QUALIFICATION HANDBOOK

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

August 2017 Version 5.1

City & Guilds

Qualification at a glance

Subject area	Mechanical Engineering
City & Guilds number	2850
Age group approved	All
Entry requirements	None
Assessment	Assignment Online test
Support materials	Centre handbook
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	GLH	TQT	City & Guilds number	Accreditation number
Level 2 Certificate in Mechanical Engineering	300	350	2850-40	600/6880/2
Level 2 Diploma in Mechanical Engineering	300	350	2850-41	600/6881/4

Version and date	Change detail	Section
1.4 November 2014	Amend range in Outcomes 1.01, 1.02, 2.02, 3.01 Amend Additional Information in Outcome 2 & 3	**Unit 203**
	Amend range in Outcomes 2.02, 2.5, 2.6, 3.4 Amend Additional Information in Outcome 1	**Unit 208**
	Amend range in Outcomes 2.1, 3.6 Amend Additional Information in Outcome 3, 4	**Unit 212**
	Amend range in Outcomes 2.1, 2.2, 3.6, 3.7 Moved Additional Information in Outcome 2 to the Range	**Unit 221**
5.1 August 2017	Added TQT details Deleted QCF	**Qualification at a glance, Structure** **Throughout**

Contents

1 Introduction

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

Area	Description
Who is are the qualifications for?	They are designed for 14-16 year olds allowing them to progress into a career in Engineering.
What do the qualifications cover?	They allow candidates to learn, develop and practise the skills required for employment and/or career progression in the broad Engineering sector.
What opportunities for progression are there?	They allow candidates to progress into employment or to the following City & Guilds qualifications: • 2850-(30-36) Level 3 Diplomas in Engineering

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.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value	GLH
Mandatory				
H/503/0174	201	Working in engineering	7	60
R/503/0204	202	Principles of engineering technology	7	60
K/503/0175	203	Principles of manufacturing technology	7	60
Optional				
Y/503/0205	204	Machine components using milling techniques	7	60
M/503/0176	205	Machine components using turning techniques	7	60
T/503/0177	206	Using bench fitting techniques	7	60
D/503/0206	207	Using computer aided manufacturing processes	7	60
D/503/0187	208	Principles of maintenance technology	7	60
H/503/0188	209	Assembling and maintaining fluid power systems	7	60
K/503/0189	210	Maintenance of mechanical devices and equipment	7	60
D/503/0190	211	Maintaining electrical wiring support systems	7	60
H/503/0191	212	Principles of fabrication and welding technology	7	60
K/503/0192	213	Welding by Manual Metal Arc process	7	60
M/503/0193	214	Welding by MIG process	7	60
F/503/0196	217	Fabricating sheet metalwork	7	60
J/503/0197	218	Fabricating thick plate, bar and sections	7	60
A/503/0200	221	Principles of electrical and electronics technology	7	60
F/503/0201	222	Maintaining electrical equipment and systems	7	60
J/503/0202	223	Wiring and testing electrical circuits	7	60
L/503/0203	224	Constructing, testing and fault finding electronic circuits	7	60

Total Qualification Time

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

Title and level	GLH	TQT
Level 2 Certificate / Diploma in Mechanical Engineering	300	350

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, eg 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:

Description	How to access
Qualification Handbook	www.cityandguilds.com

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

Unit	Title	Assessment method	Where to obtain assessment materials
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

Outcome	No. of questions	%
1. Know safe working practices	16	40
2. Know effective methods of communication	9	22.5
3. Understand drawings and specification	10	25
4. Know about working in engineering	5	12.5
Total	**40**	**100**

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

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

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

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

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

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

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

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

Signs: warning, prohibition, mandatory, information, fire

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

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

Risk assessments: slippery or uneven surfaces, spillages, scrap or waste material, flammable materials, faulty or missing machine guards, faulty electrical connections or damaged cables, dust and fumes, contaminants and irritants, materials handling and transportation

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

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

Additional Guidance

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

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

Unit 201 Working in engineering

Outcome 2 Know effective methods of communication

Assessment Criteria

The learner can:

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

Range

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

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

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

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

Sources of support: mentor, trainer, supervisor

Additional Guidance

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

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

Unit 201 Working in engineering

Outcome 3 Understand drawings and specifications

Assessment Criteria

The learner can:

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

Range

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

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

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

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

Specifications and quality systems:

Quality: assurance, quality control, inspection, quality circles

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

Corrective action procedures,

Conventions: lines, hatching, symbols, views, layout

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

Unit 201 Working in engineering

Outcome 4 Know about working in engineering

Assessment Criteria

The learner can:

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

Range

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

Work effectively:

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

Observing safety policies and regulations

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

Conflict:

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

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

Team members: team leaders, team members

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

Unit 202 Principles of engineering technology

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

Unit aim

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

Learning outcomes

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

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

Guided learning hours

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

Details of the relationship between the unit and relevant national standards

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

Support of the unit by a sector or other appropriate body (if required, otherwise omit)

This unit is endorsed by SEMTA.

Assessment

This unit will be assessed by an online multiple-choice assessment.

Unit 202 Principles of engineering technology

Outcome 1 Know requirements for materials in engineering

Assessment Criteria

The learner can:

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

Range

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

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

Identify materials: colour, appearance, density.

Additional Guidance

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

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

Unit 202 Principles of engineering technology

Outcome 2 Know properties of engineering materials

Assessment Criteria

The learner can:

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

Range

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

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

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

Unit 202 Principles of engineering technology

Outcome 3 Know how to apply analytical methods to engineering mathematical applications

Assessment Criteria

The learner can:

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

Range

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

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

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

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

Volumes: cube, rectangular prism, cylinder

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

Unit 202 Principles of engineering technology

Outcome 4 Know how to apply analytical methods to engineering science applications

Assessment Criteria

The learner can:

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

Range

Force: definition, solve problems using formulae

Work done: definition, solve problems using formulae

Power: mechanical power, electrical power

Energy: mechanical energy, electrical energy

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

Moment of a force: levers, torque

Relative density: relative to water

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

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

Pressure at depth: ρgh

Unit 203 Principles of manufacturing technology

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

Unit aim

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

Learning outcomes

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

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

Guided learning hours

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

Details of the relationship between the unit and relevant national standards

This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 65: General Machining, Fitting and Assembly Applications

Support of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Assessment

This unit will be assessed by a short answer question paper.

Unit 203 Principles of manufacturing technology

Outcome 1 Know the functions within a manufacturing organisation

Assessment Criteria

The learner can:

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

Range

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

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

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

Equipment: general purpose, dedicated, computerised.

Unit 203 Principles of manufacturing technology

Outcome 2 Know how to select suitable materials and components to manufacture products

Assessment Criteria

The learner can:

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

Range

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

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

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

Mechanical fastenings and joining techniques: non permanent, permanent

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

Additional Guidance

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

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

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

Unit 203 Principles of manufacturing technology

Outcome 3 Know how to plan production from a given specification

Assessment Criteria

The learner can

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

Range

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

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

Costs: direct, indirect costs

Additional Guidance

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

Unit 204 Machine components using milling techniques

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

Assessment Criteria

The learner can:

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

Range

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

Datum: faces, centres

Classes of fit: clearance

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

Coolants and cutting oils: oils, compounds, synthetic

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

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

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

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

Additional information

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

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

Unit 204 Machine components using milling techniques

Outcome 2 Be able to determine requirements for milling operations

Assessment Criteria

The learner can:

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

Range

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

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

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

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

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

Additional information

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

Unit 204 Machine components using milling techniques

Outcome 3 Be able to perform milling operations to produce parts

Assessment Criteria

The learner can:

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

Range

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

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

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

Unit 204 Machine components using milling techniques

Outcome 4 Be able to perform milling operations

Assessment Criteria

The learner can:

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

Range

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

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

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

Additional Guidance

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

Unit 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 (scribers, scribing block, punches [centre and dot], surface plate/table, angle plate parallels and vee blocks) hand tools (files, screwdrivers, hammers and mallets, pin punches, spanners (open-ended, socket sets, ring, torque wrenches), measuring instruments (rules, inside and outside calipers, protractor, micrometers (external, depth), verniers (height gauge, protractor, callipers), gauges (feeler, blocks/slip, radius, thread) dial test indicators, surface finish

(comparison plates, tactile machines), cutting and shaping (saws [hand, mechanical], drills (high speed steel [HSS] carbide tips drill speed tables, cutting speed formula [cutting speed = πdN/1000]), taps (spiral flute, straight flute [taper, second, bottoming], use of charts for selecting tapping sizes) and dies (circular split, rectangular, pipe), reamers, forms of power supply (230V, 110V, pneumatic, battery), powered hand tools (drills, screwdrivers, angle grinders, saws), forming equipment (bench folders, fly press).

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

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

Unit 207 Using Computer Aided Manufacturing processes

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: .dxf, .iges

Unit 207 Using Computer Aided Manufacturing processes

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

Assessment Criteria

The learner can:

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

Range

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

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

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

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

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

Additional Guidance

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

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

Unit 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 technology — Principles of maintenance

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°, never exceed the safe working load [SWL], inspection records for lifting equipment are current, lifting equipment (screw and hydraulic jacks, overhead gantry cranes, mobile cranes, jib cranes, derricks, fork lift trucks, tripods, shackles, pulley blocks)

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

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

Perform: measure using calibrated equipment and the importance of calibration

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

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

Also includes

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

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

Unit 208 Principles of maintenance technology

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

Assessment Criteria

The learner can:

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

Range

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

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

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

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

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

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

Additional information

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

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

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

Unit 209 Assembling and maintaining fluid power systems

Level: 2
Credit value: 7
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, isolation/barrier requirements, sequence of operations for dismantle/re-assemble components, provision for spillages

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

Additional Guidance

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

Unit 209 Assembling and maintaining fluid power systems

Outcome 2 Be able to apply testing/fault finding techniques

Assessment Criteria

The learner can:

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

Range

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

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

Leaks/faults:

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

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

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

Additional Guidance

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

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

Unit 209 Assembling and maintaining fluid power systems

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

Assessment Criteria

The learner can:

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

Range

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

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

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

Clean: dust (blow, vacuum), dirt (brushing, vacuum), grease (degreasing agents, solvents, 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. dissemble mechanical devices and equipment

Range

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

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

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

Information sources: 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)

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

bearings and shafts, gears, couplings, springs, seals and gaskets, circlips, seals, gaskets.

Additional Guidance

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

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)

Shielding gases/gas mixtures: tungsten-inert gas [TIG] welding (argon, helium, Ar/H_2 for stainless steels), metal inert gas/metal active gas [MIG/MAG] welding: (carbon steels. aluminum, stainless steel), effects of shielding gases (protection from gases in the atmosphere (composition of air), mode of metal transfer, penetration, weld bead profile, speed of welding, wetting/undercutting tendency)

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

Range

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

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

Distortion: causes, types, methods of control

Weld defects: types

Causes: types of operator error, other causes

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

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

Additional Guidance

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

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

Unit 212 Principles of fabrication and welding technology

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

Assessment Criteria

The learner can:

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

Range

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

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

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

Additional Guidance

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

Unit 213 Welding by Manual Metal Arc process

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

Unit aim

This unit is to enable manual metal arc (MMA) welding skills to be developed to meet the defect acceptance requirements of BS 4872 part 1 in steel or stainless steel within its scope.

The applied knowledge topics include: health and safety hazards and methods of avoiding them, preparation, electrical requirements, consumables, welding techniques, welding positions, distortion control and rectification, BS 4872 part 1 requirements and non-destructive and workshop testing.

Learning outcomes

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

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

Guided learning hours

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

Details of the relationship between the unit and relevant national standards

This unit is linked to the NVQ – Performing Engineering Operations Level 2: 2251 Unit 27: Preparing and Using Manual Metal Arc Welding Equipment

Support of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Assessment

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

Unit 213 Welding by Manual Metal Arc process

Outcome 1 Know safe working practices associated with manual metal arc welding

Assessment Criteria

The learner can:

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

Range

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

Welding fume: types of fume (visible [particulate], invisible [gaseous], carbon monoxide [CO], oxides of nitrogen, nitrous oxide [NO], nitrogen dioxide [NO_2], use of extraction (background, local, natural ventilation [e.g. on-site], air-fed headshields, respirator

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

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

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

Unit 213 Welding by Manual Metal Arc process

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

Assessment Criteria

The learner can:

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

Range

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

Leads: welding, return, earth

Electrode holders: fully insulated, partially insulated

Return clamps: types

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

Unit 213 Welding by Manual Metal Arc process

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

Assessment Criteria

The learner can:

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

Range

Electrodes: cellulosic, rutile, basic, applications.

Storage requirements: temperature, humidity.

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

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

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

Welding voltages: open circuit voltage, arc voltage.

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

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

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

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

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

Distortion rectification: mechanical, thermal.

Additional Guidance

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

Unit 213 Welding by Manual Metal Arc process

Outcome 4 Be able to visually check welds for defects

Assessment Criteria

The learner can:

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

Range

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

Assessment criteria: qualitive (defect levels, appearance), quantitive (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 (O_3), carbon monoxide [CO], oxides of nitrogen, nitrous oxide [NO], nitrogen dioxide [NO_2], 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 [CO_2], argon/oxygen [O_2], argon/CO_2, argon/O_2/CO_2, argon/helium/O_2/CO_2), applications

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

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

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

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

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

Distortion rectification: mechanical, thermal.

Additional Guidance

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

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: qualitive (defect levels, appearance), quantitive (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 [CO_2], argon / CO_2, argon/oxygen/ CO_2), Personal Protective Equipment (PPE), fume removal)
- TIG welding (equipment/consumables: direct current [d.c.] electrode negative, methods of arc ignition, welding torches, tungsten electrodes for the welding of steels: [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, draw-bolts and cleats, bridge pieces, toggle clamps, alignment jigs), distortion control (tack welding, presetting, weld sequencing).

Unit 218 Fabricating thick plate, bar and sections

Outcome 3 Be able to produce fabrications using thick plate and rolled bar sections joining techniques.

Assessment Criteria

The learner can:

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

Range

Joining techniques:

- solid rivets
- bolts and nuts
- screwed fastenings types of screwed fastening, cap/cheese head, round head, countersunk, self-tapping, use of hank bushes, use of taps and dies
- use of welded joints
- manual metal arc (MMA) welding equipment/consumables, techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, Personal Protective Equipment (PPE), fume removal
- MIG welding equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires shielding gases used for the welding of carbon steels: carbon dioxide [CO_2], argon/CO_2, argon/oxygen/CO_2), Personal Protective Equipment (PPE), fume removal

Additional Guidance

Joining techniques:

- solid rivets (single lap, double lap, single strap, double strap; types of rivet head: flat, countersunk, round [or snap], pan, mushroom, applications; riveting defects; causes of joint failure [tearing of metal, crushing of metal, splitting of metal, shearing of rivet; allowances; sources of pressure: hammers, pneumatic, hydraulic)
- bolts and nuts (types of bolts: black, turned, high-strength friction-grip, cap/cheese head; types of nuts: hexagonal, split, self-locking, wing, castellated, domed; use of washers: flat, taper, spring; defects in bolted connections; use of podging spanners and drifts; allowances)

- screwed fastenings (types of screwed fastening, cap/cheese head, round head, countersunk, self-tapping, use of hank bushes, use of taps and dies
- use of welded joints (lap, corner, butt, tee)
- manual metal arc (MMA) welding (equipment/consumables: alternating current [a.c.] direct current [d.c.], welding leads [welding, return, earth], electrode holders, return clamps, chipping hammer, wire brushes, electrode sizes [Ø2.5, 3.2 Ø 4.0 mm] techniques: arc striking, crater filling at the end of a weld, stop/restart, stringer beading, weaving, Personal Protective Equipment (PPE), fume removal)
- MIG welding (equipment/consumables: direct current [d.c.] electrode positive, wire feed unit, arc ignition, gun/torches, electrodes wires [Ø0.6 mm, Ø0.8 mm], shielding gases used for the welding of carbon steels: carbon dioxide [CO_2], argon/CO_2, argon/oxygen/CO_2), Personal Protective Equipment (PPE), fume removal)

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

Unit 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 densit, electrical resistance, capacitance, inductance, frequency, temperature, current.

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

Unit 221 Principles of electrical and electronics technology

Outcome 2 Know the application of electrotechnology

Assessment Criteria

The learner can

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

Range

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

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

Additional Guidance

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

Unit 221 Principles of electrical and electronics technology

Outcome 3 Be able to identify the characteristics of an electrical circuit

Assessment Criteria

The learner can:

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

Additional Guidance

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

Solenoid: Sketch magnetic field and determine polarity.

Capacitor: construction of typical capacitor, polarised and air capacitors

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

Transformers: Turns ratios. Primary and secondary voltage relationships.

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

Unit 222 Maintaining electrical equipment and systems

Level: **2**
Credit value: **7**
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:

Average	Grade
1 to 1.5	Pass
1.6 to 2.5	Merit
2.6 to 3	Distinction

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

	Pass (1 point)	Merit (2 points)	Distinction (3 points)
Online test unit 201			
Online test unit 202			
Assignment unit 203			
Assignment unit:			
Assignment unit:			
Assignment unit (Dip only):			
		Total	

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

	Pass (1 point)	Merit (2 points)	Distinction (3 points)
Online test unit 201	1		
Online test unit 202	1		
Assignment unit 203	1		
Assignment unit: 206		2	
Assignment unit: 208		2	
Assignment unit (Dip only): n/a			
		Total	7

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

	Pass (1 point)	Merit (2 points)	Distinction (3 points)
Online test unit 201		2	
Online test unit 202		2	
Assignment unit 203	1		
Assignment unit: 208			3
Assignment unit: 209			3
Assignment unit (Dip only): 210			3
		Total	14

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

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

About City & Guilds

As the UK's leading vocational education organisation, City & Guilds is leading the talent revolution by inspiring people to unlock their potential and develop their skills. We offer over 500 qualifications across 28 industries through 8500 centres worldwide and award around two million certificates every year. City & Guilds is recognised and respected by employers across the world as a sign of quality and exceptional training.

City & Guilds Group

The City & Guilds Group operates from three major hubs: London (servicing Europe, the Caribbean and Americas), Johannesburg (servicing Africa), and Singapore (servicing Asia, Australia and New Zealand). The Group also includes the Institute of Leadership & Management (management and leadership qualifications), City & Guilds Licence to Practice (land-based qualifications), the Centre for Skills Development (CSD works to improve the policy and practice of vocational education and training worldwide) and Learning Assistant (an online e-portfolio).

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