td>Assignment guide for centres</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>Assignments (203 to 224)</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a> (password protected)</td>
</tr>
<tr>
<td>SmartScreen</td>
<td><a href="http://www.smartscreen.co.uk">www.smartscreen.co.uk</a></td>
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</tbody>
</table>

Apprenticeship frameworks
The Level 2 Certificate/Diploma in Engineering and the Level 3 Diploma in Engineering have been approved by SEMTA as technical certificates for the Apprenticeship in Engineering in England, Wales and Northern Ireland.

Full details of the requirements of the apprenticeship framework for the Engineering Sector are available from:
Name of SSC  SEMTA
Address  14 Upton Road, Watford, WD17 0JT
Telephone  01923 238441
Fax  01923 256086
URL  www.semta.org.uk
2 Centre requirements

Centre/scheme approval
Centres approved to offer the qualification 2800 Certificate in Engineering will be given automatic approval to run the new Level 2 Certificate/Diploma in Engineering (2850).

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

To offer these qualifications new centres will need to gain both centre and qualification approval. Please refer to the Centre Manual – Supporting Customer Excellence for further information.

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

2.2 Resource requirements
Centres must have access to sufficient equipment in the centre or workplace to ensure candidates have the opportunity to cover all of the practical activities.

Centre staffing
Centre staff must satisfy the requirements for occupational expertise for this qualification. These requirements are as follows:
Staff should be technically competent in the areas for which they are delivering training and/or should also have experience of providing training.
Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:
- be occupationally competent or technically knowledgeable in the area(s) for which they are delivering training and/or have experience of providing training. This knowledge must be to the same level as the training being delivered
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

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

Assessors and internal verifiers
While the Assessor/Verifier (A/V) units are valued as qualifications for centre staff, they are not currently a requirement for the qualification.

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.

2.3 Candidate entry requirements

Candidate entry and progression

No specific prior qualifications, learning or experience are required for candidates undertaking the qualification(s). However, centres will need to make an initial assessment of each candidate 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 candidates will need basic literacy and numeracy skills: i.e. the ability to read and interpret written tasks and to write answers in a legible and understandable form.

Candidates 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 candidates should not enter for a qualification of the same level and the same content as that of a qualification they already hold.

Details of the availability of assessments and of the general regulations for their conduct are given in the 'Directory of Assessments and Awards'. If there is any inconsistency between the scheme regulations in this pamphlet and the Directory of Assessments and Awards, the Directory shall prevail.

For candidates with particular requirements, centres should refer to City & Guilds policy document Access to assessment, candidates with particular requirements. This also applies to candidates who wish to seek examinations in language other than English.

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

Age restrictions

There is no age restriction for these qualifications unless this is a legal requirement of the process or the environment.
3 Course design and delivery

Tutors/assessors should familiarise themselves with the structure and content of the award before designing an appropriate course; in particular they are advised to consider the knowledge and understanding requirements of the relevant N/SVQ.

City & Guilds does not itself provide courses of instruction or specify entry requirements. As long as the requirements for the award are met, tutors/assessors may design courses of study in any way that they feel best meets the needs and capabilities of the candidates. Centres may wish to introduce other topics as part of the programme which will not be assessed through the qualifications, e.g. to meet local needs.

It is recommended that centres cover the following in the delivery of the course, where appropriate:
- Health and safety considerations, in particular the need to impress to candidates that they must preserve the health and safety of others as well as themselves
- Key Skills (such as Communication, Application of Number, Information technology, Working with others, Improving own learning and performance, Problem solving)
- Equal opportunities
- Spiritual, moral, social and cultural issues
- Environmental education, related European issues.

Access to assessment
City & Guilds’ guidance and regulations on access to assessment are designed to facilitate access for assessments and qualifications for candidates who are eligible for adjustments to assessment arrangements. Access arrangements are designed to allow attainment to be demonstrated. For further information, please see Access to assessment and qualifications, available on the City & Guilds website.

Appeals
Centres must have their own, auditable, appeals procedure that must be explained to candidates during their induction. Appeals must be fully documented by the quality assurance co-ordinator and made available to the external verifier or City & Guilds.

Further information on appeals is given in Providing City & Guilds qualifications. There is also information on appeals for centres and learners on the City & Guilds website or available from the Customer Relations department.

3.1 Initial assessment and induction
Centres will need to make an initial assessment of each candidate 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 candidate has, and the support and guidance they may require when working towards their qualification[s]. This is sometimes referred to as diagnostic testing.
any units the candidate has already completed, or credit they have accumulated which is relevant to the qualification[s] they are about to begin.

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

3.2 Recommended delivery strategies
Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification[s] before designing a course programme.

Centres may design course programmes of study in any way which:
- best meets the needs and capabilities of their candidates
- satisfies the requirements of the qualifications.

When designing and delivering the course programme, centres might wish to incorporate other teaching and learning that is not assessed as part of the qualifications. This might include the following:
- literacy, language and/or numeracy
- personal learning and thinking
- personal and social development
- employability

Where applicable, this could involve enabling the candidate to access relevant qualifications covering these skills.
### 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 short answer question paper. 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 for assessors which contains all information required. As assignments are designed to sample practical activities, it is essential that the centres ensure that candidates cover the content of the whole unit.

Assessment components are graded (Pass, Merit, Distinction). A pass is the achievement level required for the knowledge and understanding in an NVQ 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.

#### 4.1 Summary of assessment methods

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

- **one** online multiple-choice assessment for **each** mandatory unit
- **one** short answer question paper for each ‘Principles of’ unit
- **one** assignment for **each chosen** optional unit

City & Guilds provides the following assessments:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Title</th>
<th>Assessment method</th>
<th>Where to obtain assessment materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>2850-201</td>
<td>Working in engineering</td>
<td>Online multiple-choice assessment</td>
<td><a href="http://www.walled-garden.com">www.walled-garden.com</a></td>
</tr>
<tr>
<td></td>
<td>The assessment covers all of the outcomes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2850-202</td>
<td>Principles of engineering technology</td>
<td>Online multiple-choice assessment</td>
<td><a href="http://www.walled-garden.com">www.walled-garden.com</a></td>
</tr>
<tr>
<td></td>
<td>The assessment covers all of the outcomes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2850-203</td>
<td>Principles of manufacturing technology</td>
<td>Assignment 2850-203</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td></td>
<td>The assessment includes short answer questions to verify coverage of the underpinning knowledge in the unit.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>City &amp; Guilds devised assignment, internally marked, externally verified.</td>
<td></td>
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</tr>
<tr>
<td>Unit</td>
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</tr>
</tbody>
</table>
| 2850-204 | Machine components using milling techniques                          | Assignment 2850-204  
The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.                                                                 | www.cityandguilds.com                |
|          |                                                                      | City & Guilds devised assignment, internally marked, externally verified.                                                                                                                                               |                                      |
| 2850-205 | Machine components using turning techniques                           | Assignment 2850-205  
The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.                                                                 | www.cityandguilds.com                |
|          |                                                                      | City & Guilds devised assignment, internally marked, externally verified.                                                                                                                                               |                                      |
| 2850-206 | 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.                                                                 | www.cityandguilds.com                |
|          |                                                                      | City & Guilds devised assignment, internally marked, externally verified.                                                                                                                                               |                                      |
| 2850-207 | 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.                                                                 | www.cityandguilds.com                |
|          |                                                                      | City & Guilds devised assignment, internally marked, externally verified.                                                                                                                                               |                                      |
| 2850-208 | Principles of maintenance technology                                 | Assignment 2850-208  
The assessment includes short answer questions to verify coverage of the underpinning knowledge in the unit.                                                                                               | www.cityandguilds.com                |
|          |                                                                      | City & Guilds devised assignment, internally marked, externally verified.                                                                                                                                               |                                      |
| 2850-209 | 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.                                                                 | www.cityandguilds.com                |
<p>|          |                                                                      | City &amp; Guilds devised assignment, internally marked, externally verified.                                                                                                                                               |                                      |</p>
<table>
<thead>
<tr>
<th>Unit</th>
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</tr>
</thead>
</table>
| 2850-210  | 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                                                                                                                                   |
| 2850-211  | 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                                                                                                                                   |
| 2850-212  | Principles of fabrication and welding technology   | Assignment 2850-212  
The assessment includes short answer questions to verify coverage of the underpinning knowledge in the unit.  
City & Guilds devised assignment, internally marked, externally verified. |
|           |                                                    | www.cityandguilds.com                                                                                                                                   |
| 2850-213  | Welding by Manual Metal Arc process                | Assignment 2850-213  
The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.  
City & Guilds devised assignment, internally marked, externally verified. |
|           |                                                    | www.cityandguilds.com                                                                                                                                   |
| 2850-214  | Welding by MIG process                             | Assignment 2850-214  
The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.  
City & Guilds devised assignment, internally marked, externally verified. |
|           |                                                    | www.cityandguilds.com                                                                                                                                   |
| 2850-215  | Welding by TIG process                             | Assignment 2850-215  
The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.  
City & Guilds devised assignment, internally marked, externally verified. |
<p>|           |                                                    | <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>                                                                                                                                   |</p>
<table>
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<th>Assessment method</th>
<th>Where to obtain assessment materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>2850-216</td>
<td>Welding by Oxy-Acetylene process</td>
<td>Assignment 2850-216 &lt;br&gt;The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. &lt;br&gt;City &amp; Guilds devised assignment, internally marked, externally verified.</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>2850-217</td>
<td>Fabricating sheet metalwork</td>
<td>Assignment 2850-217 &lt;br&gt;The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. &lt;br&gt;City &amp; Guilds devised assignment, internally marked, externally verified.</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>2850-218</td>
<td>Fabricating thick plate, bar and sections</td>
<td>Assignment 2850-218 &lt;br&gt;The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. &lt;br&gt;City &amp; Guilds devised assignment, internally marked, externally verified.</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>2850-219</td>
<td>Fabricating pipework assemblies</td>
<td>Assignment 2850-219 &lt;br&gt;The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. &lt;br&gt;City &amp; Guilds devised assignment, internally marked, externally verified.</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>2850-220</td>
<td>Fabricating steel work assemblies</td>
<td>Assignment 2850-220 &lt;br&gt;The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit. &lt;br&gt;City &amp; Guilds devised assignment, internally marked, externally verified.</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>2850-221</td>
<td>Principles of electrical and electronics technology</td>
<td>Assignment 2850-221 &lt;br&gt;The assessment includes short answer questions to verify coverage of the underpinning knowledge in the unit. &lt;br&gt;City &amp; Guilds devised assignment, internally marked, externally verified.</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
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<td>--------</td>
<td>-----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------</td>
</tr>
</tbody>
</table>
| 2850-222 | 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.                                                                 | www.cityandguilds.com               |
| 2850-223 | 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.                                                                 | www.cityandguilds.com               |
| 2850-224 | 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.                                                                 | www.cityandguilds.com               |
| 2850-231 | Pattern development for plate and sheet metalwork                    | Assignment 2850-231  
The assessment covers the practical activities for all outcomes and will also sample underpinning knowledge to verify coverage of the unit.                                                                 | www.cityandguilds.com               |

**Time constraints**

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

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

### 4.2 Test specifications

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

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

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. of questions</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Know engineering health and safety requirements</td>
<td>17</td>
<td>42.5</td>
</tr>
<tr>
<td>2. Know effective methods of communication</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>3. Understand drawings and specification</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>4. Know about working in engineering</td>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
### Test: 2850-202 Principles of engineering technology
### Duration: 60 minutes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. of questions</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Know requirements for materials in engineering</td>
<td>9</td>
<td>22.5</td>
</tr>
<tr>
<td>2. Know properties of engineering materials</td>
<td>9</td>
<td>22.5</td>
</tr>
<tr>
<td>3. Know how to apply analytical methods to engineering mathematical applications</td>
<td>11</td>
<td>27.5</td>
</tr>
<tr>
<td>4. Know how to apply analytical methods to engineering science applications</td>
<td>11</td>
<td>27.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

#### 4.3 Recognition of prior learning (RPL)

Recognition of Prior Learning (RPL) recognises the contribution a person's previous experience could contribute to a qualification.

RPL is allowed and is not sector specific.
5 Units

Structure of units
The units in these qualifications are written in a standard format and comprise the following:
- City & Guilds reference number
- unit accreditation number (UAN)
- title
- level
- credit value
- unit aim
- relationship to NOS, other qualifications and frameworks
- endorsement by a sector or other appropriate body
- information on assessment
- learning outcomes which are comprised of a number of assessment criteria
- notes for guidance.

Where there are references to British, European and International standards the current version should be used.
Unit 201  Working in engineering

Level: 2
Credit value: 7
UAN: H/503/0174

Unit aim
This unit will encourage candidates to find out about working in engineering. It will cover the underpinning basic skills and knowledge needed to function in engineering or manufacturing sectors.

It will cover the need to recognise and use safe working practices, consideration of the environment and working effectively as a part of a team. It includes the methods of communication that engineers use in their everyday.

Learning outcomes
There are four learning outcomes to this unit. The learner will:
1. Know engineering health and safety requirements
2. Know effective methods of communication
3. Understand drawings and specifications
4. Know about working in engineering

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 1: Working Safely in an Engineering Environment, Unit 2: Working Efficiently and Effectively in Engineering, Unit 3: Using and Communicating Technical Information

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an online multiple-choice assessment.
Unit 201 Working in engineering
Outcome 1 Know engineering health and safety requirements

Assessment Criteria
The learner will can:

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

Range
Employers’ responsibilities: a safe place of work, safe plant and a safe working environment equipment, safe methods of handling, storing and transporting goods and materials, reporting of accidents, information, instruction, training and supervision of employees
Safe working practices: be alert, maintain personal hygiene, protect yourself and other people, emergency procedures, report all hazards
Implementation: safety policies, codes of practice, safe systems of work
Protection of operators and bystanders: Personal Protective Equipment (PPE), Respiratory Protective Equipment (RPE), designated safe areas, first aid treatment: location of facilities, location of qualified first aiders
Signs: warning, prohibition, mandatory, information, fire
Roles, responsibilities and powers: health and safety advisors, health and safety representatives, health and safety executive inspectors
Human and environmental conditions: causes of accidents, accident prevention measures
Risk assessments: slippery or uneven surfaces, spillages, scrap or waste material, flammable materials, faulty or missing machine guards, faulty electrical connections or damaged cables, dust and fumes, contaminants and irritants, materials handling and transportation
Fire: conditions required for extinction, fire prevention, (fire procedures, fire drills, fire fighting equipment for different types of fires extinguishers, automatic systems, e.g. sprinklers)
Hazardous area: using barriers and/or tapes, placing warning signs in appropriate positions, informing any persons who may be affected, isolating power or pressure sources, obtaining official clearance, safety checks

Additional Guidance

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

Hazardous area: using barriers and/or tapes, placing warning signs in appropriate positions, informing any persons who may be affected, isolating power or pressure sources, obtaining official clearance (Permit to Work), safety checks (ensuring work area is free from hazards, any required safety procedures are implemented, any necessary Personal Protective Equipment is in a usable condition, tools and equipment are in a safe and usable condition).
Unit 201 Working in engineering
Outcome 2 Know effective methods of communication

Assessment Criteria
The learner can:

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

Range
Communication systems: verbal, written, drawings, electronic, signs
Roles: departments, finance/purchasing, manufacturing/production, quality assurance/control, inspection, despatch, maintenance, human resources, personnel, managers, engineers, supervisors, trainers, inspectors, safety officers, personnel staff, unions
Sources: BS EN standards, instruction manuals, technical handbooks, tables, charts, graphs, data sheets, textbooks, reference materials, computer based, Internet, Intranet, technical information
Correct approach: stating the problem clearly and succinctly, listening to the response attentively, seeking clarification on points not fully understood
Sources of support: mentor, trainer, supervisor

Additional Guidance
Communication systems: verbal (instruction, advice), written (instructions, work requests), drawings, electronic, signs
Sources: BS EN standards, instruction manuals, technical handbooks, tables, charts, graphs, data sheets, textbooks, reference materials, computer based, Internet, Intranet, technical information (sketches, drawings, diagrams, test and inspection reports, planning documents and schedules, design brief)
Unit 201 Working in engineering
Outcome 3 Understand drawings and specifications

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

Range
Technical drawings and specifications: characteristics of a product, shape, size, material, features; provide additional product information, materials, manufacturing or installation data, special processes/equipment requirements
Current standards: projections: orthographic, isometric, oblique, assembly, schematic, exploded views, sketches
Essential information: projection, scale, dimensions, issue number, author, tolerances, symbols, notes, materials, batch requirements, parts list
Standards: communicates technical information/data, produced in universal language for all stakeholders, provides the basis for quality assurance
Specifications and quality systems:
Quality: assurance, quality control, inspection, quality circles
Conformance/fitness for purpose: specifications: customer requirements, reference of standards, safety requirements, quality records, traceability
Corrective action procedures,
Conventions: lines, hatching, symbols, views, layout
Features: detailed drawings, manufacturing process(s), product make up (number of components), sequence of operations (operations sheet), quality control requirements, storage and dispatch requirements, use of graphs, tables and charts.
Unit 201  Working in engineering
Outcome 4  Know about working in engineering

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

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

Work effectively:
Behaviours, observation of rules, regulations and procedures, conduct within the workplace, relationships with colleagues, supervisors and managers, respect for company property
Observing safety policies and regulations
Conduct expected: when dealing with: customers, visitors, inspectors.

Conflict:
Reasons for: difficulties or situations that can arise due to: differences of opinion, unpopular team leader decisions, working within time constraints, team member aspirations and/or ambitions, individual skill levels, team member personalities.
Avoid conflict situations by, enquiring politely, timeliness when seeking advice or assistance, avoiding conflict and knowing when to withdraw from the situation, listening carefully, following reasonable requests from supervisors, offering help when colleagues are in need of assistance.

Team members: team leaders, team members
Working effectively: personal development, participation in group discussions and decision making: suggesting solutions to problems, how to give and receive constructive criticism, when to be assertive, when to concede to individual or group pressure.
Unit 202 Principles of engineering technology

Level: 2  
Credit value: 7  
UAN: R/503/0204

Unit aim
This unit is concerned with the basic principles of mathematics and science, along with the materials technology that underpin engineering applications. It covers common applied engineering calculations and materials selection in terms of types, common forms of supply, properties and methods of changing their properties.

Learning outcomes
There are four learning outcomes to this unit. The learner will:
1. Know requirements for materials in engineering
2. Know properties of engineering materials
3. Know how to apply analytical methods to engineering mathematical applications
4. Know how to apply analytical methods to engineering science applications

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 1: Working Safely in an Engineering Environment, Unit 2: Working Efficiently and Effectively in Engineering, Unit 3: Using and Communicating Technical Information

Support of the unit by a sector or other appropriate body (if required, otherwise omit)
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an online multiple-choice assessment.
Unit 202 Principles of engineering technology
Outcome 1 Know requirements for materials in engineering

Assessment Criteria
The learner can:
1. state the range of materials used in common engineering applications
2. state the forms of supply of materials
3. state how to identify materials by their physical properties.

Range
Select materials: ferrous metals: carbon steels, stainless steels, cast iron; non-ferrous metals: aluminium and aluminium alloys, copper and copper alloys; non-metallic materials: plastics, composites, rubber
Forms of supply: bar, plate, sheet, coated sheet, pipe and tube, castings, forgings, extrusions
Identify materials: colour, appearance, density.

Additional Guidance
Select materials: ferrous metals: carbon steels (low, medium, high), stainless steels (austenitic, ferritic, martensitic), cast iron; non-ferrous metals: aluminium and aluminium alloys, copper and copper alloys (brass, bronze); non-metallic materials: plastics (thermoplastic, thermosetting), composites (glass fibre, carbon fibre, aramid fibre) rubber
Forms of supply: bar (flat, round, square, hexagonal), plate, sheet, coated sheet (tin plate, galvanised, plasticized), pipe and tube, castings, forgings, extrusions
Unit 202  
Principles of engineering technology

Outcome 2  
Know properties of engineering materials

Assessment Criteria
The learner can:
1. state the physical properties of materials
2. define what is meant by mechanical properties of materials
3. state the mechanical properties of materials
4. describe methods of modifying properties of materials.

Range
Physical properties: melting points of metals, density, colour, magnetism, corrosion resistance, conductivity, insulation
Mechanical properties: tensile strength, toughness, hardness, elasticity, ductility, malleability
Modifying properties: effects of cold working; heat treatment: annealing, normalising, hardening and tempering
Unit 202 Principles of engineering technology
Outcome 3 Know how to apply analytical methods to engineering mathematical applications

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

Range
Degree of accuracy: decimals places, significant figures, fractions as a decimal quantity
Areas of basic shapes: square, rectangle, triangle, circle
Compound shapes: involving: squares, rectangles, triangles, circles, semi-circles, quadrants of a circle
Surface areas: cube, rectangular prism, cylinder (curved surface area only)
Volumes: cube, rectangular prism, cylinder
Angles in a triangle: right-angled, isosceles, equilateral
Unit 202 Principles of engineering technology
Outcome 4 Know how to apply analytical methods to engineering science applications

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

Range
Force: definition, solve problems using formulae
Work done: definition, solve problems using formulae
Power: mechanical power, electrical power
Energy: mechanical energy, electrical energy
Efficiency: mechanical (power, energy), electrical (power, energy)
Moment of a force: levers, torque
Relative density: relative to water
Ohm's law: of the form $V = IR$
Strength of engineering materials: yield stress, tensile stress, percentage elongation, force/extension graph, stress/strain graph
Pressure at depth: $\rho gh$
Unit 203  Principles of manufacturing technology

Level: 2
Credit value: 7
UAN: K/503/0175

Unit aim
This unit is concerned with the methods of manufacture. It includes the range of functions found in manufacturing organisations and will provide the candidate with the knowledge to plan the manufacturing production of routine engineering components by the most economic manufacturing method(s).

Learning outcomes
There are three outcomes to this unit. The learner will:
1. Know the functions within a manufacturing organisation
2. Know how to select suitable materials and components to manufacture products
3. Know how to plan production from a given specification

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 65: General Machining, Fitting and Assembly Applications

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by a short answer question paper.
Unit 203 Principles of manufacturing technology
Outcome 1 Know the functions within a manufacturing organisation

Assessment Criteria
The learner can:
1. describe the function of departments in the production process
2. classify the different types of manufacturing organisations
3. describe the different scales of production in manufacturing operations
4. state the differences between types of equipment used for manufacture.

Range
Departments: design, planning, stores, purchasing, quality, maintenance, sales, manufacturing
Organisations: light, medium and heavy engineering; mechanical, automotive, tools and equipment, aerospace, electrical, electronic, plant supplies, process industries, maintenance, installation, commissioning, fabrication and welding
Scales of production: jobbing, small batch, repeated batch, mass/flow production
Equipment: general purpose, dedicated, computerised.
Unit 203  Principles of manufacturing technology
Outcome 2  Know how to select suitable materials and components to manufacture products

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

Range
Materials: ferrous metals non-ferrous metals, plastics, composite (carbides, oxides, borides)
Properties: plasticity, elasticity, ductility, malleability, toughness, hardness, tensile strength, compressive strength, shear strength, corrosion resistance, density
Forms of supply: sheet, wire, bar, tube, extrusion, casting, forgings, moulding, granules
Mechanical fastenings and joining techniques: non permanent, permanent
Economic production: costs, availability of materials and components, fitness for purpose, production methods.

Additional Guidance
Materials: ferrous metals (low medium and high carbon, stainless steels, cast iron), non-ferrous metals (copper, aluminium, brass, bronze), plastics (thermosetting, thermoplastic). Thermosetting (acrylics, polystyrene, polyvinyl chloride (PVC), polypropylene (PP), polythene)
Mechanical fastenings and joining techniques: non permanent (nuts, bolts, studs, screws, pins, keys), permanent (welded, soldered, brazed, riveted, adhesives, compression joints)
Economic production: costs (capital, overheads, breakeven, inflation), availability of materials and components, fitness for purpose, production methods (including ease of production).
Unit 203  Principles of manufacturing technology
Outcome 3  Know how to plan production from a given specification

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

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

Additional Guidance
Costs: direct (material, direct labour, production time), indirect costs (overheads: heating, lighting, machine depreciation, scrap, rework, downtime, advertising, indirect labour, administration, security, human resources, safety, holidays, marketing)
Unit 204  
_machine components using milling techniques_

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<thead>
<tr>
<th>Level:</th>
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**Unit aim**

This unit is concerned with the underlying process in setting special holding devices prior to carrying out milling operations. The candidate will be able set and operate milling machines. They will be able to select the appropriate automatic feed and cutters to achieve the desired outcome. The candidate will be able to select and set cutters for straddle milling.

**Learning outcomes**

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

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

**Guided learning hours**

It is recommended that **60** hours should be allocated for this unit, although patterns of delivery are likely to vary.

**Details of the relationship between the unit and relevant national standards**

This unit is linked to the NVQ – Performing Engineering Operations Level 2: Unit 012 Preparing and using milling machines

**Support of the unit by a sector or other appropriate body**

This unit is endorsed by SEMTA.

**Assessment**

This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 204  Machine components using milling techniques
Outcome 1  Know how to plan and prepare for milling activities

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

Range
Health and safety precautions: emergency stop procedures, use of guards, operating procedures, moving parts, removal of swarf
Datum: faces, centres
Classes of fit: clearance
Measuring equipment: micrometers, vernier, dial test indicator (DTI), gauges, surface finish
Coolants and cutting oils: oils, compounds, synthetic
Cutting tool materials: high speed steel (HSS), carbide tips
Cutting speeds and feeds: cutting tool material/material being cut, surface finish required, type of cutting operation, power output of the machine, use of coolant, determine spindle speeds
Mounting tools: arbor (standard, short, stub); chucks (auto lock, jacobs); collets (pull [friction] positive grip, auto-lock)
Workholding: machine vice (fixed jaw, swivel and universal), direct clamping, fixtures, angle plates, vee blocks, equipment used when setting workholding devices: squares, protractors (adjustable, vernier), dial test indicators (plunger, lever), levels.

Additional information
Measuring equipment: micrometers (external, internal, depth), vernier (calliper, depth, protractor, digital), dial test indicator (DTI), gauges (plug, blocks, thread, radius/profile, bore/hole), surface finish (comparison plates), how to check that measuring equipment is within current calibration dates
Cutting tool materials: high speed steel (HSS), carbide tips (methods of holding the tip, number of cutting edges, shapes)
Unit 204  Machine components using milling techniques

Outcome 2  Be able to determine requirements for milling operations

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

Range
Cutters: vertical mounted: end mills, slot drills, tee slot, dovetail, flycutter; mounted: side and face, staggered tooth, slitting saw, angular, slab mill, helical mill, form, shell end mills
Cutter nomenclature and cutter/workpiece movement: milling cutters, twist drills, up-cut milling, down-cut milling
Calculate: spindle speeds for different materials and cutter diameters; cutting speeds for materials to be machined (carbon steels, cast iron, aluminium alloys, brass, cutting tool material, high speed steel, carbides)
Arbor mounted cutters: side and face, cylindrical cutters (slab mill), saws, angular cutters, concave and convex cutters, radius, form cutters, fluting cutters; parts and types of arbors, stub arbors and methods of mounting (construction, mounting procedures, setting cutters, support brackets, knee braces)
Collet held cutters: end mill, slot drill, fly cutters, tee slot, woodruff key and dovetail cutters; shank styles: screwed, straight, flatted; operation and application of collet chucks (types of locking devices, ease of changeability)

Additional information
Cutters: vertical mounted: end mills (4 and 2 flute), slot drills (2 and 3 flute, bull nose), tee slot, dovetail, 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
Unit 204  Machine components using milling techniques
Outcome 3  Be able to perform milling operations to produce parts

Assessment Criteria
The learner can:
1. interpret engineering drawings
2. select and set workholding devices square and central to cutter and set adjustable angle plate to a prescribe angle
3. machine slots and angles, to within specified dimensions and measure accuracy to ± 0.2 mm, angular ± 1°, surface finish 1.6 μm
4. machine holes and pockets square to surfaces and measure accuracy
5. apply health and safety precautions specific to operating milling machines.

Range
Drawings: orthographic and auxiliary views (dimensions (functional, non-functional), tolerance (linear, angular), scale, datum (face, point)
Workholding devices: clamps, machine vice, angle plate (fixed and adjustable), methods of securing work, setting aid (dial test indicators)
Measure: micrometers (external and depth) vernier (callipers and protractor).
Unit 204  Machine components using milling techniques

Outcome 4  Be able to perform milling operations

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

Range
**Calculations:** simple indexing (pitch circle diameter [PCD], angular rotation)
**Mill holes, slots and flat angled surfaces:** vertical mill, depth of holes machined within depth slot drill, angles and flat surfaces end mill.
**Measuring equipment:** micrometer (0 – 25, 25-50 and 50-11 mm): external, depth, vernier callipers (digital) and protractor, surface texture gauges (tactual method)

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

Learning outcomes
There are three learning outcomes to this unit. The learner will:
1. Know how to plan and prepare for turning activities
2. Be able to turn parallel and tapered shafts
3. Be able to offset turn, external and internal diameters

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 11: Preparing and Using Lathes for Turning Operations

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 205  Machine components using turning techniques
Outcome 1  Know how to plan and prepare for turning activities

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

**Range**
**Health and safety precautions:** emergency stop procedures, use of guards, operating procedures, moving parts, removal of swarf  
**Datum:** faces, centres  
**Classes of fit:** clearance, interference  
**Measuring equipment:** micrometers (external, internal, depth), vernier (calliper, depth, protractor, digital), dial test indicator (DTI), gauges (plug, blocks, thread, radius/profile, bore/hole), surface finish (comparison plates), how to check that measuring equipment is within current calibration dates  
**Coolants and cutting oils:** oils, compounds, synthetic  
**Cutting tool materials:** high speed steel (HSS), carbide tips  
**Cutting speeds and feeds:** cutting tool material/material being cut, surface finish required, type of cutting operation, power output of the machine, use of coolant  
**Mounting tools:** four way, quick change, tailstock  
**Workholding devices:** chuck (three jaw self centring, including soft jaws), collet, four jaw independent, face plate, steadies (fixed, travelling), catch plate and carriers
Unit 205  
Machine components using turning techniques

Outcome 2  
Be able to turn parallel and tapered shafts

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

Range
Equipment: dead, live and running, centres, catch plate, carriers, taper turning attachment, micrometers, vernier calliper and protractors
Parallel shafts: setting centres parallel, diameters to be concentric, run out to be within tolerance (±0.1 mm)
Surface finish: all surfaces to be within 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
Unit 205  
Machine components using turning techniques

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

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

Range
**Work holding devices:** four jaw chuck, self-centring chuck, face plate, between centres, clamps, setting (scribe circle and pin), wobble bar, balancing (four jaw chuck, face plate)
**Mark centres:** vernier height gauge, surface plate/table, vee blocks, angle plate, centre drill, drilling machine
**Bore and ream:** boring bars (solid, tip, insert), drills and reamers (morse taper shank, expanding, chucking, floating), sleeves (tailstock)
**Tolerances:** dial test indicator (DTI), micrometer (internal, external, depth) vernier calliper (digital).

Additional Guidance
**Restore the work area:** leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
Unit 206  Using bench fitting techniques

Level: 2
Credit value: 7
UAN: T/503/0177

Unit aim
This unit covers a broad range of fitting activities that are required in the engineering and manufacturing sectors. It covers skills and knowledge needed to produce components for assembly using appropriate tools, different materials and inspection techniques to achieve the required tolerances and conforming to specifications, whilst complying with health and safety legislation and regulations.

Learning outcomes
There are two outcomes to this unit. The learner will:
1. Know how to plan and prepare for bench fitting activities
2. Be able to apply bench fitting techniques to produce component parts

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 5: Producing Components using Hand Fitting Techniques

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 206  Using bench fitting techniques
Outcome 1  Know how to plan and prepare for bench fitting activities

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

Range
Safe working practices: wearing appropriate protective clothing and equipment (overalls, safety footwear, eye protection, hearing protection, use of barrier cream), maintaining a clean and tidy work area, preparing the work area, leaving the work area in a safe and clean condition, risk assessments
Hazards: handling of coolants and cutting oils/compounds, misuses of tools, use of damaged or badly maintained tools
Engineering drawings: dimensional, geometrical, materials, limits
Unit 206 Using bench fitting techniques
Outcome 2 Be able to apply bench fitting techniques to produce component parts

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

Range
Tools and equipment: marking out, punches surface plate/table, angle plate parallels and vee blocks, hand tools, measuring instruments, protractor, micrometers, verniers, dial test indicators, surface finish, cutting and shaping, drills, taps and dies, reamers, forms of power supply, powered hand tools, forming equipment
Safe working practices: wearing appropriate protective clothing and equipment (overalls, safety footwear, eye protection, hearing protection, use of barrier cream), maintaining a clean and tidy work area, preparing the work area, leaving the work area in a safe and clean condition, risk assessments
Portable machines and equipment: emergency stop procedures, use of guards and interlocking devices, operating procedures, moving parts, removal of swarf, setting, checking and operating off-hand grinding machines (gap between rest and wheel, wheel imperfections, changing the wheel), angle grinder (position of guards, wheel selection, changing the wheel)
Produce and assemble component parts: setting of work datums, use charts to obtain drill diameters for clearance and tapping hole, assemble component parts in the correct sequence and without damage
Accuracy and quality: inspection, quality control, compliance records.
Dispose of waste: legal requirements for the disposal of waste and the implications of failure to comply, materials (metallic materials, plastics, textiles, paper and card), procedures (segregate, label, dispose)

Additional Guidance
Tools and equipment: marking out (scribers, scribing block, punches [centre and dot], surface plate/table, angle plate parallels and vee blocks) hand tools (files, screwdrivers, hammers and mallets, pin punches, spanners [open-ended, socket sets, ring, torque wrenches], measuring instruments (rules, inside and outside calipers, protractor, micrometers [external, depth], verniers [height gauge, protractor, callipers]), gauges (feeler, blocks/slip, radius, thread) dial test indicators, surface finish (comparison plates, tactile machines), cutting and shaping (saws [hand, mechanical], drills [high speed steel [HSS] carbide tips drill speed tables, cutting speed formula [cutting speed = \( \pi dN/1000 \)], taps (spiral flute, straight flute [taper, second, bottoming], use of charts for selecting tapping sizes) and dies (circular split, rectangular, pipe), reamers, forms of power supply [230V, 110V, pneumatic, battery], powered hand tools (drills, screwdrivers, angle grinders, saws), forming equipment (bench folders, fly press).
Produce and assemble component parts: setting of work datums (faces, lines, centres, corners, edges), marking out (datum and centre lines, circles and radial lines, squares and rectangles, linear hole positions, witness mark), use of types of hole (drilled, flat bottom, countersunk, counterbored, spotface), screw fittings (bolts, screws, hexagon, countersink and caphead)

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
Unit 207 Using Computer Aided Manufacturing processes

Level: 2
Credit value: 7
UAN: D/503/0206

Unit aim
This unit is designed to enable candidates to produce standard components using computer aided manufacturing techniques. It includes the production of a component and suitable files to produce such components. It will also cover the relevant health and safety procedures required.

Learning outcomes
There are two outcomes to this unit. The learner will:
1. Be able to use a computer to produce a suitable program to enable the production of a component
2. Be able to manufacture a standard component using the appropriate machine tool

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 14: Preparing and Proving CNC Machine Tool Programs; Unit 15: Preparing and Using CNC Turning Machines; Unit 16: Preparing and Using CNC Milling Machines; Unit 17: Preparing and Using CNC Machining Centres

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 207 Using Computer Aided Manufacturing processes
Outcome 1 Be able to use a computer to produce a suitable program to enable the production of a component

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

Range
Hardware requirements: CPU, monitor, keyboard, mouse, printer, scanner, hard drive
Check: visual off-load checks
Health and safety requirements: lighting, seating, sitting and positioning of equipment, dangers of trailing leads, safe and tidy work area, screen filters
Housekeeping: organisation of files into folders, closing down equipment correctly, using storage media: hard disk drive, CD ROM, DVD ROM, USB removable storage, the Internet
Drawing: orthographic (1st and 3rd angle), isometric, procedure for creating a new drawing, setting-up, scales and sheet size, types of lines, layers
Exchange format: .dx, .iges
Unit 207 Using Computer Aided Manufacturing processes

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

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

Range
CNC machining: lathes (two axis, turning centres), milling machines (vertical, horizontal), machining centres,
Set-up: machine vice, grid plate, rotary tables, pallets, chucks, steadies, override switches, guarding, selection of speeds and feeds, tools/cutters
Part program: use of absolute and incremental co-ordinates, canned cycles, sub-routines
Check components: during manufacture, on completion, use of measuring equipment (vernier calipers, micrometers)
Disposal of waste: legal requirements for the disposal of waste and the implications of failure to comply, materials (metallic materials, plastics, textiles, paper and card), procedures (segregate, label, dispose)

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

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
Unit 208  Principles of maintenance technology

Level:  2
Credit value:  7
UAN:  D/503/0187

Unit 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.

Learners are provided with an overview of a wide range of engineering maintenance activities, terminology and practices that are needed as part of routine maintenance work.

Learning outcomes
There are three outcomes to this unit. The learner will:
1. Understand how to prepare for maintenance activities using safe and effective working practices
2. Know how to select working methods, tools and equipment
3. Know how to use dismantling/assembly techniques for components/systems

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 68: General Maintenance Engineering Applications

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by a short answer question paper.
Unit 208  Principles of maintenance technology

Outcome 1  Understand how to prepare for maintenance activities using safe and effective working practices

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

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

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

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

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

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

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

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

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

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

Mechanical system such as compressed air, steam, fuel oil etc. but not combustible gas or highly flammable hydrocarbon fuel. Can also cover domestic or industrial Electrical systems but limited to low or medium
voltages.
Unit 208  Principles of maintenance technology

Outcome 2  Know how to select working methods, tools and equipment

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

Range
Access equipment: ladders, scaffolding, platforms, mobile hoists
Lifting techniques: chains, rope and wire slings, hooks, shackles, eye bolts, methods of sling attachment to prevent damage to sling / machinery (protective padding, wooden blocks) estimation of approximate weight, use of manufacturers data, centre of gravity of load, angle of splay between two leg sling chains not to exceed 120°, never exceed the safe working load [SWL], inspection records for lifting equipment are current, lifting equipment (screw and hydraulic jacks, overhead gantry cranes, mobile cranes, jib cranes, derricks, fork lift trucks, tripods, shackles, pulley blocks)
Heavy equipment: rollers and skates, crowbars, pull-lifts, lubricated plates
Tools and equipment: torque/impact wrenches, pipe wrenches, pipe cutting and threading, spanners and socket sets, drifts and wedges, extractors, feeler gauges, screw drivers, pliers, wire cutter/stripers
Perform: measure using calibrated equipment and the importance of calibration
Equipment: Use of; rules/tapes, micrometers, vernier instruments, ammeters, voltmeters, ohmmeters, insulation resistance tester, multi-meters, straight edges, squares, feeler gauges, plumb line, spirit level, piano wire, optical instruments, lasers, checks for accuracy
Life determined: high tensile bolts and washers, nylon insert nuts, locking devices, split pins, seals and gaskets
Also includes
Bearings, slideway materials, belt and chain drives (including drive pulleys and sprockets, braking media, filters, springs, shock absorbing components, mechanical seals)
Lubricants: friction between moving parts, wear, generation of heat, force required to overcome friction, methods of reduction (oils [mineral, synthetic, animal and vegetable] greases, copper compound, graphite), application (total loss, re-circulatory, splash, grease guns and nipples), reasons for oil deterioration (excessive heat, oxidation, contamination, breakdown of structure, poor storage conditions)
Unit 208  
**Principles of maintenance technology**

Outcome 3  
Know how to use dismantling/assembly techniques for components/systems

**Assessment Criteria**

The learner can:

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

**Range**

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

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

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

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

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

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

**Additional information**

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

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

**Report**: parts beginning to show signs of wear or deterioration, that were not replaced, but would need attention when next maintained
**Unit 209  Assembling and maintaining fluid power systems**

**Level:** 2  
**Credit value:** 7  
**UAN:** H/503/0188

**Unit aim**  
This unit identifies the basic principles and commonly used components that are for assembly and maintenance of fluid power systems. It covers the assembly, testing and maintenance of fluid systems. It further deals with assembly techniques, in order to assemble the various components that will include rigid and flexible pipework, hoses, valves, actuators, cylinders regulators and sensors. 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.

**Learning outcomes**  
There are three outcomes to this unit. The learner will:
1. Know how to prepare for routine maintenance activities and dismantle devices and equipment
2. Be able to apply testing/fault finding techniques
3. Be able to dismantle, remove and replace/repair, re-assemble and test systems conform to specification

**Guided learning hours**  
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

**Details of the relationship between the unit and relevant national standards**  
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Units: 20: Assembling and Testing Fluid Power Systems, 21: Maintaining Fluid Power Equipment

**Support of the unit by a sector or other appropriate body**  
This unit is endorsed by SEMTA.

**Assessment**  
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 209  Assembling and maintaining fluid power systems
Outcome 1  Know how to prepare for routine maintenance activities and dismantle devices and equipment

Assessment Criteria
The learner can:
1. describe the hazards associated with fluid systems maintenance activities
2. produce a plan for an assembly/maintenance activity for a fluid power circuit
3. extract information from sources.

Range
Hazards: handling of oils and grease (toxicity, harmful effects to skin and body) misuse of tools, use of damaged or badly maintained tools, not following laid-down maintenance procedures, stored energy/force, handling of compressed air (harmful effects to skin and body)
Plan: description of task, location(s), date and times (commencement, completion, handover), parts and consumables to be used, test data requirements, checks to be made, permits to work required, tools and equipment requirements, isolation/barrier requirements, sequence of operations for dismantle/re-assemble components, provision for spillages
Information sources: charts (seals and gaskets, lubrication and screw threads, etc), Internet, catalogues

Additional Guidance
Information sources: drawings, charts, circuit and physical layouts, specifications, manufacturers manuals, maintenance reports, compilation of material/component list from information sources, current symbols used in hydraulic systems (valves – pressure, flow control, directional control, actuators, accumulators, pumps, filters, reservoirs, gauges, hoses and connectors), current symbols used in pneumatic systems (valves: pressure control – regulating and relief, flow control – restrictors and by-pass form, directional control – rotary and spool, quick exhaust; actuators: linear – single and double acting, cylinders, rotary; accumulators, pressure intensifiers, filters, silencers, gauges, pipework connecting methods – rigid, flexible and push-in
Unit 209  Assembling and maintaining fluid power systems
Outcome 2  Be able to apply testing/fault finding techniques

Assessment Criteria
The learner can:
1. assess fluid power system for common faults
2. carry out fluid power testing
3. identify and rectify leaks/faults
4. complete relevant test/maintenance records/documentation.

Range
Common faults: ensure all pipes/components are secure, moving parts are chocked or parked, evaluation using sensory information, diagnostic techniques, fault location techniques, diagnostic aids
Fluid power testing: connect and use suitable calibrated test/diagnostic equipment to circuit to test and/or investigate problem, importance of correct calibration of test equipment, handling/application of measuring/test equipment, static tests, dynamic test
Leaks/faults:
- hydraulic:
  o connecting hydraulic pumps and power packs to circuit
  o filling hydraulic system with fluid
  o bleeding air from system
  o applying test pressures in incremental stages
  o check for leaks
  o take test readings
  o adjust components to give required operating conditions
  o re-run of tests to confirm that system performs to specification
  o check for:
    • no open ends
    • valves in test position/status
    • moving parts in test position/status
    • pipe/components fitted to specification
    • clamps/brackets position and fitted correctly
    • bleed vents accessible
    • equipment/components which may damaged/faulty are removed
  o equipment:
    • pump/pressure source
    • connections
    • leak detection fluids
    • smoke candles
  o determine when to repair or replace faulty units
- pneumatic:
  o applying test pressures in incremental stages
  o check for leaks
- take test readings
- adjust components to give required operating conditions
- re-run of tests to confirm that system performs to specification
- check for:
  - all connections have been completed
  - all components are secure
  - moving parts are 'parked'
- equipment:
  - pump/pressure source
  - connections
  - leak detection fluids
  - calibrated pressure gauge
- determine when to repair or replace faulty units

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

**Additional Guidance**

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

**Fluid power testing:** connect and use suitable calibrated test/diagnostic equipment to circuit to test and/or investigate problem, importance of correct calibration of test equipment, handling/application of measuring/test equipment (measuring instruments, pressure and flow indicators, self-diagnostic equipment), static tests (guarantee pressure tightness of a system under set conditions, locate leaks and faults in a system), dynamic test (ensure correct operation of system components, ensure system performs to specification)
Unit 209  Assembling and maintaining fluid power systems
Outcome 3  Be able to dismantle, remove and replace/repair, re-assemble and test systems conform to specification

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

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

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

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

Clean: dust (blow, vacuum), dirt (brushing, vacuum), grease (degreasing agents, solvents, 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

Level: 2
Credit value: 7
UAN: K/503/0189

Unit aim
This unit identifies the basic principles and commonly used processes that are required to maintain mechanical devices and equipment. It covers basic maintenance requirements, routine inspection, lubrication and service of mechanical devices and equipment. It further deals with dismantling and re-assembly of equipment and the replacement of ‘life determined’ items. Devices and equipment to be covered include bearings and shafts, linkages, drives, couplings, valves, brakes, pumps and gearboxes.

Learning outcomes
There are three outcomes to this unit. The learner will:
1. Be able to prepare for routine maintenance activities and dismantle devices and equipment
2. Be able to apply fault finding techniques
3. Be able to re-assemble mechanical devices and equipment

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 19: Maintaining Mechanical Devices and Equipment

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 210  
Maintenance of mechanical devices and equipment

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

Assessment Criteria

The learner can:

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

Range

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

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

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

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

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

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

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

Additional Guidance

Tools and equipment: spanners (open-ended, socket sets, ring), hammers and mallets, screwdrivers, pliers and grips, chisels, punches, drifts and wedges, nut splitters, stud extractors, measuring instruments (rules, tapes, micrometers, vernier height gauge and calipers, feeler gauges, dial test...
indicators), equipment checks (free from damage or defect, in a safe and usable condition, within calibration, configured correctly for the intended purpose), lifting equipment (screw and hydraulic jacks, overhead gantry cranes, mobile cranes, jib cranes, derricks, fork lift trucks, tripods, shackles, pulley blocks, estimation of approximate weight, use of manufacturers data, centre of gravity of load, angle of splay between two leg sling chains not to exceed 120°, never exceed the safe working load [SWL], inspection records for lifting equipment are current), methods of moving heavy equipment across flat surfaces (rollers, skates, crowbars, pull-lifts, lubricated plates)
Unit 210  Maintenance of mechanical devices and equipment

Outcome 2  Be able to apply fault finding techniques

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

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

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

**Problems encountered:** fastenings damaged during dismantling, components not easily parted, correct tools not available, unavailability of spares.
Unit 210  
Maintenance of mechanical devices and equipment

Outcome 3  
Be able to re-assemble mechanical devices and equipment

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

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

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

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

Report: importance of completing a maintenance documentation following maintenance activities.
Unit 211  
Maintaining electrical wiring support systems

Level: 2  
Credit value: 7  
UAN: D/503/0190

Unit aim  
The unit covers the skills required to carry out the installation/maintenance of electric wiring support systems, including conduit, trunking and traywork systems.

Learning outcomes  
There are three learning outcomes to this unit. The learner will:
1. Be able to plan and prepare for electrical wiring support systems  
2. Be able to install and repair electrical support systems  
3. Be able to commission the system

Guided learning hours  
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards  
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 034 Forming and assembling electrical cable enclosure and support systems

Support of the unit by a sector or other appropriate body  
This unit is endorsed by SEMTA.

Assessment  
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 211  Maintaining electrical wiring support systems
Outcome 1  Be able to plan and prepare for electrical wiring support systems

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

Range
Health and Safety: Health and Safety at Work etc. Act, IEE wiring regulations, Electricity at Work Regulations, safe isolation procedures.
Obtain information: manufacturer's data, plans, drawings
Work plan: to include risk assessment and method statements
Installation: inspection of installation and record component specifications
Select tools and equipment: test, cutting, forming, assembly/mounting/attachment
Unit 211  
Maintaining electrical wiring support systems

Outcome 2  
Be able to install and repair electrical support systems

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

Range
Support systems requirements: cable enclosures/support system components (bends/elbows boxes (such as circular or square, terminal or multi branch), horizontal runs vertical drops, straight connectors/couplings, tee pieces, reducers, conversion units and adaptors, cross-over units)
Faulty or defective components: checking for level and alignment, checking that all connections are secure, checking that sufficient supports are used and that they are correctly spaced, checking that correct outlets are used (sockets, switches, light fittings, wire junction and inspection fittings)
Isolate: isolation and lock-off procedure (electrical isolation, locking off switchgear, removal of fuses, placing of maintenance warning notices, proving that isolation has been achieved and secured)
Components: metal and plastic conduit, metal and plastic trunking, traywork, accessories (switch gear, containment, fuse gear)
Install: marking out the locations, positioning and securing trunking, traywork and conduit using mechanical fixings, drilling and preparing holes for the trunking, traywork or conduit, leveling and alignment of the wiring enclosures and components.

Additional Guidance
Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage.
Unit 211  Maintaining electrical wiring support systems
Outcome 3  Be able to commission the system

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

Range
**Visual inspection**: containment systems to comply with BS 7671/ manufacturers data.
**Safety checks**: covers in place, safety devices commissioned and personnel notified.
**Maintenance records**: reorder parts
Unit 212  Principles of fabrication and welding technology

Level: 2  
Credit value: 7  
UAN: H/503/0191

Unit aim
This unit is concerned with the technology that underpins fabrication and welding processes. The unit covers the basic principles of welding, fabrication materials, weld symbols and terminology, distortion, weld defects, heat affects of welding, forming allowances and non-destructive and workshop testing.

Learning outcomes
There are four outcomes to this unit. The learner will:
1. Understand the basic principles of welding  
2. Know how to be able to select and apply welding terminology and symbols  
3. Understand the effects of welding  
4. Know how to identify common metals used in fabrication and determine forming allowances

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Welding and Fabrication units

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by a short answer question paper.
Unit 212  Principles of fabrication and welding technology
Outcome 1  Understand the basic principles of welding

Assessment Criteria
The learner can:
1. describe the effects of electricity in welding
2. describe the influence of electrode coverings
3. describe the influence of shielding gases/gas mixtures
4. describe the effects of welding flame conditions.

Range
Electricity: arc voltage, welding current, types of current (alternating current [ac], direct current [dc]), ‘arc blow’ (influence of joint geometry, influence of type of current, methods of avoidance)
Electrode coverings: rutile, basic, cellulosic, iron powder, effects of electrode coverings, composition of electrode coverings
Shielding gases/gas mixtures: tungsten-inert gas [TIG] welding, metal inert gas/metal active gas [MIG/MAG], effects of shielding gases
Flame conditions: geometry of oxy-acetylene gas welding flame (inner cone, outer envelope, hottest region of flame), different flame types and their applications (neutral, oxidising, reducing (carburising)

Additional Guidance
Electrode coverings: rutile, basic, cellulosic, iron powder, effects of electrode coverings (facilitates arc striking, stabilises and directs the arc, assists control of the size and frequency of filler metal globules/droplets, filler metal from atmospheric contamination during transfer, provides appropriate weld contour, prevents rapid cooling of weld metal (thermal blanket effect), provides a flux for the molten pool to remove oxides and impurities, supplies additional metal to weld pool)
Unit 212 Principles of fabrication and welding technology
Outcome 2 Know how to be able to select and apply welding terminology and symbols

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

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

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

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

**Applications:** is related to the effect the weld joint would have on the use of the product.
**Welded joints:** welding symbols (application: arrow line, reference line, identification line, symbol) types of joint (butt, tee, lap, corner), types of welded preparation (square butt (open), square butt (closed), flanged butt, single-vee butt, double-vee butt, fillet, spot, seam, projection, edge),
Unit 212  Principles of fabrication and welding technology
Outcome 3  Understand the effects of welding

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

Range
Sources of heat: methods of heat production (electric arc, electrical resistance, flame combustion, friction) temperature (methods of measurement, infra-red, pyrometer, temperature indicating crayons), means of heat transfer/loss (conduction, convection, radiation)
Heat distribution: effects on the structure of the weld metal, effects on the structure of the parent metal
Distortion: causes, types, methods of control
Weld defects: types
Causes: types of operator error, other causes
NDT: visual examination (applications, equipment, advantages, disadvantages), dye penetrant (test procedure, application, advantages, disadvantages), magnetic particle (magnetic flow [types of magnet horseshoe, yoke]; current flow [types of magnetisation – prods; test procedure, applications, advantages, disadvantages]
Workshop testing: bend tests (root, face and side), fracture (nick break), macro examination, cupping test (ductility).

Additional Guidance
Distortion: causes (uneven expansion and contraction, degree of restraint), types (longitudinal, transverse, angular), methods of control (presetting, pre-bending, weld sequencing, skip welding, back-stepping, tack welding, joint design, chills, restraint [clamping, jigs, back-to-back assembly])
Weld defects: types (cracks, lack of fusion [side wall, root, inter-pass], porosity isolated pore, piping, craters, slag inclusions, tungsten inclusions, lack of penetration, excessive penetration, undercut, excessive weld metal, underfil, concavity, overlap, burn-through), possible causes,
Unit 212  
Principles of fabrication and welding technology

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

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

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

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

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

Additional Guidance
Metals: extrusions for aluminium, low-carbon steel, austenitic stainless steels, galvanised steel, aluminium/aluminium alloys, forms of supply (sheet, plate, structural sections [equal leg angle, unequal leg angle, hollow sections: square, rectangular, round (tubular); pipe], criteria for the selection (strength, weight [mass], appearance, corrosion resistance, malleability, ductility), heat treatment of carbon steels (annealing, normalising, hardening, tempering)
Unit 213  Welding by Manual Metal Arc process

Level: 2  
Credit value: 7  
UAN: K/503/0192

Unit 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.

Learning outcomes
There are four outcomes to this unit. The learner will:
1. Know safe working practices associated with manual metal arc welding
2. Know how to prepare manual metal arc equipment and materials for welding
3. Be able to produce standard welded joints safely using manual metal arc welding
4. Be able to visually check welds for defects

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 27: Preparing and Using Manual Metal Arc Welding Equipment

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 213  Welding by Manual Metal Arc process
Outcome 1  Know safe working practices associated with manual metal arc welding

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

Range
PPE: headshield, filter lens, cover lens, light reactive filters, gauntlets, protective footwear, eye protection, flame retardant overalls, leather apron, scull cap, leather jacket, factors render PPE provided as protection against the above ineffective or unsafe
Welding fume: types of fume (visible [particulate], invisible [gaseous], carbon monoxide [CO], oxides of nitrogen, nitrous oxide [NO], nitrogen dioxide [NO₂], use of extraction (background, local, natural ventilation [e.g. on-site], air-fed headshields, respirator
Electricity: shock hazards (use of electrical insulation [condition, correct size, correct connection, tightness of connection] welding lead, welding return, welding earth); fire, burns
Arc radiation: visible light, infra-red, ultra-violet, PPE (types, purpose), screening (types, purpose), warnings (verbal, notices)
Hot metal/slag/sparks: means of avoiding hazards (identification of hazard, use of tools [tongs, etc], use of PPE.
Unit 213  
Welding by Manual Metal Arc process

Outcome 2  
Know how to prepare manual metal arc equipment and materials for welding

Assessment Criteria

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

Range

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

Leads: welding, return, earth

Electrode holders: fully insulated, partially insulated

Return clamps: types

Preparing and finishing: grinders (angle, mini, safe use), linishers, files, flame cutting, chipping hammer, wire brushes, hammer and chisel.
Unit 213  Welding by Manual Metal Arc process

Outcome 3  Be able to produce standard welded joints safely using manual metal arc welding

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

Range
Electrodes: cellulosic, rutile, basic, applications.
Storage requirements: temperature, humidity.
Welding current and polarity: alternating (a.c.), direct (d.c.) (electrode positive, electrode negative).
Apply electrode sizes to material thickness and types of joint: Ø2.5, Ø3.2, Ø4.0 mm; 3 mm to 10 mm thickness; butt, tee, lap, corner.
Welding current ranges to electrode sizes: Ø2.5, Ø3.2, Ø4.0 mm
Welding voltages: open circuit voltage, arc voltage.
Welding techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, single – run, multiple-run
BS 4872 part 1: test type, joint set-up, test piece dimensions, assessment of weld quality, destructive testing
Post welding activities: cleaning, slag removal, spatter removal, wiring brushing, removal of excess weld metal where required
Assembly and distortion control methods: clamping, alignment jigs, run on/off plates, tack welds
Distortion rectification: mechanical, thermal.

Additional Guidance
**Restore the work area:** leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage.
Unit 213  Welding by Manual Metal Arc process
Outcome 4  Be able to visually check welds for defects

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

Range
Weld flaws: lack of continuity, even or irregular weld profile, incorrect weld size or profile, undercutting, overlap, inclusions, porosity, surface cracks, internal cracks, lack of fusion (root, side wall, inter-run), lack of penetration
Assessment criteria: qualitative (defect levels, appearance), quantitative (extent, size, dimensional accuracy).
Visual assessment: use of magnification, use of weld gauges [fillet, universal], use of illumination to aid assessment.
Non-destructive testing: dye penetrant (applications, procedure, limitations) magnetic particle (techniques [current flow, magnetic flow, procedures, applications, limitations).
Destructive testing: macroscopic examination (purpose, preparation of specimen, examination of specimen) nick-break test (purpose, preparation of specimen, breaking of specimen, examination of specimen) bend tests (types [face, root, side], purpose, preparation of specimen, bending of specimen, former sizes, former arrangements, bend radius, angle of bend, examination of specimen).
Unit 214  Welding by MIG process

Level:  2
Credit value:  7
UAN:  M/503/0193

Unit 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.

Learning outcomes
There are four outcomes to this unit. The learner will:
1. Know safe working practices associated with MIG welding
2. Know how to prepare MIG equipment and materials for welding
3. Be able to produce standard welded joints safely using MIG welding
4. Be able to visually check welds for defects

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 29: Preparing and Using Manual MIG, MAG and Other Continuous Wire Welding Equipment

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 214  Welding by MIG process
Outcome 1  Know safe working practices associated with MIG welding

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

Range
PPE: headshield, filter lens, cover lens, light reactive filters, gauntlets, protective footwear, eye protection, flame retardant overalls, leather apron, scull cap, leather jacket, factors render PPE provided as protection against the above ineffective or unsafe
Welding fume: types of fume (visible [particulate], invisible [gaseous]: ozone (O₃), carbon monoxide [CO], oxides of nitrogen, nitrous oxide [NO], nitrogen dioxide [NO₂], use of extraction (background, local, natural ventilation [e.g. on-site], air-fed headshields, respirator
Electricity: shock hazards (use of electrical insulation [condition, correct size, correct connection, tightness of connection] welding lead, welding return, welding earth); fire, burns
Arc radiation: visible light, infra-red, ultra-violet, PPE (types, purpose), screening (types, purpose), warnings (verbal, notices)
Hot metal/sparks: means of avoiding hazards (identification of hazard, use of tools [tongs, etc], use of PPE.
Unit 214  Welding by MIG process
Outcome 2  Know how to prepare MIG equipment and materials for welding

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

Range
Welding equipment: direct current (d.c.) (transformer/rectifier, inverter, engine driven generators)
Leads: welding (water cooled, air cooled, construction of lead, supplies to gun/torch), return, earth
Guns/torches: goose neck, pistol, push, pull, push-pull, reel-on-gun, water cooled, air cooled
Preparing and finishing: grinders (angle, mini, safe use), linishers, files, flame cutting, chipping hammer, wire brushes, hammer and chisel.
Unit 214  Welding by MIG process
Outcome 3  Be able to produce standard welded joints safely using MIG welding

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

Range
Electrodes: solid wires (copper coated, uncoated, reel sizes), cored wire (flux cored, iron cored, self-shielded)
Storage requirements: temperature, humidity
Welding current and polarity: direct (d.c.) (electrode positive)
Electrode sizes to material thickness and types of joint: Ø2.5, Ø3.2, Ø4.0 mm; 3 mm to 10 mm thickness; butt, tee, lap, corner
Arc voltage and wire feed speed ranges to electrode sizes: Ø0.8, Ø1.0, Ø1.2 mm
Welding voltages: open circuit voltage, arc voltage
Shielding gases: inert (argon, helium, argon/helium mixtures) active (carbon dioxide [CO₂], argon/oxygen [O₂], argon/CO₂, argon/O₂/CO₂, argon/helium/O₂/CO₂), applications
Welding techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, single – run, multiple-run
BS 4872 part 1: test type, joint set-up, test piece dimensions, assessment of weld quality, destructive testing
Post welding activities: cleaning, slag removal, spatter removal, wiring brushing, removal of excess weld metal where required
Assembly and distortion control methods: clamping, alignment jigs, run on/off plates, tack welds
**Distortion rectification:** mechanical, thermal.

**Additional Guidance**

**Restore the work area:** leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage.
Unit 214  Welding by MIG process
Outcome 4  Be able to visually check welds for defects

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

Range
Weld flaws: lack of continuity, even or irregular weld profile, incorrect weld size or profile, undercutting, overlap, inclusions, porosity, surface cracks, internal cracks, lack of fusion (root, side wall, inter-run), lack of penetration
Assessment criteria: qualitative (defect levels, appearance), quantitative (extent, size, dimensional accuracy).
Visual assessment: use of magnification, use of weld gauges [fillet, universal], use of illumination to aid assessment.
Non-destructive testing: dye penetrant (applications, procedure, limitations) magnetic particle (techniques [current flow, magnetic flow, procedures, applications, limitations).
Destructive testing: macroscopic examination (purpose, preparation of specimen, examination of specimen) nick-break test (purpose, preparation of specimen, breaking of specimen, examination of specimen) bend tests (types [face, root, side], purpose, preparation of specimen, bending of specimen, former sizes, former arrangements, bend radius, angle of bend, examination of specimen).
Unit 215  Welding by TIG process

Level: 2  
Credit value: 7  
UAN: T/503/0194

Unit 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-destructive and workshop testing.

Learning outcomes
There are four outcomes to this unit. The learner will:
1. Know safe working practices associated with TIG welding
2. Know how to prepare TIG equipment and materials for welding
3. Be able to produce standard welded joints safely using TIG welding
4. Be able to visually check welds for defects

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 28: Preparing and Using Manual TIG or Plasma-arc Welding Equipment

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 215  Welding by TIG process
Outcome 1  Know safe working practices associated with TIG welding

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

Range
PPE: headshield, filter lens, cover lens, light reactive filters, gauntlets, protective footwear, eye protection, flame retardant overalls, scull cap, factors render PPE provided as protection against the above ineffective or unsafe
Welding fume: types of fume (visible [particulate], invisible [gaseous]: ozone (O₃), oxides of nitrogen, nitrous oxide [NO], nitrogen dioxide [NO₂], use of extraction (background, local, natural ventilation [e.g. on-site]), air-fed headshields, respirator
Electricity: shock hazards (use of electrical insulation [condition, correct size, correct connection, tightness of connection] welding lead, welding return, welding earth); fire, burns
Arc radiation: visible light, infra-red, ultra-violet, PPE (types, purpose), screening (types, purpose), warnings (verbal, notices)
Hot metal: means of avoiding hazards (identification of hazard, use of tools [tongs, etc], use of PPE.
Unit 215  Welding by TIG process
Outcome 2  Know how to prepare TIG equipment and materials for welding

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

Range
Welding equipment: direct current (d.c.) (transformer/rectifier, inverter, engine driven generators, a.c./d.c. converters)
Leads: welding (water cooled, air cooled, construction of lead, supplies to gun/torch), return, earth
Guns/torches: water cooled, air cooled, pencil
Preparing and finishing: grinders (angle, mini, safe use), linishers, files, wire brushes.
Unit 215  Welding by TIG process

Outcome 3  Be able to produce standard welded joints safely using TIG welding

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

Range
Electrodes: thoriated, zirconiated, ceriated, lanthanated, applications, identification, sizes (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 (d.c.) (electrode negative: heat distribution, reasons for d.c.), alternating (a.c.) (heat distribution, reasons for a.c.)
Welding voltages: open circuit voltage, arc voltage
Shielding gases: inert (argon, helium, argon/helium mixtures) active (argon/hydrogen [H₂]), applications
Welding techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, single – run, multiple-run
BS 4872: test type, joint set-up, test piece dimensions, assessment of weld quality, destructive testing
Post welding activities: cleaning, slag removal, spatter removal, wiring brushing, removal of excess weld metal where required
Assembly and distortion control methods: clamping, alignment jigs, run on/off plates, tack welds
Distortion rectification: mechanical, thermal.
Additional Guidance

*Restore the work area:* leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage.
Unit 215  Welding by TIG process
Outcome 4  Be able to visually check welds for defects

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

Range
Weld flaws: lack of continuity, even or irregular weld profile, incorrect weld size or profile, undercutting, overlap, inclusions, porosity, surface cracks, internal cracks, lack of fusion (root, side wall, inter-run), lack of penetration
Assessment criteria: qualitative (defect levels, appearance), quantitative (extent, size, dimensional accuracy).
Visual assessment: use of magnification, use of weld gauges [fillet, universal], use of illumination to aid assessment.
Non-destructive testing: dye penetrant (applications, procedure, limitations) magnetic particle (techniques [current flow, magnetic flow, procedures, applications, limitations).
Destructive testing: macroscopic examination (purpose, preparation of specimen, examination of specimen) nick-break test (purpose, preparation of specimen, breaking of specimen, examination of specimen) bend tests (types [face, root, side], purpose, preparation of specimen, bending of specimen, former sizes, former arrangements, bend radius, angle of bend, examination of specimen).
Unit 216  Welding by Oxy-Acetylene process

Level: 2  
Credit value: 7  
UAN: A/503/0195

Unit 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.

Learning outcomes
There are four outcomes to this unit. The learner will:
1. Know safe working practices associated with oxy-acetylene welding
2. Be able to prepare oxy-acetylene equipment and materials for welding
3. Be able to produce standard welded joints safely using oxy-acetylene welding
4. Be able to visually check welds for defects

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 30: Preparing and Using Manual Gas Welding Equipment

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 216  Welding by Oxy-Acetylene process

Outcome 1  Know safe working practices associated with oxy-acetylene welding

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

Range
PPE: goggles, filter lens, cover lens, gloves, protective footwear, eye protection, flame retardant overalls, leather apron, scull cap, leather jacket, factors render PPE provided as protection against the above ineffective or unsafe
Welding fume: types of fume (visible [particulate], invisible [gaseous]: carbon monoxide [CO], carbon dioxide [CO₂], use of extraction (background, local, natural ventilation [e.g. on-site], respirator
Hot metal: means of avoiding hazards (identification of hazard, use of tools [tongs, etc], use of PPE.
Hazards: sources of combustion, compressed gas cylinders (safe: storage conditions, handling/moving, use)
Unit 216  Welding by Oxy-Acetylene process
Outcome 2  Be able to prepare oxy-acetylene equipment and materials for welding

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

Range
Welding equipment: cylinders, pressure regulators, flashback arrestors, hoses, hose check-valves, hose connectors, blowpipe/torch, nozzles
Components: cylinders (oxygen, acetylene, colour coding), pressure regulators (types: single-stage, two-stage), flashback arrestors, hoses, hose check-valves, hose connectors, blowpipe/torch, nozzles (sizes, selection), use of left hand and right hand threaded connections (identification)
Variables: gas pressures, nozzle size, welding technique (leftward)
Flame condition: neutral, oxidising, carburising/reducing, parts of the flame (inner cone, outer envelope, hottest point, typical flame temperature)
Unit 216  
Welding by Oxy-Acetylene process

Outcome 3  
Be able to produce standard welded joints safely using oxy-acetylene welding

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

Range
Filler rods: copper coated steel (function of coating), common sizes (Ø1.6, Ø2.4, Ø3.2 mm)
Storage requirements: temperature, humidity
Gases: oxygen and acetylene (cylinder colours, hose colours, hazards associated with their use and how to avoid them)
Welding techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, single – run, multiple-run
BS 4872 part 1: test type, joint set-up, test piece dimensions, assessment of weld quality, destructive testing
Post welding activities: cleaning, slag removal, spatter removal, wiring brushing, removal of excess weld metal where required
Assembly and distortion control methods: clamping, alignment jigs, run on/off plates, tack welds
Distortion rectification: mechanical, thermal.

Additional Guidance
Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage.
Unit 216  Welding by Oxy-Acetylene process
Outcome 4  Be able to visually check welds for defects

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

Range
Weld flaws: lack of continuity, even or irregular weld profile, incorrect weld size or profile, undercutting, overlap, inclusions, porosity, surface cracks, internal cracks, lack of fusion (root, side wall, inter-run), lack of penetration
Assessment criteria: qualitative (defect levels, appearance), quantitative (extent, size, dimensional accuracy).
Visual assessment: use of magnification, use of weld gauges [fillet, universal], use of illumination to aid assessment.
Non-destructive testing: dye penetrant (applications, procedure, limitations) magnetic particle (techniques [current flow, magnetic flow, procedures, applications, limitations).
Destructive testing: macroscopic examination (purpose, preparation of specimen, examination of specimen) nick-break test (purpose, preparation of specimen, breaking of specimen, examination of specimen) bend tests (types [face, root, side], purpose, preparation of specimen, bending of specimen, former sizes, former arrangements, bend radius, angle of bend, examination of specimen).
Unit 217  Fabricating sheet metalwork

Level: 2
Credit value: 7
UAN: F/503/0196

Unit 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.

Learning outcomes
There are three outcomes to this unit. The learner will:
1. Be able to prepare equipment and tools for sheet metal cutting
2. Be able to use equipment, tools and materials for sheet metal forming
3. Be able to produce fabrications using sheet metalwork assembly techniques

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 22: Producing Sheet Metal Components and Assemblies

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 217  Fabricating sheet metalwork

Outcome 1  Be able to prepare equipment and tools for sheet metal cutting

Assessment Criteria
The learner can:
1. prepare equipment and tools for a cutting operation
2. prepare materials for a cutting operation.

Range
Equipment: drills (bench, pillar, portable), rotary shears (portable, nibblers [shear type, punch type], guillotines (treadle, mechanical, back stops, front stops, guards), fly press, power punch, portable angle grinders/sanders, health and safety considerations
Tools: hand shears (straight, left hand, right hand, universal), bench shears (hand-lever) tinman’s hand-level punch, health and safety considerations
Materials: methods of marking out, use of datums (line, edge, centre point), avoiding damage to surface coatings, minimal wastage, health and safety considerations
Unit 217  Fabricating sheet metalwork
Outcome 2  Be able to use equipment, tools and materials for sheet metal forming

Assessment Criteria
The learner can:
1. use equipment and tools for a forming operation
2. use stiffening techniques to strengthen materials
3. operate equipment safely.

Range
Equipment: jennys (tooling) rolling machines (pyramid type, pinch type, slip rolls, hand-operated), folding machines (box and pan, universal swing-beam), fly press (tooling: dies, forming tools), health and safety considerations
Tools: hammers, planishing hammers, mallets, wooden blocks, range of bench stakes
Forming: forms (square, rectangular, cylindrical, cones, boxed), hand forming techniques (hollowing, raising, planishing, flanging, 'split and weld' methods, health and safety considerations
Stiffening techniques: swaging, beading, wired edges [including false], folds, flanging, reinforcement, diamond break, health and safety considerations
Unit 217  Fabricating sheet metalwork
Outcome 3 Be able to produce fabrications using sheet metalwork assembly techniques

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

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

Additional Guidance
Joining techniques:
- non self-secured joints (lap, corner, butt, tee, joggled lap, flanged butt, lock seam, bottom seam [internal lap, external lap])
- self-secured joints (grooved seam, panned down, slip joint, allowances); mechanical joining methods (solid riveting, hollow riveting, threaded fastenings)
- soldering techniques (preparing the joint, cleaning the joint, types of soft solder, types of flux, types of soldered iron, heat sources [electrical, flame], cleaning the soldered joint)
- brazing techniques (preparing the joint, cleaning the joint, types of brazing alloys, types of flux, heat sources [flame, gas mixtures], cleaning the brazed joint)
- resistance welding (spot, seam, the electrodes available for spot welding, electrode functions (gripping, exertion of force, passage of high current) electrode material, electrode tip geometry (domed end, truncated cone))
- MIG welding (equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires [Ø0.6 mm, Ø0.8 mm], shielding gases used for the
welding of carbon steels: carbon dioxide (CO₂), argon / CO₂, argon/oxygen/ CO₂), Personal Protective Equipment (PPE), fume removal

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

**Restore the work area**: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
Unit 218  Fabricating thick plate, bar and sections

Level: 2
Credit value: 7
UAN: J/503/0197

Unit 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 health and safety hazards associated with cutting (including oxy-fuel gas), forming, assembly and joining of thick plate bar and rolled sections fabrication.

Learning outcomes
There are three outcomes to this unit. The learner will:
1. Be able to prepare equipment, tools and materials for cutting of thick plate, bar and rolled sections
2. Be able to use equipment and tools for thick plate, bar and rolled sections
3. Be able to produce fabrications using thick plate and rolled bar sections joining techniques.

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 23: Producing Platework Components and Assemblies

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Outcomes

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

Assessment Criteria

The learner can:

1. 
2. 
3. 

Range

Equipment:

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

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

Additional Guidance

Equipment:

- Drills (bench, pillar, portable)
- Rotary shears (portable, nibblers [shear type, punch type])
- Guillotines (mechanical, back stops, front stops, guards)
- Power punch
- Cutting-off wheel machines
- Oxy-fuel gas cutting (process, equipment (recognise the hazards from compressed gas cylinders [safe: storage conditions, handling/moving, use, start-up and shut down procedures, dealing with a backfire/flashback], hazards from hot metal/sparks, types of gasses, cylinders types and identification, flashback arrestors, hose types and identification, connector types and identification, hose check valves [protectors], cutting torch, flashback arrestors, cutting nozzles [types, gouging], guides [bevel, circle, radius bar], portable track cutting machines)
- Grinders (portable angle grinders/sanders, bench, pedestal)
- Lifting equipment (common forms of injury, use lifting aids [straps, bars, harnesses], wall and overhead mounted travelling cranes, fork lift trucks, pallets and pallet truck, block and tackle,
pull/lift lever hoist, engine hoist, chains, ropes, slings, shackles, lifting eyes, friction clamps, welded lugs, lifting capacity [safe working load (SWL)]
Unit 218  Fabricating thick plate, bar and sections

Outcome 2 Be able to use equipment and tools for thick plate, bar and rolled sections

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

Range
Forming: hot and cold bending (principles – application of heat, hand methods [clamps, vices, levers], bench mounted machines [types, applications], bench bending around a former, fly press [principles, tooling], brake press [principles, tooling], springback [principle, allowances], ‘split and weld’ methods, health and safety considerations
Assembling: work holding (clamps, pins, plate dogs, wedges, tack welding), work alignment (strong backs, clamping dogs, wedges, draw-bolts and cleats, bridge pieces, toggle clamps, alignment jigs), distortion control (tack welding, presetting, weld sequencing).
Unit 218  Fabricating thick plate, bar and sections
Outcome 3  Be able to produce fabrications using thick plate and rolled bar sections joining techniques.

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

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

Additional Guidance
Joining techniques:
- solid rivets (single lap, double lap, single strap, double strap; types of rivet head: flat, countersunk, round [or snap], pan, mushroom, applications; riveting defects; causes of joint failure [tearing of metal, crushing of metal, splitting of metal, shearing of rivet; allowances; sources of pressure: hammers, pneumatic, hydraulic)
- bolts and nuts (types of bolts: black, turned, high-strength friction-grip, cap/cheese head; types of nuts: hexagonal, split, self-locking, wing, castellated, domed; use of washers: flat, taper, spring; defects in bolted connections; use of podging spanners and drifts; allowances)
- screwed fastenings (types of screwed fastening, cap/cheese head, round head, countersunk, self-tapping, use of hank bushes, use of taps and dies
- use of welded joints (lap, corner, butt, tee)
- manual metal arc (MMA) welding (equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads [welding, return, earth], electrode holders, return clamps, chipping hammer, wire brushes, electrode sizes [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 [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires [Ø0.6 mm, Ø0.8 mm], shielding gases used for the welding of carbon steels: carbon dioxide [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

Level: 2
Credit value: 7
UAN: L/503/0198

Unit aim
This unit is concerned with the underlying process technology associated with the fabrication of pipework assemblies, in terms of: cutting, forming, assembly and joining of thick plate bar and rolled sections fabrication. It covers health and safety hazards associated with cutting (including oxy-fuel gas), forming, assembly and joining of pipework assemblies. The joining methods include non-thermal techniques: mechanical – bolting, screwed and thermal: soldering, MMA, MIG and TIG welding.

Learning outcomes
There are three outcomes to this unit. The learner will:
1. Be able to prepare equipment, tools and materials for cutting pipework
2. Be able to use equipment and tools for fabricating pipework
3. Be able to produce and test fabricated pipework assemblies using joining techniques

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 7: Forming and Assembling Pipework Systems

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 219 Fabricating pipework assemblies

Outcome 1 Be able to prepare equipment, tools and materials for cutting pipework

Assessment Criteria
The learner can:
1. prepare equipment and tools for a cutting operation
2. prepare materials for a cutting operation
3. operate equipment safely.

Range

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

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

Equipment and tools:

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

Materials:

- graphical representation of pipework (block plans and plant layout, plant equipment and positions, piping assembly drawings, isometric sub-assemblies; symbols for pipelines, joints, welds, equipment and components)
- methods of marking out, use of datums (line, edge, centre point), avoiding damage to surface coatings, minimal wastage
- forms of supply (copper: solid drawn, annealed; carbon steel: hot finished seamless, cold finished seamless, electric resistance welded; galvanised steel; austenitic stainless steel; plastic; sizes [outside diameter, inside diameter, wall thickness, nominal bore])
- fittings (welded: butt, fillet, slip-on flanges, socket welded; screwed; friction [compression]; soldered [pre-applied, plain soldered]; plastic socket
- health and safety considerations
Unit 219  Fabricating pipework assemblies
Outcome 2  Be able to use equipment and tools for fabricating pipework

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

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

Assembling:
- branches (equal, unequal, set-on, lateral, straight to elbow), trunions (equal, unequal, set-on, straight to elbow)
- fittings (elbows, tees, reducers [eccentric, concentric], flanges [weld-neck, slip-on, screwed, blanks], unions, couplings, weldedlets, elbowlets, lateralets, end caps)
- work holding (full-scale setting out, pipe vice, pipe clamps, pin blocks, vee blocks, wedges, tack welding)
- work alignment (wedges, podger spanners, square, spirit level)
- distortion control (tack welding, presetting, weld sequencing)
Unit 219 Fabricating pipework assemblies
Outcome 3 Be able to produce and test fabricated pipework assemblies using joining techniques

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

Range
**Joining techniques:**
- bolts and nuts, use of washers, use of jointing compounds, use of podging spanners and drifts, allowances, methods of freeing or disconnecting seized bolted joints, dispelling scales and corrosion, sawing / chiselling, solvents application of heat
- use of gaskets
- use of seals
- use of spanners
- screwed connections
- compression joints, push-fit fitting connection
- cemented/glued fitting connections
- soldered
- use of welded joints
- manual metal arc (MMA) welding (equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads electrode holders, return clamps, chipping hammer, wire brushes, electrode sizes techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, Personal Protective Equipment (PPE), fume removal
- MIG welding equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires, shielding gases used for the welding of carbon steels: carbon dioxide \([\text{CO}_2]\), argon/\(\text{CO}_2\), argon/oxygen/\(\text{CO}_2\)), Personal Protective Equipment (PPE), fume removal
- TIG welding (equipment/consumables: direct current [d.c.] electrode negative, methods of arc ignition, welding torches, tungsten electrodes for the welding of steels, electrode sizes filler wire sizes, shielding gas used for the welding of carbon steels: argon, Personal Protective Equipment (PPE)
- health and safety considerations

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

Joining techniques

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

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
Unit 220  Fabricating steel work assemblies

Level: 2
Credit value: 7
UAN: R/503/0199

Unit aim
This unit is concerned with the underlying process technology associated with the fabrication of steelwork assemblies, in terms of: cutting, assembly and joining of thick plate bar and rolled sections fabrication. It covers health and safety hazards associated with cutting (including oxy-fuel gas), assembly and joining of steelwork assemblies. The joining methods include non-thermal techniques: mechanical – bolting and thermal: MMA and MIG welding.

Learning outcomes
There are three outcomes to this unit. The learner will:
1. Be able to prepare equipment and materials for cutting steelwork
2. Be able to use equipment for fabricating steelwork
3. Be able to produce fabricated steelwork assemblies using joining techniques

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 66: General Fabrication and Welding Applications

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 220  Fabricating steel work assemblies

Outcome 1  Be able to prepare equipment and materials for cutting steelwork

Assessment Criteria
The learner can:
1. prepare **equipment** and **tools** for a cutting operation
2. prepare **materials** for a cutting operation
3. operate equipment safely.

Range

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

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

Additional Guidance

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

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

**Materials:**

- methods of marking out, use of datums (line, edge, centre point), avoiding damage to surface coatings, minimal wastage
- forms of supply (sheet and plate [anti-slip platform and tread materials], rolled steel equal angle, rolled steel unequal angle, rolled steel joist [RSJ], universal beam, universal column, tee bar, castellated beam, structural hollow sections [square, rectangular, round], rolled steel channel, galvanised
- health and safety considerations.
Unit 220  Fabricating steel work assemblies
Outcome 2  Be able to use equipment for fabricating steelwork

Assessment Criteria
The learner can:
1. describe steelwork assemblies
2. use equipment for assembling steelwork to the required specification within ± 3.0 mm
3. operate equipment safely
4. produce fabricated steelwork assemblies safely.

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

Assembling: work holding (clamps, pins, plate dogs, wedges, tack welding), work alignment (strong backs, clamping dogs, wedges, draw-bolts and cleats, bridge pieces, toggle clamps, alignment jigs, crowbar, podger spanner), distortion control (tack welding, presetting, weld sequencing)
Unit 220  Fabricating steel work assemblies
Outcome 3  Be able to produce fabricated steelwork assemblies using joining techniques

 Assessment Criteria

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

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

Additional Guidance
Joining techniques:
- bolts and nuts (types of bolts: black, turned, high-strength friction-grip, high tensile, load indicating, fitted; types of nuts: hexagonal, split, self-locking, wing, castellated, domed; use of washers: flat, taper, spring, load indicating, nylon; defects in bolted connections, use of jointing compounds [grease, copper]; use of podging spanners and drifts; allowances
- use of spanners (adjustable, ring, combination, podging, socket, ratchet, torque, impact)
- allowances (back marks)
- use of welded joints (lap, corner, butt, tee)
- manual metal arc (MMA) welding (equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads [welding, return, earth], electrode holders, return clamps,
chipping hammer, wire brushes, electrode sizes [Ø2.5, 3.2 Ø 4.0 mm] techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, PPE, fume removal

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

- health and safety considerations

**Restore the work area:** leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
Unit 221  Principles of electrical and electronics technology

Level: 2
Credit value: 7
UAN: A/503/0200

Unit aim
This unit is concerned with Electrical and Electronic Technology required for working with lighting, heating and power circuits. The learner will have a basic understanding of units, terminology and applications associated with Electrical and Electronics technology.

Learning outcomes
There are three learning outcomes to this unit. The learner will:
1. Know the basic units used in electrotechnology
2. Know the application of electrotechnology
3. Be able to identify the characteristics of an electrical circuit

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251
Unit 033 Wiring and testing electrical equipment and circuits and Unit 036 Assembling and testing electronic circuits

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by a short answer question paper.
Unit 221 Principles of electrical and electronics technology

Outcome 1 Know the basic units used in electrotechnology

Assessment Criteria
The learner can:
1. state the basic units used in electrotechnology
2. carry out electrical calculations.

Range
Basic Units: S.I. Units and derived units including multiples and sub-multiples for length, area and volume, force, energy, power, pressure & stress, electrical potential, charge & flux, magnetic flux, flux density, electrical resistance, capacitance, inductance, frequency, temperature, current.
Electrical calculations: basic electron theory, Ohms’ Law, resistivity, resistors in series and parallel/current, voltage and resistance in parallel circuits, power, calculation of power ratings for common components and equipment, energy as power x time.
Unit 221  Principles of electrical and electronics technology
Outcome 2  Know the application of electrotechnology

Assessment Criteria
The learner can
1. describe the function of electrical components
2. describe the application of electrical components.

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


Additional Guidance
Electrical components: Sine wave (peak, average and RMS values). Transformers (basic construction of single phase transformers, core types, core, shell and toroidal, laminations and ferrite cores, double wound and auto-transformers), semi-conductor materials, diode types and uses, bi-polar transistors, use as switching devices and amplifiers, light dependent resistors, light emitting diodes, connection methods, safe practice, soldering, crimping, IDC, commercially available sockets and plugs (phono, din, edge, ‘D’ co-axial).
Unit 221  Principles of electrical and electronics technology
Outcome 3  Be able to identify the characteristics of an electrical circuit

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

Additional Guidance
Magnetic fields: Sketch magnetic fields for single bar magnets, N-N, S-S and N-S combinations.
Solenoid: Sketch magnetic field and determine polarity.
Capacitor: construction of typical capacitor, polarised and air capacitors
Sine wave: Sketch a sine wave and indicate peak, average and root mean square values.
Transformers: Turns ratios. Primary and secondary voltage relationships.

Bridge rectifier: Circuit sketches of a simple bridge rectifier. Output waveforms, with and without smoothing.
Unit 222  
Maintaining electrical equipment and systems

Level: 2  
Credit value: 7  
UAN: F/503/0201

Unit aim  
The unit is concerned with the process and equipment essential for the maintenance of electrical engineering equipment up to 400v. The learner will be able to prepare and carry out maintenance on a range of electrical systems and equipment.

Learning outcomes  
There are two learning outcomes to this unit. The learner will:
1. Be able to prepare for maintaining electrical systems/equipment
2. Be able to carry out the maintenance of electrical systems/equipment

Guided learning hours  
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards  
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251  
Unit 037 Maintaining electrical equipment/systems

Support of the unit by a sector or other appropriate body  
This unit is endorsed by SEMTA.

Assessment  
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 222  
Maintaining electrical equipment and systems

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

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

Range
Maintenance instructions: manuals, catalogues, block diagrams, test schedules, safety & job instructions. Equipment and system specifications, BS 7671 Wiring Regulations, Guidance Notes 3, Electricity at Work regulations.
Testing operations: Test sequence as BS 7671 or GN 3, logical fault finding sequence, risk assessment, work plans.
Security of components: storage and labelling of components and disconnected conductors.
Test equipment: low reading ohmmeters, insulation resistance testers, RCD tester, open and short circuit testing, resistance faults, mechanical and component faults.
Tools: screwdrivers, pliers, side cutters, cable strippers, spanners, hammers, saws, files, drills, battery and power tools, torches and hand lamps, soldering irons, cable terminating equipment.
Unit 222  
Maintaining electrical equipment and systems

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

Assessment Criteria

The learner can:

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

Range

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

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

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

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

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

Additional Guidance

Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work.
Unit 223  Wiring and testing electrical circuits

Level: 2
Credit value: 7
UAN: J/503/0202

Unit 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.

Learning outcomes
There are two learning outcomes to this unit. The learner will:
1. Be able to assemble components and prepare for wiring and testing of electrical circuits
2. Be able to carry out the wiring of electrical circuits

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2 Unit 36: Assembling and Testing Electronic Circuits

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 223  Wiring and testing electrical circuits

Outcome 1  Be able to assemble components and prepare for wiring and testing of electrical circuits

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

Range
Safety instructions: manufacturers’ instructions, Health and Safety at Work etc. Act Electricity at Work Regulations, GS38
Plan for the installation of circuits: risk assessment, method statement, circuit and wiring diagrams
Wiring system: standard circuits as listed in BS 7671, cable types including single and multicore (twin & CPC) armoured and fire resistant cables, accessories, components, wiring systems & fixings appropriate to single phase domestic/commercial installations.
Tools, equipment and components: selection of tools and plant appropriate to small domestic/commercial installations, screwdrivers, pliers, side cutters, drills, stripping tools, power tools.
Termination, fixing and earthing: wood and machine screws, wall plugs, anchors, plasterboard fixings, cable clips, screw, pressure, crimp/compression terminations, earth clamps and terminations.
Test instruments: low resistance ohmmeter, insulation resistance test instrument, voltage indicator to GS 38.
Unit 223  Wiring and testing electrical circuits
Outcome 2  Be able to carry out the wiring of electrical circuits

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

Range
**Wiring systems**: PVC and metal conduit and trunking, metal tray, basket, PVC single and multicore, steel wire armoured, FP200.
**Circuits**: 1-way, 2-way and intermediate lighting circuits, ring final and radial power circuits, Control circuits.
**Tests**: continuity of protective conductors, insulation resistance and polarity tests, replacing any faulty components/items as identified by tests, functional tests.

Additional Guidance
**Restore the work area**: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
Unit 224  Constructing, testing and fault finding electronic circuits

Level: 2  
Credit value: 7  
UAN: L/503/0203

Unit aim
This unit is concerned with the processes and equipment essential to building and testing electronic circuits. The topics covered will enable the candidate to collect, read and interpret information, plan and prepare for electronics activities, and state how to identify electronic components. The candidate will also be able to perform circuit and diagnostic checks, and make simple deductions from the results of these checks.

Learning outcomes
There are three learning outcomes to this unit. The learner will:
1. Be able to prepare for building and testing of electronic circuits
2. Be able to test, fault find and repair electronic equipment
3. Be able to construct new, and identify faults on existing, electronic equipment

Guided learning hours
It is recommended that 60 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 036 Assembling and testing electronic circuits

Support of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 224  Constructing, testing and fault finding electronic circuits

Outcome 1  Be able to prepare for building and testing of electronic circuits

Assessment Criteria
The learner can:

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

Range
Units of measurement: ampere, volt, ohm, Watt, coulomb, Farad, Henry, pico, nano, micro, milli, Kilo, Mega, Giga, Tera, resistor colour code (4 band)
V, I and R relationships: series resistor circuits, parallel resistor circuits, series / parallel resistor circuits, Ohms Law, EMF, potential difference

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

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

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

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

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

Heat sinks: convection cooled, fan cooled, water cooled, heat sink compound
Common sources: circuit diagrams, block diagrams, layout diagrams, equipment reference manuals, data sheets, practical tests

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

Work activities: building, testing, repairing

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

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

Safety measures: isolation transformers, RCD protection, rubber matting, anti-static wrist / ankle straps / clothing, solder fume extraction
Unit 224 Constructing, testing and fault finding electronic circuits

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

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

Range
Preparatory activities: safety checks, test instrument calibration check, setting up of test instruments, removal of equipment covers / casings, mains supply isolation, cleaning of modules / components
Test instruments: multimeter, insulation resistance tester, continuity tester, oscilloscope, storage scope, signal generator, signal injector, variable dc power supply
Connection/disconnection: test probes, instrument sensors, risk of arcing, risk of shorting, risk of circuit loading
Visual inspection:
- fluid components – pipework, air / fluid lines, couplings, seals, sensors
- electrical components – instrument needles, cables, connectors
- electronic components – printed circuit boards, component / wiring positioning, component values, spillage, burning / scorching, blown fuses
- mechanical components – damaged / overheated equipment housings, physical damage, presence of foreign bodies
Terminology: symptom, fault, cause
Typical faults: leaking – pipework, air lines, fluid lines, couplings, seals, damaged or faulty – sensors, instrument needles, electrical cables, electrical connectors, printed circuit boards – breaks, spillages, burnt/charred components, reduced or no functionality
Fault diagnosis techniques: input to output checks, half split method, injection and sampling, circuit/component isolation, component/unit substitution, use of symptom(s) to determine nature of fault, correct selection of instrument, identification of test points, connection methods for test instruments, application of circuit / layout diagrams, comparison of actual readings to specified readings, interpretation of results
Common factors: time versus cost of module/unit, serviceability of module/unit, availability of individual components, possibility of damage to other components / modules
Methods for recording: paper based, electronic
Unit 224  Constructing, testing and fault finding electronic circuits
Outcome 3  Be able to construct new, and identify faults on existing, electronic equipment

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

Range
electronic components:
- resistors – carbon film, carbon composition, metal oxide, wirewound, surface mount, variable, fusible
- capacitors – ceramic, paper, polypropylene, mica, electrolytic, tantalum, surface mount, variable
- inductors – air core, ferrite core, iron core
- transformers – power, rf,
- switches – single pole, double pole, relay
- fuses – mains, quick blow, anti-surge, time delay, solid state
- indicating devices – filament lamp, LED, panel mounting devices
- semiconductors – signal diode, power diode, bridge rectifier
  - (encapsulated), zener diode, LED, photo diode, bi-polar transistor,
  - unijunction transistor, photo transistor, MOSFET, opto-coupler,
  - integrated circuits
- wiring – wire links, jumper links, cables, connectors
Connection and termination devices: plug and socket, crimp, solder pin, terminal screw
Assembly methods: component orientation, component mounting, avoidance of component damage, routing and grouping of wiring, marking of flying leads / connectors, cable ties and clamps
Insertion methods: manual insertion methods, automated insertion methods
Preparing / fixing wiring and cables: selection of wires / cables, stripping, tinning, termination, dressing, avoidance of electronic interference, avoidance of mechanical damage
Static damage to components / circuit boards: anti-static wrist / ankle straps, use of conductive mats, use of conductive bags / containers, equipotential bonding of work area, component / board transportation, static warning labels
Types of solder: rosin free, autosol (high speed), low residue no clean, hydro flux
Soldering / de-soldering equipment: 230 V a.c. high wattage iron, low voltage iron, gas iron, hot air gun, flow solder process, de-soldering pump, solder wick
Effective soldering practices: component handling, solder selection, cleaning of joint areas, mechanically and electrically sound joints, sufficient solder application, joints free of splatter, short circuits and spikes
Removal of devices: PCB – single sided, double sided, multi-layer components – discrete, multi-pin, surface mount
Values of a.c. waveshapes: periodic time, frequency, peak to peak, peak, average, RMS (root mean squared)
Test instruments: multimeter, oscilloscope, function generator
Values: d.c. voltages, d.c. currents, resistance, a.c. waveshapes,
PSU functionality: output voltage(s), ability to deliver required load current(s), effects of overload trip circuits / devices

Additional Guidance
Restore equipment: all connectors re-made, all safety components / devices correctly installed, all cables / wiring harnesses correctly fixed, equipment free of foreign bodies, all covers re-fitted and correctly secured
Restore work area: work area is tidy and free of hazards, safe working practices are observed, work area is left clean and tidy, tools / test instruments are returned to safe storage
Unit 231  Pattern development for plate and sheet metalwork

Level: 2  
Credit value: 7  
UAN: K/505/2726

Unit aim
Learners will develop the skills to undertake a broad range of pattern development techniques used extensively within the fabrication and welding sector including parallel line, radial line and triangulation methods. Learners will also develop the knowledge and skills to select the most suitable methods and techniques and produce patterns and templates that address common practical situations in the workplace. Although many organisations now use computer programmes to produce patterns, a thorough understanding of the underpinning principles will support learners. Opportunities to link this unit to 2850-217 fabricating sheet metalwork exist especially the drawing of the pattern required for the unit assignment.

Learning outcomes
There are four learning outcomes to this unit. The learner will:
1. Be able to use geometric drawing methods to support pattern development techniques
2. Be able to determine lines of intersection
3. Be able to develop patterns using various pattern development methods
4. Understand the benefits and use of templates for plate and sheet metal work

Guided learning hours
It is recommended that 56 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Assessment
This unit will be assessed by an assignment covering practical skills and underpinning knowledge.
Unit 231  Pattern development for plate and sheet metalwork

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

Assessment Criteria
The learner can:
1. use geometric drawing methods
2. construct triangles from provided data
3. construct an ellipse using a range of methods
4. construct regular polygons based on dimensional features

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

**Triangles:** right; equilateral; isosceles, scalene.

**Data:** length of sides, angles

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

**Polygons:** square, rectangles, hexagons, octagons

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

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

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

**Polygon construction (dimensional features).** Geometric methods to be used dependent on length of side, distance across flats or distance across points
Unit 231  Pattern development for plate and sheet metalwork
Outcome 2  Be able to determine lines of intersection

Assessment Criteria
The learner can:
1. construct lines of intersection between regular sections in a range of configurations using projection
2. construct lines of intersection between fabricated forms in a range of configurations using the common central sphere

Range
Regular sections: round, rectangular, square

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

Fabricated forms: right cones, cylinders, rectangular sections

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

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

Common central sphere: Right cones to cylinders; cylindrical branches to right cones; right cones to right cones
Unit 231 Pattern development for plate and sheet metalwork

Outcome 4 Be able to develop patterns using various pattern development methods Understand the benefits and use of templates for plate and sheet metal work

Assessment Criteria
The learner can:
1. produce patterns of fabricated forms using the parallel line method
2. produce patterns of fabricated forms using the radial line method
3. produce patterns of fabricated forms using the triangulation method
4. perform calculations to check patterns

Range
3.1 Fabricated forms: cylinders, rectangular sections, segmental bends
3.2 Fabricated forms: right cones and frusta; oblique cones and frusta;
3.3 Fabricated forms: transformers, cones
Calculations: circumference of cylinders; chord length of right cone templates

Additional Guidance
Parallel line: develop patterns of on centre branches at 90° and 45° between round to round and rectangular to rectangular sections of equal and unequal dimensions. Pattern required for the shape of the hole to be cut in the main pipe for all combinations. 90° right cylindrical segmental bends patterns having joint shortest side only.
Radial line: right cones to have top frusta both parallel and angled to the base, oblique cones frusta to be parallel to the base, base in both forms to be horizontal.
Triangulation: Square to square twisted through 45°, rectangular to round, slow tapered cones; all examples to have base and top horizontal
Calculations: Circumference of circles, chord length of radial line patterns. Where applicable calculations should be used to check patterns produced in previous learning outcomes
Unit 231  
Pattern development for plate and sheet metalwork

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

Assessment Criteria
The learner can:
1. select template materials to suit applications
2. explain the factors for selecting template materials
3. describe the benefits of using a template

Range
Template materials: wood, template paper, card, metal.
Factors: cost, availability, ease of production, quantity of components
Benefits: speed; accuracy; repeatability; means of checking
Appendix 1  Relationships to other qualifications

Links to other qualifications and frameworks in each unit
Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications.

These qualifications have connections to the:
- NVQ Diploma in Engineering Maintenance (City & Guilds 1788),
- NVQ Diploma in Mechanical Manufacturing Engineering (City & Guilds 1712)
- NVQ Diploma in Fabrication and Welding (City & Guilds 1781).

Literacy, language, numeracy and ICT skills development
These qualifications include opportunities to develop and practise many of the skills and techniques required for success in the following qualifications:
- Functional Skills (England) – see www.cityandguilds.com/functionalskills
- Essential Skills (Northern Ireland) – see www.cityandguilds.com/essentialskillsni
- Essential Skills (Wales).

There might also be opportunities to develop skills and/or portfolio evidence if candidates are completing any Key Skills alongside these qualifications.
Appendix 2 Sources of general information

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

Centre Guide – Delivering International Qualifications contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve ‘approved centre’ status, or to offer a particular qualification. Specifically, the document includes sections on:
- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

Centre Manual - Supporting Customer Excellence 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, as well as updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document includes sections on:
- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

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

The centre homepage section of the City & Guilds website also contains useful information such on such things as:
• **Walled Garden**: how to register and certificate candidates on line
• **Events**: dates and information on the latest Centre events
• **Online assessment**: information on how to register for online assessments.
## Useful contacts

| UK learners | T: +44 (o)844 543 0033  
| E: learnersupport@cityandguilds.com |
| International learners | T: +44 (o)844 543 0033  
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| Centres | T: +44 (o)844 543 0000  
| F: +44 (o)20 7294 2413  
| E: centresupport@cityandguilds.com |
| Single subject qualifications | T: +44 (o)844 543 0000  
| F: +44 (o)20 7294 2413  
| F: +44 (o)20 7294 2404 (BB forms)  
| E: singlesubjects@cityandguilds.com |
| International awards | T: +44 (o)844 543 0000  
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