

**ENGINEERING CRAFT SKILLS**  
**Intermediate 2**

**Fifth edition – published October 2008**

**NOTE OF CHANGES TO ARRANGEMENTS  
FIFTH EDITION PUBLISHED OCTOBER 2008**

**COURSE TITLE:** Engineering Craft Skills (Intermediate 2)

**COURSE NUMBER:** C034 11

**National Course Specification**

Course Details:      Course Outline      Minor amendments to clarify Course Structure.

## National Course Specification

### ENGINEERING CRAFT SKILLS (INTERMEDIATE 2)

**COURSE NUMBER** C034 11

#### COURSE STRUCTURE

This Course comprises two mandatory Units and one optional unit as follows:

##### Mandatory units

<i>D178 11</i>	<i>Bench Skills – Metal (Int 2)</i>	<i>1 credit (40 hours)</i>
<i>D179 11</i>	<i>Machine Processes – Metal (Int 2)</i>	<i>1 credit (40 hours)</i>

##### Optional units

One selected from:

<i>D180 11</i>	<i>Fabrication and Thermal Joining Techniques (Int 2)</i>	<i>1 credit (40 hours)</i>
<i>D181 11</i>	<i>Practical Electronics (Int 2)</i>	<i>1 credit (40 hours)</i>

In common with all Courses, this Course includes 40 hours over and above the 120 hours for the component units. This may be used for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning and preparation for external assessment. This time is an important element of the Course and advice on its use is included in the Course details.

#### RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have had some previous experience in Craft Skills. This may be evidenced by one of the following:

- Standard Grade Craft and Design
- Engineering Craft Skills at Intermediate 1 level

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#### Administrative Information

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## **National Course Specification: general information (cont)**

**COURSE**            Engineering Craft Skills (Intermediate 2)

### **CORE SKILLS**

Information on the automatic certification of any core skills in this Course are published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

## National Course Specification: Course details

### COURSE                      Engineering Craft Skills (Intermediate 2)

#### RATIONALE

Practical creativity exemplifies mankind's need to be able to control and utilise tools and materials. The sense of achievement that is experienced on the successful completion of a practical project is immense, and the value of this achievement to the development of the personal and social aspects of a candidate's education cannot be overstated. Practical creativity fosters qualities of self-esteem, technological confidence, self-discipline and maturity, all of which are essential attributes for candidates in post-16 education.

This Course will contribute to the knowledge, understanding and practical experience of candidates whose aspirations and abilities are towards practical work or who are considering a career in the engineering industry in any capacity. Candidates may wish to extend skills developed in Standard Grade Craft and Design. They may wish to progress to education or training in engineering through studies and practice focused on practical aspects of such work. They may wish to experience the rigorous standards which would apply were they serving an apprenticeship or in employment in this field.

Candidates who are pursuing studies in other fields, but who sampled the workshop environment in early secondary education, may wish to come back to gain experience and skills which may be useful and worthwhile in general education and adult life. Such candidates are to be encouraged.

The Course is of a practical nature, is workshop-based and provides many skills which are appropriate to a wide range of applications. The Course will develop skills in marking-out, cutting, shaping, machining and finishing materials, as well as adjusting and maintaining a range of hand tools. Apart from giving an insight into industrial practice, such studies help with the development of self-confidence, manual dexterity and control, perseverance, maturity and spatial awareness. The *Practical Electronics* option also extends the scope of the Course to include craft skills which interface with electronics in producing working systems.

The Intermediate 1 and Intermediate 2 Courses have similar learning outcomes and differ mainly in their assessment requirements, hence it is possible to teach two levels within the same class.

These are intended for use in both schools and colleges.

#### Differentiation

Teachers and lecturers offering the Intermediate 2 Course should be aware of the requirements of the Intermediate 1 Course. These differences focus on:

- the degree of difficulty of practical tasks
- the quality of artefacts
- the accuracy achieved in producing functional aspects
- the range of tools and equipment used
- the degree of independence of working

## National Course Specification: Course details (cont)

### COURSE                      Engineering Craft Skills (Intermediate 2)

#### Course aims

This Course:

- fosters practical skills in the creation of artefacts
- develops knowledge, understanding and skills of general aspects of practical engineering activity
- encourages independence and the ability to make choices
- highlights the importance of safety and encourages responsible attitudes in the workshop environment
- contributes to personal development, in particular to practical capability

#### COURSE CONTENT

All of the Course content will be subject to sampling in the external assessment.

The Course consists of two mandatory units each of 40 hours – *Bench Skills – Metal (Int 2)* and *Machine Processes – Metal (Int 2)*. A third unit chosen from *Fabrication and Thermal Joining Techniques (Int 2)* further extends metalworking skills, or *Practical Electronics (Int 2)* develops practical skills in constructing electronic circuits. For either option the Course assessment is based on a project which integrates the knowledge, understanding and skills of the selected units.

The Course is focused on practical work and takes place in a workshop environment. Whenever a new skill is to be introduced, this should be demonstrated to candidates and accompanied by the underpinning knowledge and understanding. Content is prescribed, but the Course is intended to be candidate-centred as opposed to being content-driven. For example, a candidate may be attracted to a particular project which requires experiences beyond the minimum competence and will require extended learning and teaching.

It is anticipated that particular candidates may require support throughout the Course with organisation of work and direct help with practical work.

## National Course Specification: Course details (cont)

**COURSE**            Engineering Craft Skills (Intermediate 2)

### *Bench Skills – Metal (Int 2)*

This introductory unit covers a range of metalwork hand skills, including bench-fitting work, basic sheet-metal work, measuring and marking-out. The general ability to read and interpret drawings and diagrams is fundamental to any craftwork and is developed in this unit. Each candidate should produce two small artefacts, one from sheet-metal and one utilising fitting and assembly skills. These artefacts should embody the prescribed content.

AREA OF STUDY	CONTENT
<p>Reading and interpretation of engineering drawings</p> <p>Practice in using:</p> <ul style="list-style-type: none"><li>• Marking-out tools</li><li>• Fitting tools and processes</li><li>• Sheet-metal tools and processes</li><li>• Measuring tools</li></ul>	<p>Simple dimensioned orthographic and pictorial drawings</p> <p>Scriber, rule, combination set, square, dividers, oddleg callipers, centre punch, witness marks</p> <p>Hammers, chisels, files, saws, tapping and threading, rivet set, riveting</p> <p>Bending equipment, shears, notchers, mallets, hammers, safe edge, tin snips, pop riveter, spot welder</p> <p>Rule, engineer's square, inside callipers, outside callipers, vernier callipers</p>

## National Course Specification: Course details (cont)

### COURSE                      Engineering Craft Skills (Intermediate 2)

#### *Machine Processes – Metal (Int 2)*

The purpose of this unit is to extend knowledge of measuring and marking-out and to gain experience of common machines, equipment and related processes. Knowledge is gained of the key features and functions of machines and other items of equipment commonly found in workshops. This includes metalworking lathes, pedestal drills and bench grinders. The range of machines may be extended to utilise milling machines, and it is desirable that all candidates are aware of these through use, videos, industrial visits, or by demonstration at another facility. Candidates should work with a range of metals appropriate to the applications.

Candidates are expected to manufacture artefacts from given drawings. Where possible, the choice of artefact should reflect areas of interest to the candidates, while embodying the content of the unit. It is likely that some artefacts may be suitable for integration with work produced in the other units.

Candidates should understand that the quality of work depends partly on the care and maintenance of tools and equipment, and this should be incorporated into their Course. The effectiveness of planned maintenance on workplace efficiency should be mentioned.

AREA OF STUDY	CONTENT
<p>Knowledge and understanding of the applications for which machine tools are used:</p> <ul style="list-style-type: none"> <li>• Centre lathe</li> <li>• Milling machine</li> <li>• Pedestal drill</li> <li>• Bench grinder</li> <li>• Machine tool equipment</li> </ul>	<p>Plain turning, facing, chamfering, centre drilling                      Slotting, surface levelling                      Drilling, countersinking                      Sharpening a single-point tool                      Cutting and knurling tools, parting off, chucks (including four-jaw chuck), chuck keys, morse tapers, revolving centres, machine vices, safety equipment</p>
<p>Practical experience of:</p> <ul style="list-style-type: none"> <li>• Centre lathe</li> <li>• Pedestal drill</li> <li>• Routine user checks</li> </ul>	<p>Plain turning, facing, chamfering, taper turning using the compound slide, centre drilling, drilling, parting off                      Drilling, countersinking                      General condition of hand tools, position and condition of guards, position of cutting tools on machine tools, security of work holding</p>
<p>Measuring and marking-out equipment</p>	<p>Micrometer, vernier calipers</p>

## National Course Specification: Course details (cont)

### COURSE Engineering Craft Skills (Intermediate 2)

#### *Optional unit: Fabrication and Thermal Joining Techniques (Int 2)*

Fabrication implies the forming and joining of components. Thermal joining techniques employed are those such as manual metal arc (MMA), metal inert gas (MIG) or tungsten inert gas (TIG). These techniques are prescribed to allow an insight into methods commonly used in heavy fabrication work. Other thermal processes for joining metals, for example brazing or soldering, may also be covered.

Forging is another process related to fabrication. It might best be introduced by videos dealing with the related terminology, equipment and applications in an industrial context. However, each candidate needs to gain practical experience of basic forging procedures. This will provide opportunity to consider the effects of heat on carbon steels.

AREA OF STUDY	CONTENT
Practical experience of <ul style="list-style-type: none"> <li>• Hot-forming techniques</li> <li>• Hot-bending techniques</li> <li>• Heat-treatment methods</li> <li>• Thermal joining techniques</li> </ul>	Twisting, drawing down, flattening Metal-bar bending and strip bending Annealing, hardening, tempering Welding: preparation, clamping, single-weld bead, tack welding, resistance (spot) welding Brazing: preparation, clamping or wiring, fluxing, applying braze or spelter
Measuring and marking-out	Allowances for bending, forming, welding, brazing

#### *Optional unit: Practical Electronics (Int 2)*

This unit provides experience of building a range of simple electronic circuits, by non-permanent and permanent methods. Through this experience of assembling circuits, candidates learn to recognise and gain knowledge of the function of a range of electronic components. At Intermediate 2, candidates will work initially from given layout diagrams, and progress to designing their own circuits. Completed circuits will undergo checking procedures for fault finding and, if necessary, rectification to ensure operation to specifications. The culmination of this unit is the construction of a full electronic system from a given circuit diagram and specifications.

AREA OF STUDY	CONTENT
Layout diagrams	Creating layout diagrams from written specifications
Reading and interpreting layout diagrams	Eight different types of component to be included
Selection and insertion of common components	Sensors, transistors, amplifiers, logic gates, capacitors, protection and regulation devices and output devices
Using various construction techniques	Solderless prototype board (non permanent); soldering, ie stripboard (permanent); printed circuit board (PCB)
Inspection and testing	Multi-meter, logic probe, oscilloscope

## National Course Specification: Course details (cont)

### COURSE                      Engineering Craft Skills (Intermediate 2)

#### Course organisation

While the Course is integrative in nature, some sequential teaching will be required. This will apply mainly in the case of the metalworking path, where ideally the units would be approached in the following order:

- 1      Bench Skills – Metal (Int 2)
- 2      Machine Processes – Metal (Int 2)
- 3      Fabrication and Thermal Joining Techniques (Int 2)

However, for class organisation purposes, it is possible to deal with the general topics of reading drawings and marking-out before allowing candidates to be directed into two or three different activities. This type of approach should enable candidates to have adequate access to machines and equipment.

For the unit Practical Electronics (Int 2), the stage at which it is introduced is not critical, but it should be introduced to a group rather than to individuals.

#### ASSESSMENT

When the units are taken as component parts of a Course, candidates will have the opportunity to achieve at levels beyond those required to attain each of the unit outcomes. This attainment may, where appropriate, be recorded and used to contribute towards Course estimates and to provide evidence for appeals. Further information on the key principles of assessment is provided in the paper *Assessment*, published in May 1996.

As this Course is predominantly practical in nature, the majority of the features contained within the additional 40 hours must also be practical. Hence the Course assessment is based entirely on a practical project. It is anticipated that this project will require between 20 and 30 hours and be tackled near the end of the Course.

The project allows integration of the knowledge, understanding and skills gained in the units of the Course. It is proposed that candidates will be able to select projects from a range approved by their teacher/lecturer. This range should be graded according to degree of difficulty so that each candidate tackles work at an appropriate level, ie to suit his/her performance in the units.

The project will be manufactured to a given working drawing. The role for the Course project should be introduced at an early stage to allow candidates to develop and integrate their Course experiences towards their final assessment.

Candidates will not be assessed on the ability to design a product, although designing should be encouraged and developed as part of effective learning and teaching and motivation.

The integrative nature of the final project has several advantages. Depth of understanding can be consolidated and there are opportunities for additional, integrated or applied learning. The additional time allowed for project work encourages more complex artefacts to be manufactured, and hence provides an opportunity to achieve good-quality work and a useful product. In addition, the project is based on some earlier experience, so candidates will be able to approach their work with confidence.

## National Course Specification: Course details (cont)

**COURSE**                      Engineering Craft Skills (Intermediate 2)

### DETAILS OF THE INSTRUMENTS FOR EXTERNAL ASSESSMENT

External assessment will be based on the outcome of the project. An overall grade (A, B or C) will be determined by assessment of each candidate's performance in manufacturing an artefact. This assessment will be subject to external moderation. To gain the Course award, the candidate must pass all three unit assessments, as well as the project assessment.

There are four aspects to be considered in determining the grade of award at Intermediate 2:

- 1     The range of working practices demonstrated.
- 2     The level of difficulty of the project undertaken.
- 3     The overall quality of the finished artefact.
- 4     The degree of independence and the amount of practical assistance required.

#### ***1     The range of working practices demonstrated***

The range of working practices will extend from covering a limited number of processes to covering the majority of processes and skills from the units. These notional levels are explained within the assessment criteria. In general Intermediate 2 candidates will cover approximately 80% of the skills and processes from the units and Intermediate 1 candidates, approximately 60%.

#### ***2     The level of difficulty of the project undertaken***

Normally a project will have options which cover various levels of difficulty. These will reflect the range of difficulties demonstrated in the units and the limits for accurate working at Intermediate 1 and 2. Candidates will attempt to reproduce and extend the skills previously produced within the units. There will be clear differences between the manufacturing options that can be attempted in the manufacture of the Course project. There will be definitive projects for Intermediate 1 and Intermediate 2.

#### ***3     The overall quality of the finished artefact***

The levels of skill and accuracy will be linked to individual projects but will be based on:

- quality of manufacture
- quality of finish
- functionality of the artefact

#### ***4     The degree of independence and the amount of practical assistance required***

This will be summarised and reported on a checklist. It is anticipated that most candidates will require some guidance to proceed with the project. This will include executing the manufacture, managing materials, tools and equipment and safe working practices.

Suitable limits for accurate working have been stated in the Unit Specifications. These provide the notional levels for assessment of accuracy in the Course project. In Course projects that are substantially larger than unit artefacts, manufacturing tolerances can be adjusted accordingly.

## **National Course Specification: Course details (cont)**

**COURSE**            Engineering Craft Skills (Intermediate 2)

### **GRADE DESCRIPTIONS**

#### ***Grade C***

For performance at Grade C, the candidate, with occasional guidance and showing due regard for safety procedures and practices, has produced work which demonstrates attainment of an acceptable standard of craftsmanship.

In this work there is evidence of:

- good skill levels in the use of hand tools, machine tools and workshop equipment
- many tolerances in fitting, sheet-metal work and hot forming are in line with those demanded by the component units at Intermediate 2
- a fairly good level of neatness and consistency in the finish
- occasional support in completing the project

#### ***Grade B***

For performance at Grade B, the candidate, with little guidance and showing due regard for safety procedures and practices, has produced work which demonstrates attainment of a reasonable standard of craftsmanship.

In this work there is evidence of:

- good skill levels in the use of hand tools, machine tools and workshop equipment
- the majority of tolerances in fitting, sheet-metal work and hot forming in line with those demanded by the component units at Intermediate 2
- a good level of neatness and consistency in the finish
- little support in completing the project

#### ***Grade A***

For performance at Grade A, the candidate, with minimal or no support in organisation and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.

In this work there is evidence of:

- high skill levels in the use of hand tools, machine tools and workshop equipment
- tolerances in fitting, sheet-metal work and hot forming being substantially in line with those demanded by the component units at Intermediate 2
- a high level of neatness and consistency in the finish
- minimal or no support in completing the project

## National Course Specification: Course details (cont)

**COURSE**                    Engineering Craft Skills (Intermediate 2)

### APPROACHES TO LEARNING AND TEACHING

Where appropriate, arrangements should be made to ensure that there will be no artificial barriers to learning and assessment. The nature of a candidate's special needs should be taken into account when planning learning experiences and selecting assessment instruments. Alternative arrangements can be made as necessary.

#### Induction

The Course will commence with some time from the additional 40 hours being spent on setting the scene for the Course, including:

- an industrial visit to see engineering in action
- a tour of the centre's workshop facilities and equipment
- matters of general safety and expectations of acceptable conduct and attitudes in a workshop environment
- the structure of the Course
- how the Course relates to previous experiences
- an outline of the Course content and the units
- the role of the optional units
- the assessment requirements for the Course
- advice for candidates on how to access knowledge for themselves
- progression available beyond successful completion

Appropriate videos to introduce engineering processes and safety aspects might be useful at this stage.

*Bench Skills – Metal (Int 2)* should be regarded as the first unit of the Course. The unit includes developing experience of reading and interpreting drawings and diagrams, marking-out, and manufacturing two artefacts – one requiring sheet-metal skills and one requiring fitting skills.

It would be advisable to complete the sheet-metalwork artefact first, thus establishing some of the skills, knowledge, discipline, and housekeeping procedures associated with the workshop facility. The second artefact should be used to reinforce and further develop these skills. This second artefact should also provide scope for introducing some of the activities from the other units of the Course, such as the use of the pillar drill or perhaps hot-bending.

After establishing the necessary skills and information to ensure that safe working practices are adhered to, the class group may be organised into smaller working groups to tackle the remainder of the Course and to make best use of access to machines and equipment.

Each new operation, process or stage will need to be demonstrated or discussed, possibly with reference to video material, on a need-to-know basis. This should enable candidates to proceed with some confidence and safety. Teaching inputs should be kept as brief as possible to allow the main activity of 'hands-on' practical work. Likewise, assessment should be kept as brief as possible, mainly by noting successful achievement on checklists.

## **National Course Specification: Course details (cont)**

### **COURSE**                    Engineering Craft Skills (Intermediate 2)

The learning and teaching involved in each unit is a means to an end, and leads to the manufacture of one or more artefacts. Candidates need to be made aware that their performance throughout the Course will determine the level of difficulty of their prescribed project and hence influence their final grade. They should be encouraged to aim high in this respect. Within the Course, from the additional 40 hours, there is time and opportunity for additional learning and practice of skills to try to achieve enhanced grades.

Candidates should be thinking at an early stage about the demands that the project will make and relating their Course experiences to what will be expected in the project.

### **SPECIAL NEEDS**

This Course specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

### **SUBJECT GUIDES**

A Subject Guide to accompany the Arrangements documents has been produced by the Higher Still Development Unit (HSDU) in partnership with the Scottish Consultative Council on the Curriculum (SCCC) and Scottish Further Education Unit (SFEU). The Guide provides further advice and information about:

- support materials for each Course
- learning and teaching approaches in addition to the information provided in the Arrangements document
- assessment
- ensuring appropriate access for candidates with special educational needs

The Subject Guide is intended to support the information contained in the Arrangements document. The SQA Arrangements documents contain the standards against which candidates are assessed.

## National Unit Specification: general information

<b>UNIT</b>	Bench Skills – Metal (Intermediate 2)
<b>NUMBER</b>	D178 11
<b>COURSE</b>	Engineering Craft Skills (Intermediate 2)

### SUMMARY

This unit aims at developing the candidates' abilities in reading working drawings and producing products using metalworking tools.

### OUTCOMES

- 1 Use marking-out tools and equipment to mark out components.
- 2 Demonstrate knowledge of common bench tools and equipment.
- 3 Use a range of metal-working hand tools and equipment.
- 4 Manufacture artefacts from working drawings.

### RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained some previous experience of Craft Skills. This may be evidenced by:

- Standard Grade Craft and Design
- Engineering Craft Skills at Intermediate 1 level

### CREDIT VALUE

1 credit at Intermediate 2.

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### Administrative Information

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## **National Unit Specification: general information (cont)**

**UNIT**      Bench Skills – Metal (Intermediate 2)

### **CORE SKILLS**

Information on the automatic certification of any core skills in this unit is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

## **National Unit Specification: statement of standards**

### **UNIT        Bench Skills – Metal (Intermediate 2)**

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

#### **OUTCOME 1**

Use marking-out tools and equipment to mark out components.

##### **Performance criteria**

- (a) Datums are located correctly.
- (b) Workpiece is marked out correctly.
- (c) Functional dimensions are marked out correctly within prescribed limits of accuracy.

##### **Note on range for the outcome**

Equipment: scribe, rule, combination set, square, dividers, oddleg callipers, centre punch.

##### **Evidence requirements**

Performance and observed evidence that the candidate can use tools and equipment to mark out workpieces to meet the performance criteria. Evidence should show a minimum of five functional sizes, with tolerances of  $\pm 0.5$  mm on three linear sizes.

#### **OUTCOME 2**

Demonstrate knowledge of common bench tools and equipment.

##### **Performance criterion**

- (a) Identification of common bench tools and equipment is correct.

##### **Evidence requirements**

Written and/or oral evidence to demonstrate that the candidate can correctly identify at least 17 items from a selection of bench tools and equipment.

#### **OUTCOME 3**

Use a range of metal-working hand tools and equipment.

##### **Performance criteria**

- (a) Common bench tools and equipment are selected correctly.
- (b) Hand tools and equipment are used correctly.

##### **Evidence requirements**

Performance evidence that the candidate can select and use six fitting tools, three sheet-metal tools and three measuring tools.

## **National Unit Specification: statement of standards (cont)**

**UNIT**      Bench Skills – Metal (Intermediate 2)

### **OUTCOME 4**

Manufacture artefacts from working drawings.

#### **Performance criteria**

- (a) Artefacts are produced in accordance with given working drawings.
- (b) Functional dimensions are within prescribed limits.
- (c) The quality of the finish complies with stated standards.
- (d) All safety practices and procedures are observed correctly in the use of tools and in the manufacture of the artefacts.

#### **Note on range for the outcome**

Artefacts: one artefact from sheet-metal, one artefact using fitting skills.

#### **Evidence requirements**

Performance evidence that the candidate can manufacture an artefact to meet the PCs (a), (b) and (c).  
Observed adherence to safe working practices for PC (d).

The artefact should show evidence of three functional sizes within tolerances of  $\pm 0.5$  mm for two linear dimensions in fitting work, and  $\pm 1$  mm for sheet-metal work and  $\pm 2$  mm for bending.

## **National Unit Specification: support notes**

### **UNIT          Bench Skills – Metal (Intermediate 2)**

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

This unit develops knowledge and skills in reading and interpreting working drawings, hand-fitting skills and some basic sheet-metalworking.

Candidates attempting this unit will mainly be in post-16 education, although it may also be undertaken by some adult returners and perhaps some candidates in the 14 to 16 curriculum.

Candidates require little prior experience but will be expected to produce good practical work. The artefacts produced should have a personal appeal to the client group, but must provide challenge and stimulation.

Apart from developing basic engineering hand skills, this unit should emphasise the need for safe working practices and a disciplined approach to achieving quality work. As part of a Course in the post-16 curriculum, the candidates should be required to act and perform as adults and, accordingly, the tasks set should be challenging to the candidates at the level at which they are working. As the Course develops, the candidates will be required to operate machinery and equipment to a code of practice, with a degree of independence, and it is essential that ground rules for acceptable standards are set and applied throughout this unit.

### **GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT**

Content:

- engineering drawings: orthographic, pictorial, assembly drawings
- drawings should include features such as diameters, machining symbols, linear dimensions, tolerances, fold lines, threads, datums, chamfers and countersinks, sequence diagrams
- graphic representations: tolerances, machining symbols
- common bench tools: fitting tools, sheet-metal tools, measuring tools
- fitting tools to include hammers, chisels, files, saws, taps and dies, and riveting set
- sheet-metal tools to include folding bars, mallets, hammers, tin snips, pop riveter, spot welder
- measuring tools to include rule, square and calipers, vernier calipers (non-digital)

This unit is practical in nature and requires the candidate to develop skills in:

- reading and interpreting workshop drawings
- using marking-out tools to mark out one sheet-metal and one fitting artefact
- using a range of tools to manufacture one sheet-metal artefact and one fitting-type artefact
- adhering to safe working practices at all times

## **National Unit Specification: support notes (cont)**

### **UNIT          Bench Skills – Metal (Intermediate 2)**

#### **GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT**

##### ***Reading and interpreting workshop drawings***

Candidates should have practice at reading and interpreting drawings containing the required range of features. It would assist candidates at this level if orthographic and pictorial views were provided together. Candidates should be aware of the importance of data and references for BS PP7308 should be provided for candidates to use as required. Candidates should be introduced to more sophisticated symbols, such as machining and tolerance symbols, and should be shown how to access information on them for future reference.

##### ***Using marking-out tools***

The marking-out of a model sports-pitch could serve to introduce datums in a familiar context. On metal the datums would first be established by filing two adjacent edges straight and at 90°, and using basic marking-off equipment – rule, square, oddlegs, scriber, centre punch, and dividers – to achieve the required accuracy.

##### ***Using a range of tools to manufacture one sheet-metal artefact and one fitting-type artefact***

Depending on the experience of the candidates some practice work will normally be carried-out. This may take the form of a cardboard mock-up or the manufacture of an introductory artefact. This will help the candidates appreciate the finer points and problems involved in manufacturing in sheet-metal. By doing this, candidates should develop the necessary personal experience to manufacture the unit artefact.

At this stage it will be necessary to amply cover all stages by demonstration and constantly supervise activities. Safety in general, and that specific to the unit, must be stressed and firmly enforced.

Emphasis should be given to the desire for accuracy and quality rather than speed in manufacturing the fitting item.

The type of artefact produced might require the candidates to use equipment and processes from other units in the Course, and should be sufficiently complex to stretch the more able candidates in preparation for the final assessment project.

Drilling, although generally a machine process, would most likely be covered at this time. Accuracy would be determined by rule, in conjunction with vernier callipers if necessary, but there is no reason why devices such as micrometers cannot be used at this time. Assembly/joining methods should be covered, as should finishing with no major flaws, although there is scope here for additional support.

##### ***Adhering to safe working practices at all times***

Safe working practices will be demonstrated and highlighted by the teacher/lecturer throughout the Course, but the opportunity should be taken here to ensure that the candidates are aware that their approach to this topic is being monitored and will continue to be monitored throughout the Course.

Care of tools and recognition of the dangers of tool defects with regard to quality of work and possible hazard will be a recurrent theme in the Course, and the topic should be broached in this unit.

## **National Unit Specification: support notes (cont)**

### **UNIT**      Bench Skills – Metal (Intermediate 2)

#### **GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT**

Whenever possible, the dynamic nature of this Course should not be hindered by overburdening assessment of the candidate.

The candidate should be aware that certain performances are being monitored constantly and recorded on an observation checklist, and that finished artefacts will be tested against the stated criteria for accuracy and quality. Lengthy written tests are not required for tool, process or equipment recognition and use. Short-answer tests that are mainly of a visual nature will be provided. Another technique would be to display the tools and equipment, and ask the candidates to write or state their names and uses.

#### ***Approaches to generating evidence***

Assessment evidence for this unit should be able to be drawn from the manufacture of two artefacts – one sheet-metal and one fitting artefact. In situations where candidates fail to achieve the required standard of performance in one area, this weakness can be targeted in the next part of the Course when the next artefact is manufactured.

In situations where candidates fail to achieve the required standard of performance in more than one area, it may be necessary to provide tasks aimed specifically at the areas to be reassessed.

Some candidates may require additional support and help to ensure success in the manufacturing process, but candidates must also be aware that the overall Course assessment takes into account the amount of practical assistance given by the teacher/lecturer, and that ultimately a degree of independence is expected from the candidate.

#### **SPECIAL NEEDS**

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

## National Unit Specification: general information

<b>UNIT</b>	Machine Processes – Metal (Intermediate 2)
<b>NUMBER</b>	D179 11
<b>COURSE</b>	Engineering Craft Skills (Intermediate 2)

### SUMMARY

Candidates will learn how to operate a range of machine tools and manufacture an artefact involving their use.

### OUTCOMES

- 1 Use marking-out tools and equipment.
- 2 Demonstrate knowledge of common machine tools and equipment.
- 3 Perform a range of operations on a pedestal drill and a centre lathe.
- 4 Manufacture an artefact from a working drawing.

### RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have had some previous experience of practical skills, including reading engineering drawings. This may be evidenced by one of the following:

- Standard Grade Craft and Design
- Engineering Craft Skills at Intermediate 1

### CREDIT VALUE

1 credit at Intermediate 2.

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### Administrative Information

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## **National Unit Specification: general information (cont)**

**UNIT**      Machine Processes – Metal (Intermediate 2)

### **CORE SKILLS**

Information on the automatic certification of any core skills in this unit is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

## **National Unit Specification: statement of standards**

### **UNIT          Machine Processes – Metal (Intermediate 2)**

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

#### **OUTCOME 1**

Use marking-out tools and equipment.

##### **Performance criteria**

- (a) The construction of datums is correct.
- (b) The workpiece is marked out correctly in accordance with the given working drawing.
- (c) Three functional dimensions are within the permitted limits.

##### **Evidence requirements**

Performance evidence that the candidate can mark out a workpiece to meet the performance criteria, on three functional sizes, with tolerances of  $\pm 0.5$  mm on three linear sizes.

#### **OUTCOME 2**

Demonstrate knowledge of common machine tools and equipment.

##### **Performance criteria**

- (a) Identification of common machine tools and their related equipment is correct.
- (b) Machines and equipment are correctly matched to applications.

##### **Note on range for the outcome**

Machine tools: centre lathe, milling machine, grinder, pedestal drill.

##### **Evidence requirements**

Written and/or oral evidence that the candidate can score a minimum of 16/20 in identifying types of machine equipment and processes associated with them.

#### **OUTCOME 3**

Perform a range of operations on a pedestal drill and a centre lathe.

##### **Performance criteria**

- (a) Drilling and countersinking on the pedestal drill meets specified requirements.
- (b) The centre lathe operations of parallel and taper turning, facing, chamfering and parting-off are performed to specified standards.

##### **Evidence requirements**

Performance evidence that the machines have been operated to meet the requirements of the performance criteria.

## **National Unit Specification: statement of standards (cont)**

**UNIT**        Machine Processes – Metal (Intermediate 2)

### **OUTCOME 4**

Manufacture an artefact from a working drawing.

#### **Performance criteria**

- (a) The artefact produced is in accordance with the working drawing.
- (b) Appropriate machines and equipment are used correctly.
- (c) The accuracy achieved is within specified tolerances.
- (d) The quality of the machined finish complies with stated standards.
- (e) All safety practices and procedures are observed correctly in the use of machine tools and in the manufacture of an artefact.

#### **Evidence requirements**

Performance evidence that the candidate can manufacture an artefact to meet the performance criteria. For PC (c) the required accuracy should be achieved on at least three functional sizes, to tolerances of  $\pm 0.2$  mm on diameter and  $\pm 0.5$  mm on linear. Compliance with safe practices and procedures should be recorded from observation.

## National Unit Specification: support notes

### UNIT Machine Processes – Metal (Intermediate 2)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

This unit develops knowledge and skills in metalworking machines, equipment and their uses.

Candidates attempting this unit will mainly be in post-16 education, although it may also be undertaken by some adult returners and perhaps some candidates in the 14 to 16 curriculum.

Candidates require little prior experience, but will be expected to produce good practical work. Artefacts produced should have a personal appeal to the client group, but must provide challenge and stimulation.

Apart from developing basic machining skills, this unit should emphasise the need for safe working practices and a disciplined approach to achieving quality work. As part of a Course in the post-16 curriculum, the candidates should be required to act and perform as adults and, accordingly, the tasks set should be challenging to the candidates at the level at which they are working. The candidates will be required to operate machinery and equipment to a code of practice with a degree of independence, and it is essential that a mature and responsible approach is taken by the candidate.

Artefacts will be produced to working drawings and should where possible involve integration of previous experience, for example *Bench Skills – Metal (Int 2)*.

Prior knowledge of reading drawings is assumed.

### GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

Content:

- marking off tolerances of  $\pm 0.5$  mm on functional dimensions
- machine tools: knowledge of centre lathe, milling machine, bench grinder, pedestal drill
- equipment: knowledge of cutting, parting, and boring tools, diamond and straight knurling tools, three and four jaw chucks, chuck keys, morse tapers, morse taper sleeves, revolving centres, machine vices, safety equipment
- applications: knowledge of slotting, parallel turning, facing, chamfering, taper turning using the compound slide, drilling, boring, countersinking, surface levelling, centre drilling, grinding

This unit tries to balance practical activity with knowledge and understanding that can be transferred to more complex machinery in industrial situations at a later date. The context should relate to industrial applications whenever possible.

Through these practical activities the candidate should develop respect for codes of practice and develop a healthy attitude to safety regulations.

## **National Unit Specification: support notes (cont)**

### **UNIT            Machine Processes – Metal (Intermediate 2)**

#### **GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT**

This unit seeks to broaden the candidates' knowledge of workshop machinery available in an industrial situation. An industrial visit is an essential part of this Course. The candidates should be offered the opportunity to see CNC machine tools, such as capstan lathes and vertical milling machines, in action. Industrial standards for surface finish should also be a feature of the visit and opportunities should be taken to view machine tools such as surface grinders in action. If access cannot be gained to an appropriate industrial centre, then videos should be used to emphasise the use of these machines, although it must be stated that there can be no substitute for the real-life experience.

#### ***Using special marking-out techniques***

The need for special marking-out techniques for certain precision work and irregular components should be discussed. Marking-out of larger products, and repetitive marking-out should also be discussed.

#### ***Demonstrating knowledge of common machine tools and equipment***

Candidates should be made aware of different metal-cutting situations and should match these to particular machines. If milling and shaping machines are not available in the centre, these should be covered by an industrial visit, by visiting another centre or by video.

#### ***Performing routine user checks on tools and machinery prior to their use***

The candidate should be responsible for ensuring that the machinery to be used is set up appropriately, with all safety equipment in place prior to use. Similarly, the inspection of hand tools and reporting of defects should become a routine event in this Course.

#### ***Operating common machine tools in accordance with safe working practice***

The candidate should use as many machines and items of equipment as possible (a minimum of two), and artefacts that are produced to given working drawings should embody as wide a range as possible.

If a milling machine is not available to the candidates for actual use, then drilling-machine operations should involve at least one activity whereby the machine vice is clamped to the table. This will ensure that the candidates have practical experience of work holding of this type.

Morse tapers should be used to hold larger drills, rather than the 'Jacobs' chuck.

Turning operations should include: plain parallel turning, facing, taper turning using a compound slide, centre drilling and drilling, and knurling, although this range might well be extended, according to needs, to include boring and parting off. Machined finishes should be without significant defects, and probably best gauged against exemplar pieces, visually and by thumbnail check.

#### ***Adhering to safe working practices at all times***

Safe working practices will be demonstrated and highlighted by the teacher/lecturer throughout the Course, but the opportunity should be taken here to ensure that the candidates are aware that their approach to this topic is being monitored and will continue to be monitored throughout the Course.

## **National Unit Specification: support notes (cont)**

### **UNIT            Machine Processes – Metal (Intermediate 2)**

Care of tools and recognition of the hazards of tool defects with regard to quality of work and possible hazard to the user will be a recurrent theme in the Course, and the topic should be further reinforced in this unit.

#### **GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT**

Whenever possible, the dynamic nature of this Course should not be hindered by overburdening assessment of the candidate.

The candidate should be aware that certain performances are being monitored constantly and recorded on an observation checklist, and that finished artefacts will be tested against the stated criteria for accuracy and quality. Lengthy written tests are not required for tool, process or equipment recognition and use. Short-answer tests that are mainly of a visual nature will be provided. Another technique would be to display the tools and equipment, and ask the candidates to write or state their names and uses.

#### ***Approaches to generating evidence***

Assessment evidence for this unit should be able to be drawn from the manufacture of one or two artefacts that perhaps also include reinforcement and additional evidence for other units in the Course. Examples of this might be additional practice and evidence in reading drawings, measuring, and marking-out and fitting skills. A manufacturing plan could also be produced as a matter of good practice, but would not be required for assessment purposes in this unit. In situations where candidates fail to achieve the required standard of performance in one area, this weakness can be targeted in the next part of the Course, when the next artefact is manufactured, or perhaps in the Course assessment project itself.

In situations where candidates fail to achieve the required standard of performance in more than one area, it may be necessary to provide tasks aimed specifically at the areas to be reassessed.

Some candidates may require additional support and help to ensure success in the manufacturing process, but candidates must also be aware that the overall Course assessment takes into account the amount of practical assistance given by the teacher/lecturer, and that ultimately a degree of independence is expected from the candidate.

#### **SPECIAL NEEDS**

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

## National Unit Specification: general information

<b>UNIT</b>	Fabrication and Thermal Joining Techniques (Intermediate 2)
<b>NUMBER</b>	D180 11
<b>COURSE</b>	Engineering Craft Skills (Intermediate 2)

### SUMMARY

This unit provides knowledge and skills in basic metal hot-forging, thermal joining and fabrication processes.

### OUTCOMES

- 1 Apply hot-forging techniques to form and bend steel.
- 2 Apply thermal joining techniques.
- 3 Manufacture an artefact incorporating fabrication and thermal joining techniques from working drawings.
- 4 Use a range of fabrication and thermal joining tools and equipment

### RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have previous experience of reading drawings and practical work. This may be evidenced by one of the following:

- Standard Grade Craft and Design
- Engineering Craft Skills at Intermediate 1 level

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### Administrative Information

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## **National Unit Specification: general information (cont)**

**UNIT**        Fabrication and Thermal Joining Techniques (Intermediate 2)

### **CREDIT VALUE**

1 credit at Intermediate 2.

### **CORE SKILLS**

Information on the automatic certification of any core skills in this unit is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

## **National Unit Specification: statement of standards**

### **UNIT          Fabrication and Thermal Joining Techniques (Intermediate 2)**

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

#### **OUTCOME 1**

Apply hot-forging techniques to form and bend steel.

##### **Performance criteria**

- (a) Hot-forging techniques of forming and bending are demonstrated correctly.
- (b) Hardening and tempering is carried out successfully on carbon steel.

##### **Evidence requirements**

Performance evidence that the candidate can apply forging techniques to meet the performance criteria using both bending and forming techniques, and hardening and tempering.

#### **OUTCOME 2**

Apply thermal joining techniques.

##### **Performance criteria**

- (a) A weld deposit or a braze that is consistent in its width and form is produced.
- (b) Spot-welding equipment is operated successfully.

##### **Evidence requirements**

Performance evidence that the candidate can produce a weld deposit or a braze that is consistent in width and form over a minimum length of 50 mm. Spot welding equipment should be operated successfully to produce effective and well-formed joints.

#### **OUTCOME 3**

Manufacture an artefact incorporating fabrication and thermal joining techniques from working drawings.

##### **Performance criteria**

- (a) An artefact is produced in accordance with the working drawings.
- (b) The quality of thermal joining and fabrication meets specified standards.
- (c) Functional dimensions are within specified limits.

##### **Evidence requirements**

Performance evidence that the candidate can manufacture one artefact made from several components.

## **National Unit Specification: statement of standards (cont)**

### **UNIT**      Fabrication and Thermal Joining Techniques (Intermediate 2)

#### **OUTCOME 4**

Use a range of fabrication and thermal joining tools and equipment.

##### **Performance criteria**

- (a) Hot-forging tools and equipment are used correctly.
- (b) Thermal joining equipment is used correctly.
- (c) All safety practices and procedures are observed correctly in the use of tools and equipment.

##### **Evidence requirements**

Performance evidence that the candidate is competent in the correct use of thermal joining and hot-forming equipment, with due regard to personal and colleagues' safety in line with safe working practices.

## **National Unit Specification: support notes**

### **UNIT          Fabrication and Thermal Joining Techniques (Intermediate 2)**

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

This unit extends the range of metal craft skills to fabrication work and associated processes, including thermal joining and forging. It would normally be taken only by candidates who have had experience of previous units and who wish to extend their metalworking experience into more specialised areas.

Experience of reading drawings and basic marking-out is assumed.

### **GUIDANCE ON CONTENT AND CONTEXT FOR THE UNIT**

Content:

- forming techniques: twisting, drawing down, flattening
- bending techniques: metal-bar bending, metal-strip bending (including on edge)
- heat-treatment methods: annealing, hardening, tempering
- allowances when marking out: expansion, bending, stretching, trimming
- thermal joining techniques: tack welding and brazes, short runs over a minimum of 50 mm; spot welding
- specified limits: accuracy depends on the process as described below:  
Marking-out:  $\pm 0.5$  mm  
Forged limits:  $\pm 5$  mm

This unit is practical in nature and requires the candidate to develop skills in:

- using hot-forging techniques to form shapes and components as an alternative to material removal
- knowing, understanding and applying simple thermal joining techniques to join materials
- marking-out, with appropriate allowances for fabrication and thermal joining techniques to be used
- using fabrication and thermal joining techniques to manufacture an artefact
- adhering to safe working practices at all times (with particular reference to thermal joining techniques, a clear understanding of the need for eye protection). Ventilation, protective clothing, circuit polarity and work holding will be required

## **National Unit Specification: support notes (cont)**

### **UNIT          Fabrication and Thermal Joining Techniques (Intermediate 2)**

#### **GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT**

##### ***Using hot-forging techniques to form shapes and components as an alternative to material removal***

Forging is related to fabrication. It might best be introduced by a video showing the terminology, equipment and applications in an industrial context. Advantages in creating shapes by hot-forging rather than removing material should be discussed and applications provided. Candidates should have practical experience of basic hot-forging shaping processes, such as hot-bending of the strip on the flat surface or on edge, drawing down and twisting. The forging process would naturally lead on to the observation of effects of heat on carbon steels, and this might be best studied through the manufacture of a cold chisel or screwdriver, the latter having the advantage of providing scope for several integrative skills across the Course.

##### ***Knowing, understanding and applying simple thermal joining techniques to join materials***

This aspect of the unit would be best undertaken in isolation from other practical activities in the Course, as a learning process, and then applied in a larger context.

The joining of components by manual metal arc (MMA), metal inert gas (MIG) or tungsten inert gas (TIG) and by resistance (spot) welding are prescribed to allow an insight into a permanent method common in steel fabrication work, and to give some practice in using one of the techniques. Other thermal processes for joining other metals, for example brazing and soldering, could also be covered if required.

##### ***Using fabrication and thermal joining techniques to manufacture an artefact***

One or two artefacts could be produced to incorporate most of the skills required for this unit, which could also provide the opportunity to revisit skills from other areas of the Course if required.

A screwdriver would feature forging, heat treatment and several integrative skill experiences. Similarly, decorative ironwork would apply unit content and provide scope for integrative experiences.

##### ***Adhering to safe working practices at all times***

Thermal joining and forging have their own safety practices and procedures, including safety-wear, ventilation, equipment checks and work holding. These should be fully covered and firmly enforced.

## **National Unit Specification: support notes (cont)**

### **UNIT            Fabrication and Thermal Joining Techniques (Intermediate 2)**

#### **GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT**

Whenever possible, the dynamic nature of this Course should not be hindered by overburdening assessment of the candidate.

The candidate should be aware that certain performances are being monitored constantly and recorded on an observation checklist, and that finished artefacts will be tested against the stated criteria for accuracy and quality. Lengthy written tests are not required for tool, process or equipment recognition and use. Short-answer tests that are mainly of a visual nature will be provided. Another technique would be to display the tools and equipment, and ask the candidates to write or state their names and uses.

#### ***Approaches to generating evidence***

Examples of artefacts that could be produced only for this unit might be a curved boot-scraper with welded legs, to stand outside a front door. An example of an integrative artefact dealing with areas from elsewhere in the Course might be a horseshoe door-knocker. The actual knocker could be a forged horseshoe shape fixed to shaped lugs, which in turn would be thermally joined on to a shaped back-plate. The back-plate would require countersunk screw holes. The knocker could be attached to the back-plate with a turned and threaded pivot arrangement and perhaps a turned handle to be fixed to the face of the knocker. The scale of work in this unit will vary according to the needs of the candidate and, if time permits, larger, more repetitive projects may be undertaken.

This approach could serve any or all of the following three purposes:

- as a rehearsal for the Course assessment project, during which the candidate is expected to work independently, with the minimum of assistance
- as a means of re-testing certain performances from other areas of the Course
- as a means of employing a holistic approach to assessment, whereby much of the evidence for the other two units of the Course could be found in the artefact as it is described

#### **SPECIAL NEEDS**

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

## National Unit Specification: general information

<b>UNIT</b>	Practical Electronics (Intermediate 2)
<b>NUMBER</b>	D181 11
<b>COURSE</b>	Engineering Craft Skills (Intermediate 2)

### SUMMARY

The purpose of this unit is to recognise electronic components, and how they are assembled into electronic circuits. Electronic construction in this context would be aimed at integrating with an engineering construction to provide a working electronics device.

### OUTCOMES

- 1 Construct an electronic circuit using a prototype circuit board.
- 2 Plan and construct an electronic circuit using stripboard.
- 3 Plan and construct an electronic system using a Printed Circuit Board (PCB) from a given specification and using individual components.

### RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have had some experience in reading and interpreting working drawings, as well as some experience in using hand tools. This may be evidenced by one of the following:

- Standard Grade Craft and Design
- Engineering Craft Skills at Intermediate 1 level

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### Administrative Information

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## **National Unit Specification: general information (cont)**

**UNIT**      Practical Electronics (Intermediate 2)

### **CREDIT VALUE**

1 credit at Intermediate 2.

### **CORE SKILLS**

Information on the automatic certification of any core skills in this unit is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

## **National Unit Specification: statement of standards**

### **UNIT      Practical Electronics (Intermediate 2)**

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

#### **OUTCOME 1**

Construct an electronic circuit using a prototype circuit board.

##### **Performance criteria**

- (a) The components are selected correctly from stock.
- (b) The circuit is constructed correctly to given layout diagram.
- (c) The circuit diagram is interpreted correctly.
- (d) Pre-power-up checks are carried out.
- (e) The circuit is verified to operate to a given specification.

##### **Evidence requirements**

A practical exercise to demonstrate competence in the interpretation of a diagram, the selection of components and the construction of a working circuit using a prototype circuit board.

#### **OUTCOME 2**

Plan and construct an electronic circuit using stripboard.

##### **Performance criteria**

- (a) A layout diagram is drawn from the circuit diagram.
- (b) The components are selected correctly from stock.
- (c) The components (including connections) are soldered into position neatly and to layout diagram.
- (d) The circuit diagram is interpreted correctly.
- (e) Pre-power-up checks are carried out.
- (f) The circuit is verified to operate to a given specification.

##### **Evidence requirements**

A practical exercise in interpreting a circuit diagram, planning a layout circuit, selecting and soldering components and constructing a working circuit on a stripboard to a given specification.

## **National Unit Specification: statement of standards (cont)**

**UNIT**      Practical Electronics (Intermediate 2)

### **OUTCOME 3**

Plan and construct an electronic system using a Printed Circuit Board (PCB) from a given specification and using individual components.

#### **Performance criteria**

- (a) A layout diagram is drawn from the circuit diagram.
- (b) The system is constructed correctly.
- (c) Pre-power-up checks are carried out.
- (d) The system operates to specification.

#### **Evidence requirements**

A practical exercise in interpreting a circuit diagram, planning a circuit layout, and constructing a working electronic system using a PCB.

## **National Unit Specification: support notes**

### **UNIT          Practical Electronics (Intermediate 2)**

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

The purpose of this unit is to branch out into an associated area of engineering practical work: electronic-circuit construction.

Candidates attempting this unit will be mainly in post-16 education, although it may also be undertaken by some adult returners and perhaps some candidates in the 14 to 16 curriculum.

Candidates require little prior experience, but will be expected to produce good practical work and develop a knowledge of the functions of some electronic components. Artefacts produced should have a personal appeal to the client group, but must provide challenge and stimulation.

Apart from developing basic electronic manufacturing hand skills, this unit should emphasise the need for safe working practices and a disciplined approach to achieving quality work. As part of a Course in the post-16 curriculum, the candidates should be required to act and perform as adults and, accordingly the tasks set should be challenging to the candidates at the level at which they are working. As the Course develops, the candidates will be required to operate machinery and equipment to a code of practice, with a degree of independence, and it is essential that ground rules for acceptable standards are set and applied throughout this unit.

### **GUIDANCE ON CONTENT AND CONTEXT FOR THE UNIT**

Content:

- simple diagrams: electronic circuit diagrams, layouts and connection lists
- common components: sensors, signal-processing devices, protection and regulating devices, and output devices
- construction techniques: solderless prototype board (non-permanent); soldering, on stripboard (permanent); Printed Circuit Board (PCB)
- verification equipment: oscilloscope, multi-meter, logic probe

This unit is practical in nature and requires the candidate to develop skills in:

- reading and interpreting electronic-circuit and layout diagrams, creating a component listing and selecting components from stock
- assembling electronic circuits, while taking into account component pin connections and polarity
- applying pre-power-up checks and fault-finding techniques and taking appropriate remedial action
- from a specification, developing a layout diagram and a component listing
- constructing a fully functioning electronic system and confirming its operation to specification, using test equipment
- adhering to safe working practices at all times

## National Unit Specification: support notes (cont)

### UNIT Practical Electronics (Intermediate 2)

The range of electronic components is extensive but could include:

- Sensors such as moisture, light, temperature; displacement, velocity
- Process devices such as resistors, capacitors, transistors, amplifiers, logic gates, ICs
- Output devices such as loudspeakers, buzzers, relays, motors, LEDs, lamps, LEDs and arrays, seven-segment displays
- Polarity-conscious devices electrolytic capacitors, diodes, transistors, ICs
- Multi-pin devices transistors, field-effect transistors (FETs), ICs, relays, variable resistors, thyristors

### GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

There is a progressive learning process in this unit, and this is best achieved in a concentrated manner and in a different workshop environment from that of the other areas of the Course, preferably a laboratory. The recommended approach is that outcomes would be addressed entirely through the building of circuits. Candidates should start by practising on simple circuits containing only a few components, by a range of methods, before attempting more demanding circuits. Candidates should be directed to consider the circuit as being interfaced with metalwork structures or simple mechanisms, to provide an operational system in the project.

#### *Reading and interpreting circuit diagrams and selecting components*

Candidates should be introduced to colour coding of resistors, and know how to recognise values of other components such as capacitors. Identification of components in the initial stages would be aided greatly by suitable, clearly marked storage systems, for example small drawer units.

#### *Assembling electronic circuits, while taking into account component pin connections and polarity*

Candidates with no experience of electronic circuit construction should initially be provided with layout diagrams having only a few components, and should build circuits from these, starting with prototype boards followed by soldering, on stripboard. In the early stages, candidates could be guided as to which technique would be appropriate for a particular circuit.

#### *Applying pre-power-up checks and fault-finding techniques and taking appropriate remedial action*

An important routine in building circuits is the pre-power-up checking, fault-finding and rectification procedures, before testing for operation to specification.

#### *Constructing a fully functioning electronic system and confirming its operation to specification*

A full electronic 'system' should be constructed from a given circuit diagram or series of diagrams, using a permanent construction technique. More demanding work is envisaged at this time, and this aspect of the Course provides ample opportunity to integrate other areas of the Course. At this level, candidates are expected to develop an understanding of the functions of components and should develop their own layout diagrams and component lists from a clear and unambiguous written specification. The operation of the system should be verified using an oscilloscope, a multi-meter, or a logic probe, as appropriate.

## National Unit Specification: support notes (cont)

### UNIT Practical Electronics (Intermediate 2)

#### *Adhering to safe working practices at all times*

Electronics and soldering have their own safety practices and procedures, including safetywear, ventilation, equipment checks and work holding. These should be fully covered and firmly enforced.

### GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

#### *Approaches to assessment*

Whenever possible, the dynamic nature of this Course should not be hindered by overburdening assessment of the candidate.

The candidate should be aware that certain performances are being monitored constantly and recorded on an observation checklist, and that finished artefacts will be tested against the stated criteria for accuracy and quality. Lengthy written tests are not required for tool, process or equipment recognition and use. Short-answer tests that are mainly of a visual nature will be provided. Another technique would be to display the tools and equipment, and ask the candidates to write or state their names and uses.

#### *Approaches to generating evidence*

Examples of artefacts that could be produced for only this unit might be an alarm system with multiple sensor inputs, combinational logic processing to meet the performance specification and variable output tones, where all aspects of the artefact are electronic. An example of an integrative artefact dealing with areas from elsewhere in the Course might be an electronic system housed in a sheet-metal enclosure manufactured during the *Bench Skills – Metal (Int 2)* unit. Similarly, calibration dials or spindles and bearings could be turned on the lathe during the *Machine Processes – Metal (Int 2)* unit and used in the integrative artefact.

This approach could serve any or all of the following three purposes:

- as a rehearsal for the Course assignment project, during which the candidate is expected to work with a degree of independence
- as a means of re-testing certain performances from other areas of the Course
- as a means of employing a holistic approach to assessment, whereby much of the evidence for the other two units of the Course could be found in the artefact as it is described

### SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).