Qualification at a glance

<table>
<thead>
<tr>
<th>Subject area</th>
<th>Mechanical Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>City &amp; Guilds number</td>
<td>2850</td>
</tr>
<tr>
<td>Age group approved</td>
<td>All</td>
</tr>
<tr>
<td>Entry requirements</td>
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</tr>
<tr>
<td>Assessment</td>
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</tr>
<tr>
<td></td>
<td>Online test</td>
</tr>
<tr>
<td>Support materials</td>
<td>Centre handbook</td>
</tr>
<tr>
<td>Registration and</td>
<td>Consult the Walled</td>
</tr>
<tr>
<td>certification</td>
<td>Garden/Online Catalogue</td>
</tr>
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<td></td>
<td>for last dates</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Title and level</th>
<th>GLH</th>
<th>TQT</th>
<th>City &amp; Guilds number</th>
<th>Accreditation number</th>
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<td>350</td>
<td>2850-40</td>
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<table>
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<tr>
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<tr>
<td>1.4 November 2014</td>
<td>Amend range in Outcomes 1.01, 1.02, 2.02, 3.01</td>
<td>Unit 203</td>
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<td></td>
<td>Amend Additional Information in Outcome 2 &amp; 3</td>
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</tr>
<tr>
<td></td>
<td>Amend range in Outcomes 2.02, 2.5, 2.6, 3.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amend Additional Information in Outcome 1</td>
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</tr>
<tr>
<td></td>
<td>Unit 208</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amend range in Outcomes 2.1, 3.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amend Additional Information in Outcome 3, 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit 212</td>
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<tr>
<td>5.1 August 2017</td>
<td>Added TQT details</td>
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<td></td>
<td>Qualification at a glance, Structure Throughout</td>
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</tr>
</tbody>
</table>

City & Guilds Level 2 Certificate / Diploma in Mechanical Engineering (2850-40/41)
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Introduction</td>
<td>4</td>
</tr>
<tr>
<td>Structure</td>
<td>5</td>
</tr>
<tr>
<td>2  Centre requirements</td>
<td>7</td>
</tr>
<tr>
<td>Approval</td>
<td>7</td>
</tr>
<tr>
<td>Resource requirements</td>
<td>7</td>
</tr>
<tr>
<td>Candidate entry requirements</td>
<td>8</td>
</tr>
<tr>
<td>3  Delivering the qualification</td>
<td>9</td>
</tr>
<tr>
<td>Initial assessment and induction</td>
<td>9</td>
</tr>
<tr>
<td>Support materials</td>
<td>9</td>
</tr>
<tr>
<td>4  Assessment</td>
<td>10</td>
</tr>
<tr>
<td>5  Units</td>
<td>13</td>
</tr>
<tr>
<td>Unit 201 Working in engineering</td>
<td>14</td>
</tr>
<tr>
<td>Unit 202 Principles of engineering technology</td>
<td>20</td>
</tr>
<tr>
<td>Unit 203 Principles of manufacturing technology</td>
<td>25</td>
</tr>
<tr>
<td>Unit 204 Machine components using milling techniques</td>
<td>29</td>
</tr>
<tr>
<td>Unit 205 Machine components using turning techniques</td>
<td>34</td>
</tr>
<tr>
<td>Unit 206 Using bench fitting techniques</td>
<td>38</td>
</tr>
<tr>
<td>Unit 207 Using Computer Aided Manufacturing processes</td>
<td>42</td>
</tr>
<tr>
<td>Unit 208 Principles of maintenance technology</td>
<td>45</td>
</tr>
<tr>
<td>Unit 209 Assembling and maintaining fluid power systems</td>
<td>52</td>
</tr>
<tr>
<td>Unit 210 Maintenance of mechanical devices and equipment</td>
<td>58</td>
</tr>
<tr>
<td>Unit 211 Maintaining electrical wiring support systems</td>
<td>63</td>
</tr>
<tr>
<td>Unit 212 Principles of fabrication and welding technology</td>
<td>67</td>
</tr>
<tr>
<td>Unit 213 Welding by Manual Metal Arc process</td>
<td>72</td>
</tr>
<tr>
<td>Unit 214 Welding by MIG process</td>
<td>78</td>
</tr>
<tr>
<td>Unit 217 Fabricating sheet metalwork</td>
<td>84</td>
</tr>
<tr>
<td>Unit 218 Fabricating thick plate, bar and sections</td>
<td>89</td>
</tr>
<tr>
<td>Unit 221 Principles of electrical and electronics technology</td>
<td>95</td>
</tr>
<tr>
<td>Unit 222 Maintaining electrical equipment and systems</td>
<td>99</td>
</tr>
<tr>
<td>Unit 223 Wiring and testing electrical circuits</td>
<td>102</td>
</tr>
<tr>
<td>Unit 224 Constructing, testing and fault finding electronic circuits</td>
<td>105</td>
</tr>
<tr>
<td>Appendix 1 Qualification grading</td>
<td>112</td>
</tr>
<tr>
<td>Appendix 2 Links to other qualifications</td>
<td>114</td>
</tr>
<tr>
<td>Appendix 3 Sources of general information</td>
<td>115</td>
</tr>
</tbody>
</table>
# 1 Introduction

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

<table>
<thead>
<tr>
<th>Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who is the qualification for?</td>
<td>They are designed for 14-16 year olds allowing them to progress into a career in Engineering.</td>
</tr>
<tr>
<td>What do the qualifications cover?</td>
<td>They allow candidates to learn, develop and practise the skills required for employment and/or career progression in the broad Engineering sector.</td>
</tr>
<tr>
<td>What opportunities for progression are there?</td>
<td>They allow candidates to progress into employment or to the following City &amp; Guilds qualifications:</td>
</tr>
<tr>
<td></td>
<td>• 2850-(30-36) Level 3 Diplomas in Engineering</td>
</tr>
</tbody>
</table>
Structure
To achieve the **Level 2 Certificate in Mechanical Engineering**, learners must achieve 35 credits overall - 21 credits from the mandatory units and a minimum of 14 credits from the optional units available.

To achieve the **Level 2 Diploma in Mechanical Engineering**, learners must achieve 42 credits overall - 21 credits from the mandatory units and a minimum of 21 credits from the optional units available.

<table>
<thead>
<tr>
<th>Unit accreditation number</th>
<th>City &amp; Guilds unit number</th>
<th>Unit title</th>
<th>Credit value</th>
<th>GLH</th>
</tr>
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<tbody>
<tr>
<td><strong>Mandatory</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H/503/0174</td>
<td>201</td>
<td>Working in engineering</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>R/503/0204</td>
<td>202</td>
<td>Principles of engineering technology</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>K/503/0175</td>
<td>203</td>
<td>Principles of manufacturing technology</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td><strong>Optional</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y/503/0205</td>
<td>204</td>
<td>Machine components using milling techniques</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>M/503/0176</td>
<td>205</td>
<td>Machine components using turning techniques</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>T/503/0177</td>
<td>206</td>
<td>Using bench fitting techniques</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>D/503/0206</td>
<td>207</td>
<td>Using computer aided manufacturing processes</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>D/503/0187</td>
<td>208</td>
<td>Principles of maintenance technology</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>H/503/0188</td>
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<td>Assembling and maintaining fluid power systems</td>
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<tr>
<td>K/503/0189</td>
<td>210</td>
<td>Maintenance of mechanical devices and equipment</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>D/503/0190</td>
<td>211</td>
<td>Maintaining electrical wiring support systems</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>H/503/0191</td>
<td>212</td>
<td>Principles of fabrication and welding technology</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>K/503/0192</td>
<td>213</td>
<td>Welding by Manual Metal Arc process</td>
<td>7</td>
<td>60</td>
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<td>M/503/0193</td>
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<td>60</td>
</tr>
<tr>
<td>F/503/0196</td>
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<td>Fabricating sheet metalwork</td>
<td>7</td>
<td>60</td>
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<td>J/503/0197</td>
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<td>A/503/0200</td>
<td>221</td>
<td>Principles of electrical and electronics technology</td>
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<tr>
<td>F/503/0201</td>
<td>222</td>
<td>Maintaining electrical equipment and systems</td>
<td>7</td>
<td>60</td>
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<tr>
<td>J/503/0202</td>
<td>223</td>
<td>Wiring and testing electrical circuits</td>
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<td>60</td>
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<tr>
<td>L/503/0203</td>
<td>224</td>
<td>Constructing, testing and fault finding electronic circuits</td>
<td>7</td>
<td>60</td>
</tr>
</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>
<thead>
<tr>
<th>Title and level</th>
<th>GLH</th>
<th>TQT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2 Certificate / Diploma in Mechanical Engineering</td>
<td>300</td>
<td>350</td>
</tr>
</tbody>
</table>
2 Centre requirements

Approval
Centres approved to offer the qualification 2850 Level 2 Certificate/Diploma in Engineering will be given automatic approval to run the new Level 2 Certificate/Diploma in Mechanical Engineering (2850-40 & 41).

To offer this 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 qualifications before designing a course programme.

Resource requirements

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

- be occupationally competent or technically knowledgeable in the areas 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, e.g. tutor and assessor or internal quality assurer, but cannot internally verify their own assessments.

Health and Safety
The Department for Education has produced advice in terms of Health & Safety in Schools. The advice document replaces a number of guidance documents on health, safety and security in schools, including Health and Safety: Responsibilities and Powers (2001) and Health and Safety of Pupils on Educational Visits (HASPEV 1998)."

Further DfE guidance can be found here.
Assessors and Internal Quality Assurer
Assessor/Internal Quality Assurer TAQA qualifications are valued as qualifications for centre staff, but they are not currently a requirement for the qualifications.

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.

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

Initial assessment and induction
An initial assessment of each candidate should be made before the start of their programme to identify:

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

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

Support materials
The following resources are available for these qualifications:

<table>
<thead>
<tr>
<th>Description</th>
<th>How to access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification Handbook</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
</tbody>
</table>
4 Assessment

**External assessment**
120 of the total 300 GLH is externally assessed.

**Synoptic assessment**
Candidates are required to complete three knowledge units and two practical units.
The assessment for the practical units assess not only the knowledge and skills in the specific practical unit but also covers the techniques, concepts and knowledge contained with the knowledge only units. For example effective communication, use of drawings and specifications, working in the engineering industry, the requirements and properties for materials etc. These are all applied in the synoptic practical tasks making up the assignments.

Candidates must:
- successfully complete one online test /assignment for each mandatory unit
- successfully complete one assignment for each chosen optional unit

City & Guilds has written the following assessments to use with this qualification:
- online multiple choice tests
- assignments

<table>
<thead>
<tr>
<th>Unit</th>
<th>Title</th>
<th>Assessment method</th>
<th>Where to obtain assessment materials</th>
</tr>
</thead>
</table>
| 201  | Working in engineering                     | City & Guilds e-volve multiple choice test  
The test covers the all of the knowledge in the unit. | Examination provided on e-volve.     |
| 202  | Principles of engineering technology       | City & Guilds e-volve multiple choice test  
The test covers the all of the knowledge in the unit. | Examination provided on e-volve.     |

All other units are assessed by assignment
**Time constraints**

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

- Candidates must finish their assessment within their period of registration.
- Each assignment has specific time constraints; please refer to the individual assignments. If candidates are taking longer to complete assignments, centres should consider why this is, and make sure that they are not trying to gather too much evidence.

**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 safe working practices</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>2. Know effective methods of communication</td>
<td>9</td>
<td>22.5</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>

**Grading**

Each assessment is graded as either Pass, Merit, Distinction in accordance with the grading criteria.

These grades are then combined according to the rules for qualification grading in Appendix 1 to give an overall grade for the qualification being claimed.
Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification. RPL is allowed and is not sector specific.
5 Units

Availability of units
Below is a list of the learning outcomes for all the units.

Structure of units
These units each have the following:
- City & Guilds reference number
- unit accreditation number (UAN)
- title
- level
- credit value
- guided learning hours
- 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 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, plasticised), pipe and tube, castings, forgings, extrusions
Unit 202 technology

Outcome 2

Principles of engineering

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  
Technology

Outcome 3

Principles of manufacturing technology

Know how to plan production from a given specification

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

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

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

Level: 2  
Credit value: 7  
UAN: Y/503/0205

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

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**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.

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**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.

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**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 205  Machine components using turning techniques

Level: 2
Credit value: 7
UAN: M/503/0176

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 (scribes, 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 \(\text{cutting speed} = \pi dN/1000\)), 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, \( \text{rpm} = \frac{1000\pi}{D}, \text{feed} = \text{rpm} \times \text{number of teeth} \times \text{feed per tooth} \)), tools/cutters (using bar and slip, using cutting tool, probe, high speed steel, carbide, ceramic, geometry [top rake, front rake, clearance])
Restore the work area: leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
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: Manual Handling techniques including assessment of load, individual capacity, task and environment conditions. 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\(^\circ\), never exceed the safe working load [SWL], inspection records for lifting equipment are current, lifting equipment (screw and hydraulic jacks, overhead gantry cranes, mobile cranes, jib cranes, derricks, fork lift trucks, tripods, shackles, pulley blocks)
Heavy equipment: rollers and skates, crowbars, pull-lifts, lubricated plates
Tools and equipment: torque/impact wrenches, pipe wrenches, pipe cutting and threading, spanners and socket sets, drifts and wedges, extractors, feeler gauges, screw drivers, pliers, wire cutter/strippers
Perform: measure using calibrated equipment and the importance of calibration
Equipment: Use of; rules/tapes, micrometers, vernier instruments, ammeters, voltmeters, ohmmeters, insulation resistance tester, multimeters, 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), misuses of tools, use of damaged or badly maintained tools, not following laid-down maintenance procedures, stored energy/force, handling of compressed air (harmful effects to skin and body)

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

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

Additional Guidance

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

Outcome 2  Be able to apply testing/fault finding techniques

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

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

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

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

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

**Additional Guidance**

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

**Fluid power testing:** connect and use suitable calibrated test/diagnostic equipment to circuit to test and/or investigate problem, importance of correct calibration of test equipment, handling/application of measuring/test equipment (measuring instruments, pressure and flow indicators, self-diagnostic equipment), static tests (guarantee pressure tightness of a system under set conditions, locate leaks and faults in a system), dynamic test (ensure correct operation of system components, ensure system performs to specification)
Unit 209  

Assembling and maintaining fluid power systems

Outcome 3  
Be able to dismantle, remove and replace/repair, re-assemble and test systems conform to specification

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

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

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

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

Clean: dust (blow, vacuum), dirt (brushing, vacuum), grease (degreasing agents, solvents, 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. dismantle 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, 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.
Unit 212 Principles of fabrication and welding technology

Outcome 3 Understand the effects of welding

Assessment Criteria
The learner can:
1. describe 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 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.
Unit 218   Fabricating thick plate, bar and sections

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

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

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

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

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

- grinders (portable angle grinders/sanders, bench, pedestal)
- lifting equipment (common forms of injury, use lifting aids [straps, bars, harnesses], wall and overhead mounted travelling cranes, fork lift trucks, pallets and pallet truck, block and tackle, pull/lift lever hoist, engine hoist, chains, ropes, slings, shackles, lifting eyes, friction clamps, welded lugs, lifting capacity [safe working load (SWL)])
Unit 218  Fabricating thick plate, bar and sections

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

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

Range
Forming: hot and cold bending (principles – application of heat, hand methods [clamps, vices, levers], bench mounted machines [types, applications], bench bending around a former, fly press [principles, tooling], brake press [principles, tooling], springback [principle, allowances], ‘split and weld’ methods, health and safety considerations
Assembling: work holding (clamps, pins, plate dogs, wedges, tack welding), work alignment (strong backs, clamping dogs, wedges, drawbolts 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 [CO₂], argon/CO₂, argon/oxygen/CO₂), Personal Protective Equipment (PPE), fume removal)

**Restore the work area:** leave the work area free of unused consumables, cleaning the work area, putting tools and equipment into safe storage, identifying and recording finished work
Unit 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 Resistors (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
Appendix 1  Qualification grading

2850-40/41 Level 2 Certificate/Diploma in Mechanical Engineering

To determine the grade achieved by a candidate for the overall qualification each unit result is awarded points.

**Pass** = 1 point  
**Merit** = 2 points  
**Distinction** = 3 points

A minimum of a Pass must be obtained for each unit.

The points are then averaged and a conversion table (provided) is used to convert this to a grade.

Overall grade conversion chart:

<table>
<thead>
<tr>
<th>Average</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 1.5</td>
<td>Pass</td>
</tr>
<tr>
<td>1.6 to 2.5</td>
<td>Merit</td>
</tr>
<tr>
<td>2.6 to 3</td>
<td>Distinction</td>
</tr>
</tbody>
</table>

The following page contains an example for the Certificate and Diploma qualifications. Note the difference is the number of assessments that a candidate is required to achieve.

Grading table

<table>
<thead>
<tr>
<th>Pass (1 point)</th>
<th>Merit (2 points)</th>
<th>Distinction (3 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Online test unit 201</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Online test unit 202</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assignment unit 203</td>
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<tr>
<td>Assignment unit:</td>
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<tr>
<td>Assignment unit:</td>
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<td></td>
</tr>
<tr>
<td>Assignment unit (Dip only):</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total points divided by no. of assessments (_): 

Overall qualification grade (see conversion chart above):

The resulting grade should be entered onto the City & Guilds Walled Garden using the grading/certification module.
The following examples of qualification grading have been provided:

**Example 1 – 2850-40 Level 2 Certificate in Mechanical Engineering**

<table>
<thead>
<tr>
<th></th>
<th>Pass (1 point)</th>
<th>Merit (2 points)</th>
<th>Distinction (3 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online test unit 201</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Online test unit 202</td>
<td>1</td>
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</tr>
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<td>2</td>
<td></td>
</tr>
<tr>
<td>Assignment unit: 208</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Assignment unit (Dip only): n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total points divided by no. of assessments (5): 1.4
Overall qualification grade (see chart on previous page): Pass

**Example 2 - 2850-41 Level 2 Diploma in Mechanical Engineering**

<table>
<thead>
<tr>
<th></th>
<th>Pass (1 point)</th>
<th>Merit (2 points)</th>
<th>Distinction (3 points)</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tr>
<tr>
<td>Assignment unit: 209</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Assignment unit (Dip only): 210</td>
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<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total points divided by no. of assessments (6): 2.3
Overall qualification grade (see chart on previous page): Merit
Appendix 2  Links to other qualifications

Mapping is provided as guidance and suggests areas of commonality between the qualifications. It does not imply that candidates completing units in one qualification have automatically covered all of the content of another.

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:
• 2850-(30-36) Level 3 Diplomas in Engineering

Literacy, language, numeracy and ICT skills development
These qualifications can develop skills that can be used in the following qualifications:
• Functional Skills (England) – see www.cityandguilds.com/functionalskills
• Essential Skills (Northern Ireland) – see www.cityandguilds.com/essentialskillsni
• Essential Skills Wales – see www.cityandguilds.com/esw
Appendix 3  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 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.

**Our Quality Assurance Requirements** encompasses all of the relevant requirements of key regulatory documents such as:

- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

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

**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**: how to register for e-assessments.
City & Guilds
Believe you can

www.cityandguilds.com
## Useful contacts

<table>
<thead>
<tr>
<th>UK learners</th>
<th>T: +44 (0)844 543 0033</th>
<th>E: <a href="mailto:learnersupport@cityandguilds.com">learnersupport@cityandguilds.com</a></th>
</tr>
</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
<th>International learners</th>
<th>T: +44 (0)844 543 0033</th>
<th>F: +44 (0)20 7294 2413</th>
<th>E: <a href="mailto:intcg@cityandguilds.com">intcg@cityandguilds.com</a></th>
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<td>General qualification information</td>
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<th>Centres</th>
<th>T: +44 (0)844 543 0000</th>
<th>F: +44 (0)20 7294 2413</th>
<th>E: <a href="mailto:centresupport@cityandguilds.com">centresupport@cityandguilds.com</a></th>
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<tr>
<td>Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results</td>
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<th>Single subject qualifications</th>
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<th>F: +44 (0)20 7294 2413</th>
<th>E: <a href="mailto:intops@cityandguilds.com">intops@cityandguilds.com</a></th>
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<th>Walled Garden</th>
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<th>F: +44 (0)20 7294 2413</th>
<th>E: <a href="mailto:walledgarden@cityandguilds.com">walledgarden@cityandguilds.com</a></th>
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<th>Employer</th>
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<th>T: +44 (0)844 543 0000</th>
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<td>Logbooks, Centre documents, Forms, Free literature</td>
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