National Unit Specification: general information

UNIT Artificial Intelligence (Higher)

NUMBER DF31 12

COURSE Computing (Higher)

SUMMARY

This Unit is designed to develop knowledge and understanding of the principles of artificial intelligence together with some of the concepts associated with the representation and processing of knowledge. Candidates are also provided an opportunity to apply this knowledge to solve practical problems through the use of contemporary hardware and software. It is designed as an option for candidates undertaking the Higher Computing Course, but is also suitable for anyone wishing to extend and deepen their experience of artificial intelligence beyond Intermediate 2 level.

OUTCOMES

1. Demonstrate knowledge and understanding of a range of facts, ideas and terminology relevant to the development, applications and features of artificial intelligence.
2. Demonstrate practical skills in the context of artificial intelligence using contemporary software and hardware.

RECOMMENDED ENTRY

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

♦ Intermediate 2 Artificial Intelligence Unit
♦ Intermediate 2 Computing
♦ Standard Grade Computing Studies at Credit level

Administrative Information

Superclass: CB

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National Unit Specification: general information (cont)

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CREDIT VALUE
1 credit at Higher (6 SCQF credit points SCQF level 6*).

*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.

CORE SKILLS

There is no automatic certification of Core Skills or Core Skill components in this Unit.

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 the Scottish Qualifications Authority.

OUTCOME 1
Demonstrate knowledge and understanding of a range of facts, ideas and terminology relevant to the development, applications and features of artificial intelligence.

Performance Criteria
a)   A range of computing terminology is used appropriately.
b)   Technically accurate descriptions and explanations are related to practical and familiar contexts.
c)   Conclusions, predictions and generalisations are made from knowledge and understanding.

Evidence Requirements
Written or oral evidence that the candidate can describe and explain the principles, features and purposes of artificial intelligence accurately. Evidence should be obtained using questions in a closed book test, under supervision, lasting no more than 45 minutes. The test must sample content (see Computing Higher Course content) in the following areas:

♦   the development of artificial intelligence
♦   applications and uses of artificial intelligence
♦   search techniques
♦   knowledge representation

(The content statements are also reproduced for convenience as a table in the support notes for this Unit).

The standard to be applied is illustrated in the National Assessment Bank items available for this Unit. If a centre wishes to design its own assessments for this Unit, they should be of a comparable standard.

National Unit Specification: statement of standards (cont)

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OUTCOME 2
Demonstrate practical skills in the context of artificial intelligence using contemporary software and hardware.

Performance Criteria
a)   A range of appropriate hardware and software is used effectively and efficiently.
b)   An appropriate range of features of declarative languages is selected and used effectively.
c)   Practical tasks are planned and organised with minimal guidance.
d)   Practical tasks are undertaken in an appropriate range of familiar contexts.

Evidence Requirements
Observational checklist showing that the candidate has demonstrated of the following skills in the context and at a level defined by the content statements (see Computing (Higher) Course content):

♦   construction of a knowledge base of facts and rules
♦   implementation of recursion, inheritance or negation
♦   creation of queries to elicit information from a knowledge base
♦   testing a knowledge base
♦   evaluating an expert system

Hard copy evidence should be provided of the knowledge base constructed.

The practical skills may all be demonstrated in a single extended task, or in a number of smaller tasks.

The candidate will be allowed access to books, notes and online help while completing the task(s).

(The content statements are also reproduced for convenience as a table in the support notes for this Unit).

The standard to be applied is illustrated in the National Assessment Bank items available for this Unit. If a centre wishes to design its own assessments for this Unit, they should be of a comparable standard.

National Unit Specification: support notes

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This part of the Unit Specification is offered as guidance.

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

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT
The content for this Unit is detailed below (and also in the National Course Specifications: Course details.)

Content statements in the left–hand column describe the content covered in the corresponding Unit at Intermediate 2 level, and are included here to clarify the context for the new learning for this Unit. They indicate the prior learning required by the candidate before undertaking new learning within this Unit. Content in the right–hand column is the new content for this Unit.

Content Statements: The development of artificial intelligence	
Intermediate 2	Higher
Description of human intelligence (including the ability to communicate, retain knowledge, solve problems). Description of the Turing test and explanation of its rationale.	Definitions of human intelligence and artificial intelligence. Descriptions of aspects of intelligence (including language, learning, cognitive ability, problem solving skills, memory, creativity). Explanation of the difficulties of determining an accurate and agreed definition of intelligence. Explanation of the inherent flaws of the Turing test as a method for determining the existence of artificial intelligence. Description of the change in emphasis from modelling the human brain to producing systems exhibiting 'intelligent behaviour'.
Explanation of the need for a different approach to programming which could represent knowledge.	Description of the need for knowledge representation techniques (including semantic nets and logic programming). Explanation of the need for a restricted domain. Identification of languages: LISP (functional), Prolog (declarative/logic). Description of difference between declarative and imperative languages.

National Unit Specification: support notes (cont)

UNIT Artificial Intelligence (Higher)

Simple description of:	Explanation (with examples) of:
♦ *the development of game playing programs from simple early examples to contemporary complex examples exhibiting intelligence* ♦ *the development of language processing from Eliza to chatterbots and contemporary applications* ♦ *the development of expert systems*	♦ the success and failures of game playing programs from simple early examples to contemporary complex examples exhibiting intelligence ♦ the successes and failures of language processing (including Eliza, SHRDLU, chatterbots and contemporary applications) ♦ the scope and limitations of expert systems
Identification of hardware developments (including faster processors, more memory, and increasing backing store capacity) which have assisted the development of AI.	Explanation of the effects of hardware developments (including faster processors, more memory, and increasing backing store capacity) on the field of AI. Description of the implementation and advantages of parallel processing. Description of the practical problems associated with AI despite advances in hardware/software.

Content Statements : Applications and Uses of AI	
Intermediate 2	Higher
Artificial neural systems: *Simple description of a neural network as an electronic model of the brain consisting of many interconnected simple processors.* *Description of uses and examples of artificial neural systems (including learning to read postcodes; stock market prediction; debt risk assessment; other examples of pattern recognition).* *Description of advantages and disadvantages of artificial neural systems.*	**Artificial neural systems (ANS):** Comparison of a human neuron with an artificial neuron. Description of the structure of a neural net (including artificial neuron, links, weights, layers). Comparison of a neural net with the human brain. Description of 'learning' through iterative process as opposed to algorithmic programming. Explanation that a neural net may be a software model or hard-wired.
Vision systems: *Explanation of the need to interpret/make sense of visual input.* *Description of applications (including industrial, military use, satellite photo interpretation).*	**Vision systems:** Description of the problems of interpreting 2D images of 3D objects. Description of the stages of computer vision (image acquisition, signal processing, edge detection, object recognition, image understanding).

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Speech recognition: *Description of applications (including word processor, punctuation commands, disabled users, cars, military, mobile phones).* *Description of characteristics (training for each voice pattern, control instructions, influence of background noise, factors affecting accuracy).*	**Natural language processing (NLP):** Identification of the main stages of NLP (speech recognition, natural language understanding (NLU), natural language generation, speech synthesis). Explanation of some difficulties in NLP (including ambiguity of meaning; similar sounding words; inconsistencies in grammar of human language; changing nature of language). Identification of applications of NLP (including automatic translation, speech driven software, NL search engines, NL database interfaces).
Handwriting recognition: *Description of common applications (including palmtops and tablet PCs).* *Explanation of possible need to train the system.*	**Smart/embedded technology:** Description of examples of the use of intelligent software to control devices (including car engine control systems; domestic appliances).
Intelligent robots: *Description of:* ♦ *types of sensors used* ♦ *contemporary applications (including automated delivery, pipe inspection, bomb disposal, exploration of unknown environments)* ♦ *advantages of intelligent robots*	**Intelligent robots:** Explanation of the difference between dumb and intelligent robots. Description of contemporary research and developments. Description of possible social and legal implications of the increasing use of intelligent robots. Descriptions of practical problems (including processor power, power supply, mobility, vision recognition, navigation, path planning, pick and place, and strategies used to overcome these problems).
Expert systems: *Description of purpose of expert systems.* *Description of advantages of expert systems over human experts, including:* ♦ *expertise always available* ♦ *reduced wage bill* ♦ *combines expertise of several experts* ♦ *less chance of errors* *Description of contemporary applications of expert systems:* *Description of social, legal and ethical issues related to the use of expert systems (including loss of jobs, training issues, public reactions, loss of human expertise).*	**Expert systems:** Description of the components of an expert system (knowledge base, inference engine, user interface with justification/explanation, working memory). Distinction between an expert system and an expert system shell. Description of contemporary applications of expert systems. Description of advantages of expert systems (including permanence, cost effectiveness, consistency, portability). Description of disadvantages of expert systems (including narrow domain, lack of 'common sense', need for expertise to set up and maintain, inability to acquire new knowledge, inflexibility). Description of moral issues (including medical). Description of legal issues (including responsibility when advice is wrong).

National Unit Specification: support notes (cont)

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Content Statements: Search techniques	
Intermediate 2	Higher
Exemplification of problem solving by search. *Construction of a simple search tree.* *Description of breadth-first and depth-first search and exemplification on a search tree.*	Comparison of depth-first and breadth-first search (order of visiting nodes, memory implications, advantages and disadvantages, need for backtracking), and exemplification on a search tree. Description and exemplification of combinatorial explosion. Description and exemplification of use of heuristics to reduce search time/space.

Content Statements: Knowledge representation	
Intermediate 2	Higher
	Description of the software development process as it applies to declarative language programming.
Construction of semantic net to represent simple relationships and facts.	Creation of a semantic net from given problem statement.
Description and exemplification of the following features in Prolog (or similar declarative language): ♦ *simple facts (single/double argument)* ♦ *simple rules (up to two sub-goals)* ♦ *simple queries (true/false, single variable)* ♦ *operators: and, >, <, =*	Description and exemplification of the following features in Prolog (or similar declarative language): ♦ multi-argument clauses ♦ recursive and non recursive rules ♦ complex queries: (multiple variable, conjunction of queries) ♦ negation ♦ inheritance
Explanation of the concepts of goal and sub-goal.	Explanation of the concepts of goal, sub-goal, instantiation, matching.
Perform simple manual trace: one rule/level.	Perform complex manual trace: multiple level including backtracking.
	Description and exemplification of inheritance Creation of rules involving inheritance.
	Explanation of the importance of the order of rules.

National Unit Specification: support notes (cont)

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GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Candidates will require individual access to appropriate computer hardware and software throughout this Unit.

The two Outcomes should be delivered in an integrated way rather than sequentially. For Outcome 2, the practical activities should be taught and used to illustrate and exemplify the knowledge and understanding required for Outcome 2, whenever this is possible. At the very least, candidates should carry out practical tasks using Prolog, and have experience of consulting and evaluating an expert system which could be a simple one prepared for the purpose, or a commercial example. Practical illustrations of other applications and uses of artificial intelligence should be provided where suitable hardware and software is available.

Candidates who have completed the *Artificial Intelligence* Unit at Intermediate 2 level should already have covered the content listed in the left–hand column of the content grids, but may need to revise this material before progressing to the right–hand column.

The amount of time spent on each area of content will vary depending on the teaching methodology used and the ability and prior experience of the candidates. However, the following times are suggested as a rough guide:

development of artificial intelligence	6 hours
applications and uses of artificial intelligence	8 hours
search techniques	4 hours
knowledge representation	18 hours

1½ hours should be set aside to:
  ♦ administer the Outcome 1 test
  ♦ gather evidence for Outcome 2

A further 2½ hours is allowed for remediation and re-assessment if required.

If the Unit is delivered as part of a Course, the Course documentation will provide further information on teaching and learning in a Course context, including the identification of a number of 'themes' to facilitate holistic learning across the Course.

National Unit Specification: support notes (cont)

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GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT
National Assessment Bank tests have been created specifically to assess Outcome 1 of the Unit. This assessment consists of a closed book test, and must be conducted under examination conditions. In order to gain success in this Outcome, the candidate must achieve at least the cut-off score for the test. If a centre wishes to design its own assessments for this Unit, they should be of a comparable standard.

Outcome 2 requires the candidate to demonstrate practical skills while using contemporary hardware and software. These practical skills will normally be demonstrated in a single extended task or a number of relatively small tasks. The skills will normally be demonstrated by the candidate during the teaching and learning activities of the Unit, rather than during separate formal assessment activities. The candidate will be allowed access to books, notes and online help while demonstrating the skills. The practical skills should be demonstrated in the context and at a level defined by the content statements (see Computing (Higher) Course content).

To gain success in this Outcome, the candidate must demonstrate practical skills in the following contexts:

♦   construction of a knowledge base of facts and rules
♦   implementation of recursion, inheritance or negation
♦   creation of queries to elicit information from a knowledge base
♦   testing a knowledge base
♦   evaluating an expert system

Hard copy evidence should be provided for the knowledge base constructed.

Note: the candidate is only required to evaluate an expert system, not to construct one.

A pro-forma observation checklist for Outcome 2 is provided in the National Assessment Bank materials.

All evidence must be retained by the centre. The assessment of this Unit is subject to moderation by SQA.

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 special alternative Outcomes for Units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, September, 2003).