National Course Specification: Course details (cont)

Higher Computing: Computer Systems (mandatory Unit)

The candidate must demonstrate knowledge and understanding, practical skills and problem solving based on the following content statements:

Data representation

- Representation of positive numbers in binary including place values and range up to and including 32 bits
- Conversion from binary to decimal and vice versa
- Description of the representation of negative numbers using two's complement using examples of up to 8 bit numbers
- Description of the relationship between the number of bits assigned to the mantissa/exponent and the range and precision of floating point numbers
- Conversion to and from bit, byte, Kilobyte, Megabyte, Gigabyte, Terabyte. (Kb, Mb, Gb, Tb)
- Description of Unicode and its advantages over ASCII
- Description of the bit map method of graphic representation using examples of colour/greyscale bit maps
- Description of the relationship of bit depth to the number of colours using examples up to and including 24 bit depth (true colour)
- Description of the vector graphics method of graphic representation
- Description of the relative advantages and disadvantages of bit mapped and vector graphics
- Description of the relationship between the bit depth and file size
- Explanation of the need for data compression using the storage of bit-map graphic files, as examples

Computer structure

- Detailed description of the purpose of the ALU and control unit
- Description of the purposes of registers: to hold data being processed, instructions being executed, and addresses to be accessed
- Description of the function of the data bus and the address bus
- Description of the read, write and timing functions of the control lines
- Identification of other control lines, including reset and interrupt lines
- Simple description, referring to the appropriate buses and control lines, of the steps in the fetch-execute cycle
- Description of the following elements of computer memory: registers, cache, main memory, backing storage
- Distinction between the above elements of memory according to function and speed of access
- The concept of addressability
- Description and evaluation of the following measures of performance: clock speed, MIPS, FLOPS, and application based tests
- Description of the effect the following factors have on system performance: data bus width, use of cache memory, rate of data transfer to and from peripherals
- Description of current trends in computer hardware, including increasing clock speeds, increasing memory and backing storage capacity

National Course Specification: Course details (cont)

Higher Computing: Computer Systems (mandatory Unit) (cont)

Peripherals

- Description of the use and advantages of buffers and spooling
- Description of a suitable selection of hardware, including peripherals, to support typical tasks including production of a multimedia catalogue, setting up a LAN in a school, development of a school website
- Justification of the hardware selected in terms of appropriate characteristics including resolution, capacity, speed, cost and compatibility
- Description of the features, uses and advantages of solid state storage devices including flash cards
- Description of the development trends in backing storage devices
- Description of the following functions of an interface: buffering, data format conversion (serial to parallel and analogue to digital), voltage conversion, protocol conversion, handling of status signals
- Distinction between parallel and serial interfaces
- Description and explanation of the current trends towards increasing interface speeds and wireless communication between peripherals and CPU

Networking

- Comparison of LANs, WANs, Intranet and Internet work in terms of transmission media, bandwidth, geographical spread and functions
- Distinction between a mainframe with terminals and a network of computers
- Descriptive comparison of peer-to-peer networks and client server networks
- Description of the functions of file, print and web servers
- Description of a node and a channel
- Description of bus, star, ring and mesh topologies using the terms node and channel
- Description of the consequences for each of the above topologies of node and channel failure
- Simple description of the functions and uses of a hub, switch and router
- Identification of the need for a network interface card (NIC)
- Description and explanation of the trends towards higher bandwidth and wireless communications
- Description of the following technical reasons for the increasingly widespread use of networks:
  - advances in computer hardware, including processors, main memory capacity, backing storage, data transfer rates
  - improved network related software, including browsers and network operating systems
- Description of the misuse of networks for the following illegal purposes: breaching copyright, hacking and planting viruses
- Description of the application of the Computer Misuse Act, the Copyright Designs and Patents Act and the Data Protection Act to the misuse of networks

Computer software

- Description of the function of a bootstrap loader
- Description and exemplification of the main functions of a single user operating system: interpreting users commands, file management, memory management, input/output management, resource allocation, managing processes
- Definition of a utility program
- Description of utility programs (including virus checker, disk editor and defragmenter)
- Description of the standard file formats for graphics files: jpeg, gif, TIFF
- Description of a suitable selection of software to support typical tasks including production of a multimedia catalogue, setting up a LAN in a school, development of a school website

National Course Specification: Course details (cont)

Higher Computing: Computer Systems (mandatory Unit) (cont)

- Description and exemplification of software compatibility issues (including memory and storage requirements, and OS compatibility)
- Classification of viruses by type of file infected: file virus, boot sector virus, macro virus
- Description of the following virus code actions: replication, camouflage, watching, delivery
- Distinction between a virus, a worm and a trojan horse
- Description of anti-virus software detection techniques: use of checksum, searching for virus signature, heuristic detection and memory resident monitoring

National Course Specification: Course details (cont)

Higher Computing: Software Development (mandatory Unit)

The candidate must demonstrate knowledge and understanding, practical skills and problem solving based on the following content statements:

Software development process

- Explanation of the iterative nature of the software development process
- Description of the purposes of the software specification, and its status as a legal contract
- Explanation of the importance of each stage (analysis, design, implementation, testing, documentation, evaluation, maintenance) of the development process
- Identification of the personnel at each stage (client, systems analyst, project manager, programmer, independent test group) and brief description of their roles
- Description and exemplification of pseudocode and one graphical design notation (structure diagram or other suitable) including data flow
- Description and exemplification of top-down design and stepwise refinement
- Explanation of the need for systematic and comprehensive testing
- Explanation of the need for documentation at each stage
- Evaluation of software in terms of robustness, reliability, portability, efficiency and maintainability
- Description and exemplification of corrective, adaptive and perfective maintenance

Software development languages and environments

- Description and comparison of procedural, declarative and event-driven languages
- Comparison of the functions, uses and efficiency of compilers and interpreters
- Description of the features and uses of scripting language (including creating and editing a macro)
- Explanation of the need for and benefits of scripting languages
- Description of the use of module libraries

High level programming language constructs

- Description and exemplification of the following constructs in pseudocode and an appropriate high level language: string operations (concatenation and substrings), formatting of I/O, CASE (or equivalent multiple outcome selection)
- Description and exemplification of real, integer and boolean variables; and 1-D arrays
- Description and exemplification of procedures/subroutines/subprograms, user-defined functions, modularity, parameter passing (in, out, in/out), call by reference/value, local and global variables, scope

Standard algorithms

- Description and exemplification of the following standard algorithms in pseudocode and an appropriate high level language:
  - linear search
  - counting occurrences
  - finding min/max

National Course Specification: Course details (cont)

Higher Computing: Artificial Intelligence (optional Unit)

The candidate must demonstrate knowledge and understanding, practical skills and problem solving based on the following content statements:

The development of artificial intelligence

- 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'
- 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
- Explanation (with examples) of:
  - 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
- 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

Applications and uses of artificial intelligence

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

- 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)

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)

Smart/embedded technology:

- Description of examples of the use of intelligent software to control devices (including car engine control systems; domestic appliances)

National Course Specification: Course details (cont)

Higher Computing: Artificial Intelligence (optional Unit) (cont)

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 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 implications)
- Description of legal issues (including responsibility when advice is wrong)

Search techniques

- 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

Knowledge representation

- Description of the software development process as it applies to declarative language programming
- Creation of a semantic net from given problem statement
- 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, sub-goal, instantiation, matching
- Explanation of complex manual trace: multiple level including backtracking
- Explanation of the importance of the order of rules