Higher National Unit Specification

General information for centres

Unit title: CNC

Unit code: DT5P 34

Unit purpose: This Unit is designed to introduce candidates to the principles of Computer Numerical Control (CNC) and to allow them to develop both part programming and CAD/CAM skills.

On completion of the Unit the candidate should be able to:

1   Describe CNC systems with respect to industrial requirements.
2   Apply programming skills to manufacture or simulate a component part.
3   Apply CAD/CAM skills.

Credit points and level: 1 HN Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.

Recommended prior knowledge and skills: It would be an advantage if candidates had a basic knowledge of CNC part programming and machining. This may be evidenced by possession of the following NC Units: CNC Machining 1, CNC Part Programming 1, CNC Machining 2 and CNC Part Programming 2.

Core Skills: There may be opportunities to gather evidence towards the following listed Core Skills components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Application of Information Technology	Higher
Critical Thinking	Higher
Written Communication	Intermediate 2

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.

General information for centres (cont)

Assessment: The assessment for Outcome 1 will be conducted by means of an assessment paper. This will be taken by candidates at a single assessment event conducted under controlled, supervised conditions, at the end of the delivery of Outcome 1.

The assessment for Outcomes 2 and 3 will consist of practical assignments culminating in a short report.

For Outcome 2 the candidate will be assigned a component to manufacture or simulate using a CNC machine or suitable software. This will entail producing a planning sheet, compiling an efficient part programme, proving the programme by means of a dry run, correct setting up of the CNC tool or software to successfully manufacture the component.

For Outcome 3 the candidate is required to produce a part-program for a specified CNC system, using Computer Aided Part Programming software. This will entail importing an existing drawing, transferring it to CAD/CAM system and completing all necessary steps to finally produce the part-programme.

Higher National Unit specification: statement of standards

Unit title: CNC

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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. Candidates 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 CNC systems with respect to industrial requirements

Knowledge and/or skills

♦   Computer Numerical Control (CNC)
♦   Industrial CNC applications
♦   Engineering drawings
♦   Machine axes
♦   Absolute and incremental programming methods
♦   Programming code to current industrial/international standards
♦   Direct Numerical Control (DNC)
♦   Distributed Numerical Control (DNC)
♦   Computer Aided Manufacture (CAM)
♦   Computer Aided Part Programming
♦   Adaptive Control

Evidence Requirements

Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis.
The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above.
In any assessment of this Outcome **seven out of eleven** knowledge and/or skills items should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of seven out of eleven knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all seven items.

Higher National Unit specification: statement of standards (cont)

Unit title: CNC

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

♦ explain a Computer Numerical Controlled (CNC) system
♦ identify and distinguish between industrial CNC systems
♦ interpret engineering drawings
♦ identify machine axes correctly with reference to industrial machinery
♦ explain the difference between absolute and incremental programming
♦ demonstrate knowledge of current industrial/international standards programming code
♦ explain a Direct Numerical Controlled (DNC) System
♦ explain a Distributed Numerical Controlled (DNC) System
♦ explain the term CAM
♦ explain Computer Aided Part Programming
♦ explain the term adaptive control

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed-book conditions and as such candidates must not be allowed to bring any textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions. It is advised that the assessment should last no more than 40 minutes.

Outcome 2

Apply programming skills to manufacture or simulate a component part

Knowledge and/or skills

♦ Industrial programming code
♦ Part program planning
♦ Part program generation
♦ Optimum tool and machine utilisation
♦ Part program simulation
♦ Operation or simulation of industrial CNC machinery
♦ Full documentation of component manufacture

Evidence Requirements

The assessment of this Outcome should take the form of a practical assignment and be combined with that of Outcome 3 to produce a short report, details of which are given in Outcome 3.

Assessment guidelines

See Outcome 3.

Higher National Unit specification: statement of standards (cont)

Unit title: CNC

Outcome 3

Apply CAD/CAM skills

Knowledge and/or skills

♦ CAD/CAM system
♦ Computer Aided Part Programming
♦ File management
♦ Post processor
♦ File transfer
♦ CNC simulation

Evidence Requirements

This is a practically based Outcome and **all** of the knowledge and/or skills items above should be assessed. The evidence should be presented in response to a practical assignment in which the candidate is set the task of producing a Computer Aided Part Programme and proving this programme using or simulating an industrial CNC machine.

A candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

♦ import a component CAD drawing with sufficient complexity to allow 6 machinery operations
♦ transfer drawing to a CAD/CAM system
♦ generate machine operations (generic file)
♦ post process operations to generate part program
♦ transfer program to appropriate industrial CNC machine
♦ run simulation of part program
♦ produce report as detailed in Outcome 2

It is essential that centres ensure that evidence generated is the candidate's own work. Centres should therefore issue each candidate with a different specification for the component to be manufactured.

Assessment guidelines

The assessment of this Outcome should take the form of a practical assignment and be combined with that of Outcome 2 to produce a single report, which summarises the steps taken by the candidate to complete both Outcomes. The time that may be allocated for the assignment is 6 hours in total. It is recommended that that Centres develop checklists to support the assessment requirements for each of the knowledge and/or skills items.

Administrative Information

Unit code: DT5P 34

Unit title: CNC

Superclass category: XF

Original date of publication: August 2005

Version: 02

History of changes:

Version	Description of change	Date
02	Page 4 — Assessment time for Outcome 1 amended from 20 minutes to 40 minutes Page 9 — Assessment time for Outcome 1 amended from 1 hour to 40 minutes	Mar 2007

Source: SQA

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre for further details, telephone 0845 279 1000.

Higher National Unit specification: support notes

Unit title: CNC

This part of the Unit specification is offered as guidance. The support notes 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 has been written in order to allow candidates to develop knowledge, understanding and practical skills in the following areas:

1   CNC systems and their capabilities.
2   Part programming and CNC machining.
3   Computer Aided Part Programming.

In designing this Unit, the Unit writers have identified the range of topics that they expect to be covered by lecturers. Recommendations are also given as to how much time should be spent on each Outcome. This has been done to help lecturers to decide what depth of treatment should be given to the topics attached to each of the Outcomes.

The list of topics for each Outcome is given below. Lecturers are advised to study this list in conjunction with the 'Guidance on delivery and assessment of this Unit' topic below so that they can get a clear indication of the standard of achievement expected of the candidates in this Unit.

1   Describe CNC systems with respect to industrial requirements (7 hours)

- ♦ History of Numerical Control
- ♦ Progression made in CNC systems — tape to DNC links
- ♦ Range of industrial CNC systems — milling machines, lathes, laser machines, routers, machining centres, spark erosion machines, wire EDM machines, welding machines, robots
- ♦ Machinery axis of each of the above CNC systems
- ♦ Engineering drawing interpretation
- ♦ Transfer of CAD drawing
- ♦ Programming methods – absolute and incremental
- ♦ Industrial/International standard programming codes relevant to controllers such as Fanuc, Seimens, Heidenhain, Anilam, Mazak (relative to centre)
- ♦ Function of Geometry and Machine codes – G & M codes
- ♦ The purpose and capabilities of computer aided manufacture (CAM)
- ♦ Integration of CAD with CAM
- ♦ Direct Numerical Control (DNC)
- ♦ Distributed Numerical Control (DNC)

Unit title: CNC

2   Apply programming skills to manufacture or simulate a component part (18 hours)

- ♦ Relevant Programming code: Fanuc, Heidenhain, Seimens, Mazak, Anilam etc
- ♦ Planning sheet for component manufacture
- ♦ Manual part programme
- ♦ Machine modes: manual; programme and edit; manual data input; single block; automatic run
- ♦ G and M codes, canned cycles, datum shift
- ♦ Tool selection
- ♦ Speeds, feeds and tool optimisation
- ♦ Simulation of part programme
- ♦ Loading component into machine
- ♦ Machine operation

3   Apply CAD/CAM skills (15 hours)

- ♦ Import CAD drawing
- ♦ Transfer to CAD/CAM system
- ♦ CAD/CAM software
- ♦ Generate machine operations:
  - — set up material block
  - — material type
  - — operation planning: number of cuts, finish etc
  - — tool path generation
  - — tool library
  - — tool selection
  - — feeds and speeds
  - — tool path verification
  - — generate part programme
- ♦ Post processor
- ♦ Transfer part program to CNC machine
- ♦ Prove part programme through simulation

Guidance on the delivery and assessment of this Unit

The Unit may be taught as a freestanding Unit, however it could also be combined with appropriate Units to allow integration of related topics.

The Unit is designed to develop the candidates' knowledge and understanding of the fundamentals of CNC part programming and machining. It will also introduce the candidate to the capabilities of Computer Aided Part Programming. Due to the practical content of the Unit, the candidate will require access to both a CNC machine tool and Computer Aided Part Programming software.

Higher National Unit specification: support notes (cont)

Unit title: CNC

The delivery of Outcome 1 is critical to the Unit as it equips the candidate with the fundamentals required to complete the remainder of the Unit. Therefore it should be taught at the start of the Unit to ensure that candidates have the correct level of knowledge. The assessment should be a short answer exercise lasting no more than 40 minutes.

Delivery of Outcome 2 and 3 should focus on the practical application of the knowledge and skills acquired in Outcome 1. Therefore the candidate should be provided with the opportunity to gain as much "hands on" experience as possible. This will involve the use of CNC machine tools and Computer Aided Part Programming. The assessment will involve the candidate producing two part programmes, one of which will be manufactured or simulated on a CNC machine tool. A short report will be submitted at the end of the Unit to include, planning sheet, part programmes and any other relevant documentation.

Opportunities for developing Core Skills

There may be opportunities to gather evidence towards the following listed Core Skills components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Application of Information Technology   Higher
Critical Thinking   Higher
Written Communication   Intermediate 2

Open learning

This Unit may be delivered by distance learning however, due to the practical nature of Outcome 2 and 3 a considerable degree of centre support may be required. With regard to assessment, planning would be required by the centre to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that the assessments were conducted under controlled, supervised conditions.

Candidates with disabilities and/or additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (**www.sqa.org.uk**).

General information for candidates

Unit title: CNC

This Unit has been designed to provide you with the knowledge and skills that will enable you to understand the fundamentals of CNC part programming and machining and also introduce you to Computer Aided Part Programming.

You will study the fundamentals of CNC systems, gaining a knowledge and understanding of these systems and how the systems operate. As the Unit progresses you will be given the opportunity to apply these fundamentals in the programming and manufacture of a given component. This knowledge will be complemented by an introduction to the capabilities of Computer Aided Part Programming, culminating in taking a given design from drawing through to part program generation.

Assessment of Outcome 1 will consist of a short test, based on the fundamentals of CNC systems. This assessment will be carried out under closed-book conditions in which you will not be allowed to take notes, handouts, textbooks etc into the assessment. Outcome 2 and 3 will be assessed by a project report, which will contain two part programmes, one generated through manual part programming and one through Computer Aided Part Programming.