Higher National Unit specification

General information

Unit title: Physical Computing Fundamentals (SCQF level 7)

Unit code: HF3G 34

Superclass: CB

Publication date: June 2016

Source: Scottish Qualifications Authority

Version: 02

Unit purpose

This Unit is suitable for learners who wish to gain the knowledge and skills necessary to design and implement basic embedded processor systems. The Unit will provide the underpinning theoretical knowledge necessary for an understanding of physical computing and embedded processor systems. The Unit will also look at the use of wiring diagram software and integrated design environments for application development.

The Unit is intended for learners who will be working in the design or implementation of embedded processor systems or for those seeking practical and theoretical knowledge of concepts in physical computing.

This Unit will be useful for learners studying Units that form part of HNC Digital Design and Web Development, HND Digital Design and Development and HND Web Development. This Unit forms a useful preparation for learners going on to study the HN Unit *Physical Computing Practice/Development*.

Outcomes

On successful completion of the Unit the learner will be able to:

1 Describe properties, applications and physical concepts underlying embedded processor systems.
2 Describe components used in the construction of embedded processor systems.
3 Implement and test a basic embedded processor system application.

Credit points and level

1 Higher National Unit credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Higher National Unit specification: General information (cont)

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Recommended entry to the Unit

While entry is at the discretion of the centre, it is recommended that learners should have relevant work experience or studied relevant Computing or Digital Design Units at Intermediate 2 or Higher levels, for example, F3SY 12 *Computer Hardware and Systems*.

Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill	None
Core Skill component	Critical Thinking at SCQF level 5 Planning and Organising at SCQF level 5

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

Higher National Unit specification: Statement of standards

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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 SQA.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Describe properties, applications and physical concepts underlying embedded processor systems.

Knowledge and/or Skills

- Properties and applications of embedded processor systems
- Basic electrical theory: current, voltage, resistance, power, Units of electrical measurement
- Relationships between current, voltage, resistance, power and electrical circuits
- Basic operation of CPU, ROM, RAM
- Parallel and serial input/output, DAC (Digital to Analogue Conversion) and ADC (Analogue to Digital Conversion)

Outcome 2

Describe components used in the construction of embedded processor systems.

Knowledge and/or Skills

- Embedded system hardware platforms
- Power supplies, wires, resistors, breadboards
- Switches
- Sensors, actuators
- Interfaces

Outcome 3

Implement and test a basic embedded processor system application.

Knowledge and/or Skills

- Wiring diagram
- Integrated development environment
- Creation of code
- Connection of physical components
- Testing

Higher National Unit specification: Statement of standards (cont)

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Evidence Requirements for this Unit

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills across all Outcomes.

The evidence for this Unit may be written or oral or a combination of these. Evidence may be captured, stored and presented in a range of media (including audio and video) and formats (analogue and digital). Particular consideration should be given to digital formats and the use of multimedia.

The Evidence Requirements for this Unit will take two forms:

1 Evidence of cognitive competence (Knowledge and Understanding) for Outcomes 1 and 2.
2 Evidence of practical competence (practical abilities) for Outcome 3.

For Outcomes 1 and 2, candidates will be required to describe the following:

- Basic properties of an embedded processor system. Practical uses of embedded processor systems in everyday electronic devices.
- Properties of Current, Voltage, Resistance, Power, and Capacitance. Units used to measure Current, Voltage, Resistance, Power, and Capacitance.
- Relationships between Current, Voltage, Resistance, and Power. Current flow in electrical circuits.
- Function of CPU in a computer system. CPU clock speed. Address, data, and control buses. Function of ROM (Read Only Memory) in a computer system. Function of RAM (Random Access Memory) in a computer system. Flash RAM.
- Parallel and Serial Input/Output. Properties of Analogue signals. Properties of Digital signals. Digital to Analogue Conversion. Analogue to Digital Conversion.
- At least one commonly used embedded system hardware platform.
- Types and properties of power supplies, wires, resistors and breadboards commonly used in embedded processor system applications.
- Types and properties of switches commonly used in embedded processor system applications.
- Types and properties of sensors and actuators commonly used in embedded processor system applications.
- Types and properties of interfaces commonly used in embedded processor system applications.

Sampling is permissible when the evidence for cognitive competence is produced by a test of knowledge and understanding. The test may take any form (including oral) but must be supervised, unseen and timed. The contents of the test must sample broadly and proportionately from the contents of the knowledge domain (see above). Access to reference material is not appropriate for this type of assessment.

Higher National Unit specification: Statement of standards (cont)

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For the practical competence in Outcome 3, candidates will be required to carry out the following activities to implement and test at least one basic embedded processor system application:

- Produce a prototype wiring diagram for an application that has at least one sensor and one actuator component
- Use an IDE (Integrated Development Environment) or programming language to create code to run an embedded processor system application
- List the code created
- connect physical components to build an embedded processor system application
- Produce a completed log detailing work carried out in building the application
- Produce a test plan
- Test an embedded processor system application
- Log the test results

Evidence for practical competence may be produced over an extended period of time under open-book conditions; but where it is generated without supervision some means of authentication must be carried out.

The Guidelines on Approaches to Assessment (see the Support Notes section of this specification) provides specific examples of instruments of assessment.

Higher National Unit Support Notes

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Unit Support Notes are offered as guidance and are not mandatory.

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

Guidance on the content and context for this Unit

This Unit is intended to introduce learners to the field of physical computing and the use of embedded processor systems. These systems are increasingly used in a wide range of electronic devices and interactive systems used in Science, Production and Interactive Art.

While the Unit includes some underlying theory it is intended that the emphasis should be on hands-on use of an embedded processor system. No previous programming experience is required and it is recommended that a suitable IDE (Interactive Development Environment) is used for production of code by learners without prior programming skills. Programming skills will be covered in the more advanced Unit *Physical Computing Practice/Development*.

This Unit will be very useful for learners intending later to do the Unit xxxx 35 *Physical Computing Practice/Development*. It may also be useful for learners studying the Computing, Interactive Media, and Engineering Courses at the HN level.

Guidance on approaches to delivery of this Unit

In Outcome 1 learners should be encouraged to explore the wide range of applications for embedded processor systems.

Learners can be introduced to Ohm's Law and related formulae (V=IR, P=VI), but a detailed grasp of electrical theory and manipulation of formulae is not necessary. Learners should however be aware, eg that current is directly proportional to voltage and inversely proportional to resistance; power is equal to the product of current and voltage.

In Outcome 2 learners should be introduced to a hardware platform, eg Arduino Uno and to a range of components used in the production of applications, eg:

- Power supplies — battery, AC to DC converter
- Switches — Push button, magnetic, tilt, toggle
- Sensors — photocell, touch, temperature, humidity, microphone
- Actuators — LEDs, LCDs, motors, loudspeakers
- Interfaces — USB, digital, analogue

Where possible learners should be introduced to real examples of hardware components and be encouraged to research available alternatives.

Higher National Unit Support Notes (cont)

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There are a wide range of low cost embedded processor systems available which could be used in the delivery of the Unit. At the time of writing a suitable system may be the Arduino Uno. The Arduino website (http://www.arduino.org) contains tutorials and a large amount of example projects. Other suitable systems

For the wiring diagrams in Outcome 3 a suitable open source application at the time of writing may be Fritzing (http://fritzing.org/home/). The Fritzing website contains large amounts of tutorials and examples.

The latest version of the Arduino IDE can be downloaded from http://www.arduino.org/download. This IDE allows you to write scratches (small programs) and upload them to the arduino. For production of code without detailed programming skills a suitable IDE at the time of writing may be S4A — Scratch4Arduino (http://s4a.cat/). The S4A website also contains large amounts of tutorials and examples.

For Outcome 3 where possible learners should be able to select from several alternative application projects, and be encouraged to use their imagination in the creation of their finished applications. It would be advisable to introduce example projects to the students and also to provide guidance in the development of their own ideas.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to candidates.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where candidates experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Outcome 1

Below is a suggested assessment format for this Outcome though the instrument of assessment is at the discretion of the assessor.

Evidence for the knowledge/skills in this Outcome could be demonstrated by means of a 15 question multiple-choice test, with questions drawn equally from the five bullet points below. It is suggested that the assessment should be closed-book and should be completed within 45 minutes. The minimum pass mark is 60%. The assessment could be combined into a single test including Evidence Requirements from Outcome 2.

- Properties and applications of embedded processor systems
- Basic electrical theory: current, voltage, resistance, power, Units of electrical measurement
- Relationships between current, voltage, resistance, power and electrical circuits
- Basic operation of CPU, ROM, RAM
- Parallel and serial input/output, DAC (Digital to Analogue Conversion) and ADC (Analogue to Digital Conversion)

Higher National Unit Support Notes (cont)

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If a candidate requires to be reassessed, a predominantly different selection of questions should be used.

Centres are encouraged to explore opportunities for delivering the multi-choice assessment online.

Outcome 2

Below is a suggested assessment format for this Outcome though the instrument of assessment is at the discretion of the assessor.

Evidence for the knowledge/skills in this Outcome could be demonstrated by means of a 15 question multiple-choice test, with questions drawn equally from the five bullet points below. It is suggested that the assessment should be closed-book and should be completed within 45 minutes. The minimum pass mark is 60%. The assessment could be combined into a single test including Evidence Requirements from Outcome 1.

- Embedded system hardware platforms
- Power supplies, wires, resistors, breadboards
- Switches
- Sensors and actuators
- Interfaces

If a candidate requires to be reassessed, a predominantly different selection of questions should be used.

Centres are encouraged to explore opportunities for delivering the multi-choice assessment online.

Outcome 3

Evidence for the knowledge/skills in this Outcome could be demonstrated by the candidate in the form of a completed log though the instrument of assessment is at the discretion of the assessor. Logs may be based on a pro-forma given to the candidate, but should include a brief outline of the task presented and the following:

- Produce wiring diagram to satisfy requirements for an embedded processor system application - a prototype wiring diagram
- Use an IDE (Integrated Development Environment) or programming language to create code to run an embedded processor system application — listing of code created
- Connect physical components to build an embedded processor system application — a completed log detailing work carried out in building the application
- Test an embedded processor system application — a test plan and log of test results

As an alternative to paper-based methods, candidates could provide a digital record of evidence to demonstrate Knowledge and/or Skills. This could include digital logs and screenshots, audio and video narratives, and methods for capturing desktop activity.

Higher National Unit Support Notes (cont)

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Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Opportunities for developing Core and other essential skills

During the teaching and assessment of this Unit there should arise opportunities for the development of Core Skills in *Numeracy, Information and Communication Technology (ICT),* and *Problem Solving*. Use of team work may also present opportunities for the development of *Working with Others*. In terms of broader skills the Unit may help with the development of enterprise and employability.

This Unit has the Critical Thinking and Planning and Organising components of Problem Solving embedded in it. This means that when learners achieve the Unit, their Core Skills profile will also be updated to show they have achieved Critical Thinking at SCQF level 5 and Planning and Organising at SCQF level 5.

History of changes to Unit

Version	Description of change	Date
02	Core Skills Components Critical Thinking and Planning and Organising at SCQF level 5 embedded.	19/08/16

General information for learners

Unit title: Physical Computing Fundamentals (SCQF level 7)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit is designed to enable you to understand the principles and tools involved in the creation of embedded processor system applications. You will then gain practical experience by implementing and testing a working application.

The Unit is intended for learners who will be working in the design or implementation of embedded processor systems or for those seeking practical and theoretical knowledge of concepts in Physical Computing.

While no previous knowledge of the subject is assumed it is recommended that you should have relevant work experience or studied relevant Computing or Digital Design Units at Intermediate 2 or Higher levels, eg F3SY 12 *Computer Hardware and Systems*.

On completion of the Unit you should be able to:

1 Describe properties, applications and physical concepts underlying embedded processor systems.
2 Describe components used in the construction of embedded processor systems.
3 Implement and test a basic embedded processor system application.

You may have two assessments for this Unit. One for Outcomes 1 and 2 which will assess your knowledge and a practical assessment for Outcome 3.

During the teaching and assessment of this Unit there should arise opportunities for the development of Core Skills in *Numeracy, Information and Communication Technology (ICT),* and *Problem Solving*. Use of team work may also present opportunities for the development of Working with Others. In terms of broader skills the Unit may help with the development of enterprise and employability.

This Unit has the Critical Thinking and Planning and Organising components of Problem Solving embedded in it. This means that when you achieve the Unit, your Core Skills profile will also be updated to show you have achieved Critical Thinking at SCQF level 5 and Planning and Organising at SCQF level 5.