National Unit Specification: general information

UNIT PIC® Microcontrollers: Principles and Applications (Advanced Higher)

NUMBER D8XR 13

COURSE Mechatronics (Advanced Higher)

SUMMARY
The candidate will develop an understanding of PIC® microcontrollers and their applications.

OUTCOMES
1 Describe PIC microcontroller types and architectures.
2 Describe microcontroller interfacing principles.
3 Describe digital and analogue input devices.
4 Create a simple control program.

RECOMMENDED ENTRY
While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Higher Grade in Mechatronics or Technological Studies
- A Scottish Group Award at Higher level in an appropriate area
- An appropriate grouping of national units or an NC Group Award.

CREDIT VALUE
1 credit at Advanced Higher.

Administrative Information

Superclass: XL

Publication date: June 2003

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

UNIT PIC® Microcontrollers: Principles and Applications (Advanced Higher)

CORE SKILLS

There is no automatic certification of core skills or core skills components in this unit.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

National Unit Specification: statement of standards

UNIT PIC® Microcontrollers: Principles and Applications (Advanced Higher)

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
Describe PIC microcontroller types and architectures.

Performance Criteria

a) Explanation of the program and data bus implementation in microcontroller hardware is correct.
b) Completion of the internal block diagram of a specified PIC microcontroller is correct.
c) Identification of the different functions related to the 'pin-out' diagram of a PIC microcontroller is correct in terms of manufacturers' data sheets.
d) Description of PIC microcontroller features and memory types that could influence a programmer are correct.

Note on Range for the Outcome
Microcontroller hardware: Harvard architecture, program bus, data bus, Arithmetic and Logic Unit (ALU), Working register, RAM, ROM.

Block diagram: ALU, Working (W) register, program counter, stack, clock circuit, reset interrupt circuits, RAM, ROM, bus structure, decoding and timing controller, input/output (I/O)ports, Analogue to Digital Converter (ADC).

'Pin-out' diagrams: control pins and input/output pins.

Types: PROM (OTP), EPROM, EEPROM.

Evidence Requirements

Written and graphical evidence that the candidate can describe the bus implementation on a PIC microcontroller.
Blank diagram where the student has to correctly identify and label the correct component parts or pin functions.
Written and graphical evidence that the candidate can describe five of the following features of a typical microcontroller; size of ROM, size of RAM, program instructions available, number of I/O pins available, external or watchdog interrupts, using digital and/or analogue inputs.
Written evidence that the candidate can describe the features and types of PIC microcontrollers.

OUTCOME 2
Describe microcontroller interfacing principles.

Performance Criteria

a) Description of digital input interfacing principles is correct.
b) Description of analogue input interfacing principles is correct.
c) Description of digital output interfacing principles is correct.
d) Description of interfacing a microcontroller with an analogue controlled actuator is correct.

National Unit Specification: statement of standards (cont)

UNIT PIC® Microcontrollers: Principles and Applications (Advanced Higher)

Note on Range for the Outcome
Digital input: input voltage requirements, pull up resistor, pull down resistor.

Analogue input: Analogue to Digital Conversion (ADC), signal amplication (op-amp), signal attenuation (voltage divider), bridge circuit.

Digital output: darlington driver, electro-mechanical relay, solid state relay.

Analogue output interfacing: Pulse Width Modulation (PWM), Digital to Analogue Conversion (DAC).

Evidence Requirements
Written and graphical evidence that the candidate understands the interfacing requirements of a microcontroller that uses digital and analogue inputs, digital outputs and digital outputs controlling an analogue device.

OUTCOME 3
Describe digital and analogue input devices.

Performance Criteria
a) Description of the operating principles and signal conditioning of digital input devices is correct.
b) Description of the operating principles and signal conditioning of analogue input devices is correct.

Note on Range for the Outcome
Digital input devices: microswitch, infra red proximity sensor, Hall effect sensor, shaft encoder, turbine/vane flow sensor.

Analogue input devices: strain gauge, light dependant resistor (LDR), resistance thermometer, piezo electric pressure sensor.

Evidence Requirements
Written and graphical evidence that the candidate understands the principles of the digital and analogue input devices.

OUTCOME 4
Create a simple control program.

Performance Criteria
a) Production of the program using digital I/O signals is correct in terms of a given specification.
b) Execution of the program is in accordance with set test procedures.
c) Production of the program documentation is correct in terms of given specification.

National Unit Specification: statement of standards (cont)

UNIT PIC® Microcontrollers: Principles and Applications (Advanced Higher)

Note on Range for the Outcome

Program: I/O port setup, Inputs, read/test/process inputs, Output to devices.

Test procedures: draw up test strategy, download source code to a microcontroller, test in system, record results.

Documentation: program brief, problem analysis, program listing (including program documentation), test strategy, test results, analysis of results and conclusions.

Evidence Requirements

Performance and written evidence of the candidate's ability to develop, verify and document programs as specified in PCs (a) to (c).

National Unit Specification: support notes

UNIT PIC® Microcontrollers: Principles and Applications (Advanced Higher)

This part of the unit specification is offered as guidance. None of the sections of the support notes is mandatory.

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

GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

The candidate should achieve the level of competence of someone who may be expected to program, install or test a microcontroller-based system, involving the following:

Outcome 1

The candidate should be aware of the architectures used, the types of PICs available and the influences PIC microcontrollers characteristics have on a programmer.

Outcome 2

Interfacing to microcontroller should be introduced and developed. Candidates should know how to interface with input signals from eg a micro switch or hall effect sensor and analogue signals from a strain gauge or temperature sensor. Interfacing outputs from the microcontroller could include using a relay or darlington driver to drive on/off actuators as well as D/A conversion and Pulse Width Modulation (PWM) techniques to control analogue actuators.

Outcome 3

Input devices should be examined and their principles taught using written, graphical or software modelling techniques. Their input/outputs should be measured using multimeters, logic probes and/or oscilloscopes to give the candidates a better understanding of how the output signals react to changes of input.

Outcome 4

Sample programs using a range of instructions should be used to develop the candidate's knowledge and understanding of the microcontroller being studied. Initially the candidate should be encouraged to expand or modify given programs when developing their own software skills. Basic programming would be best suited to this outcome, it has a range of commands which will aid the programmer in creating control programs. A modeller's servo motor can be used in a position control program, they can also be modified for use in a speed and direction control program.

National Unit Specification: support notes

UNIT PIC® Microcontrollers: Principles and Applications (Advanced Higher)

Instructions set for Advanced Higher Mechatronics – PIC Microcontrollers: Principles and Applications

Debug
End
For….next
Gosub
Goto
Halt
High
If…then
Input
Low
Output
Pause
Pulsin
Pulsout
Return
Switch on
Switch off
Symbol
Toggle
Wait

National Unit Specification: support notes (cont)

UNIT PIC® Microcontrollers: Principles and Applications (Advanced Higher)

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The unit should be delivered in the order in which the outcomes are listed. This enables the basic theory to be dealt with prior to consideration of the practical aspects.

Outcome 1 could use animated (eg. Power Point) programs to build up the architecture of the microcontroller.

Outcomes 2 and 3 should be approached using worksheets to suit the laboratory activities. References to theory notes and small group discussions should be encouraged at this time.

Outcome 4 could be approached by introducing the candidates to written programs and then editing them to change the input and outputs of the system. The candidates could then write and test small programs before progressing on to more difficult programming techniques. Flowcode programming may be an option for introducing this outcome. Candidates can quickly and easily program PIC microcontrollers before moving on to text programming.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

It is recommended that centres use National Assessment Bank material for this unit.

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 Arrangements* (SQA, 2001).