

**THE BCS PROFESSIONAL EXAMINATION
Certificate**

April 2002

EXAMINERS' REPORT

Technology

General Comments

The general comments made on previous occasions are worth repeating one again; that is:

Examination technique was poor for a significant number of candidates. It is important to read the question carefully, understand what the examiners are asking for and then answer the question given - not the question you would like to have been asked. The question paper carries 120 marks and there are 120 minutes in which to answer the questions. That is, one mark per minute; spending 30 minutes on a question that carries 12 marks is not sensible.

As an example, many candidates gave lengthier answers to part-questions in Section B worth 6 marks, than they gave for complete questions in Section A worth 30 marks.

For questions that required some amount of computation, for example, binary arithmetic, there were many instances where an answer was provided without showing any working - it is important that the examiner can see the method used. There were also cases where an obviously wrong method was used but the correct answer mysteriously appeared. Full marks are only gained where a correct method is shown.

Section A - Comments

The answers to all the questions in Section A had a remarkable similarity in terms of both the mark profile and popularity. Apart from examination technique, there were no consistent mistakes or omissions.

Question 1

- a) The specification of a microprocessor is given by the following: *200 MHz processor, 64-bit Bus, 256 KByte cache, floating-point accelerator, superscalar dual-pipeline*. Describe each of the specifications (shown in italics) and, in particular, state the significance of each in relation to the processing power of the microprocessor.**
- (20 marks)**

- b) An Instruction Cycle comprises three stages: fetch, decode and execute. Explain what happens in each of the stages, with reference to the internal registers. State any assumptions made.**
- (10 marks)**

Answer Pointers:

(4 marks were awarded for each term in italics)

The term megahertz is commonly used to express microprocessor clock speed in cycles per second. 1 MHz is equivalent to 1,000,000 cycles per second. Typically, one computer process (e.g. memory access, arithmetic) is carried out in a single cycle.

A bus is the data path on the computer's motherboard that interconnects the microprocessor with the other devices (e.g. memory, disks, I/O). A 64-bit Bus implies there are 64 parallel data paths.

Cache memory is random access memory that a microprocessor can access more quickly than regular RAM. The microprocessor looks first in the cache memory and if the data is found there (from a previous reading of data), it does not have to access the main RAM, which takes longer. Cache memory is sometimes described in levels of closeness and accessibility to the microprocessor. An L1 cache is on the same chip as the microprocessor. L2 is usually a separate static RAM chip.

Floating Point Accelerator is additional hardware to perform functions on floating-point numbers such as addition, multiplication, logarithms, exponentials, trigonometric functions and various kinds of rounding and error detection. A floating-point accelerator is sometimes referred to as a co-processor to the CPU.

Superscalar describes a microprocessor design that makes it possible for more than one instruction at a time to be executed during a clock cycle. In a superscalar design, the processor is able to determine whether an instruction can be carried out independently of other sequential instructions, then uses multiple execution units to simultaneously carry out two or more independent instructions at a time.

b) The following uses an ADD instruction with a memory access (ADD memory contents to the ALU) to illustrate the answer.

Fetch:

MAR $\Leftarrow$ PC;

MBR $\Leftarrow$ M[MAR]; PC $\Leftarrow$ PC+1;

IR $\Leftarrow$ MBR;

Decode/Execute:

CU $\Leftarrow$ IR

PC $\Leftarrow$ Addr[CU]; The address part of the instruction is transferred to the PC

MAR $\Leftarrow$ PC;

MBR $\Leftarrow$ M[MAR];

ALU $\Leftarrow$ ALU+MBR;

Question 2

- a) Explain the differences between a compiler and an interpreter. (10 marks)
- b) Describe the main stages of the compilation process, showing the purpose of each stage. (20 marks)

Answer Pointers:

a) A compiler processes statements written in a particular programming language and turns them into machine language or "code" that the computer's processor uses.

An interpreter turns the source code of a programming language into an intermediate language and then "interprets" this language. It does not turn it into machine language. At run time the execution is slower than a compiled program but can offer good diagnostics for run time errors.

b) Lexical Analysis: Recognise strings in the source programs; e.g. identifiers, arithmetic operations

Syntactic Analysis: the compiler then parses (or analyses) all of the language statements syntactically one after the other to check it complies with the language definition;

Code generation: builds the output code, making sure that statements that refer to other statements are referred to correctly in the final code. The output of the compilation is called *object code*. The object code is machine code that the processor can process or "execute" one instruction at a time.

Linking/Consolidation: When more than one object module (or library routine) is to be run, linking/consolidation is carried out to resolve the relative location of instructions and data which are cross-referenced. This produces the executable program.

Question 3

Some of the problems associated with managing a computer network are related to the security of data and equipment. Describe the potential security problems with networking and identify possible solutions to these problems.

(30 marks)

Answer Pointers:

A number of areas could have been described including

Viruses - a piece of program usually disguised as something else that causes some unexpected and usually undesirable event. A virus is often designed so that it is automatically spread to other computer users. Viruses can, for example, be transmitted as attachments to an e-mail, as downloads, or be present on a diskette or CD.

Hacking - breaking into computer systems usually by experienced programmers or engineers with sufficient technical knowledge to understand the weak points in a security system.

Spoofing - to deceive for the purpose of gaining access to someone else's resources (for example, to fake an Internet address so that one looks like a certain kind of Internet user).

Smurfing - is the attacking of a network by exploiting Internet Protocol broadcast addressing; Echo responses are sent to victim address, which can flood the network making it unusable for real traffic. One way to defeat smurfing is to disable IP broadcast addressing at each network routers.

also - Spam/Piracy/Counterfeiting

Solutions can include: Good security policies, including acceptable use policy (AUP). Intrusion detection systems; Firewalls - security systems designed to prevent unauthorised access to or from a private network.

Question 4

a) In view of current trends in computing technology, discuss changes you foresee in the way computers will be *used* in the future. You are not required to state the obvious, such as faster speeds and more memory.

(15 marks)

b) The Internet has grown to an extent that it is now difficult to control the activities taking place. Discuss ways you think illegal and unethical activities can be curbed on the Internet.

(15 marks)

Answer Pointers:

a) This was an open ended question allowing the candidate to demonstrate their broad understanding and appreciation of computing. One approach to answering the question was as follows:-

Computing would become all pervasive (Ubiquitous) - a trend towards increasingly computing devices in the environment, a trend being brought about by a convergence of electronics, in particular wireless technologies and the Internet. This includes mobile computing and embedded devices in almost any type of object, including cars, tools, appliances, and various consumer goods - all communicating through increasingly interconnected networks. Emerging technologies: mobile computing, wearable computers; smart homes; speech recognition.

b) As with part a), this section allowed the candidate to express their views and thoughts. Some areas that could have been mentioned include the following:-

Strong powers to the police to seize and have access to records of cyber crimes like hacking, pornography, racial incitement;

Proposals that email and other communications should be able to be intercepted by appropriate government authorities.

Internet service providers and other carriers to provide a mechanism through which government agencies could look at suspect communications.

International agreements on the jurisdiction that nation states have for activities that happen over the Internet.

Section B - Comments

Question 5

- a) What is meant by the bandwidth of a bus when referring to computer systems?** (6 marks)
- b) State two ways by which the bandwidth of a bus can be increased.** (6 marks)

This was not a popular question and those that attempted the question generally gained poor marks. There appeared to be a basic lack of knowledge on the subject.

Answer Pointers:

- a) Bandwidth is used to mean how fast data flows on a given transmission path, expressed in bits per second.
- b) Increasing bandwidth: increase bus size; increase clock speed.

Question 6

- a) What is the difference between machine language and assembly language?** (6 marks)
- b) An instruction comprises an "op-code" and an "operand". Explain the significance of each.** (6 marks)

Most candidates had a reasonable understanding of the topic and addressed the issues asked.

Answer Pointers:

- a) Machine language is the basic language of computers, consisting of a stream of 1's and 0's. Assembly language reflects the basic instruction set of the processor, in humanly understandable form. One-to-one correspondence with machine language.
- b) *Op-code* the type of instruction to be carried out; *Operand* the "data" the instruction operates with.

Question 7

- a) State what *RAM* and *ROM* stand for, and describe the characteristics of each. What is each used for in a computer system? (8 marks)
- b) What is the purpose of a modem? Briefly explain how it operates. (4 marks)

A purely factual question and the most popular question on the paper as well as being the best answered question.

Answer Pointers:

- a) RAM (random access memory) is the place in a computer where the OS, application programs, and data in current use is kept so that they can be quickly reached by the processor. Volatile. ROM is computer memory containing data that normally can only be read, not written to. ROM contains the programs that allows a computer to be "booted up". Non-volatile.
- b) A modem modulates outgoing digital signals from a computer (or other digital devices) to analogue signals that are transmitted along telephone lines and demodulates the incoming analogue signal and converts it to a digital signal for the computer (or other digital device).

Question 8

What is meant by a network topology? Describe three typical network topologies giving one advantage and one disadvantage of each topology. (12 marks)

As with question 7, a popular question and well answered.

Answer Pointers:

In communication networks, a topology describes the configuration or arrangement of a network (nodes and connections). Types - Bus, Star, Ring.

Bus: advantages - low cost, easy expansion; disadvantages - low speed, limited size

Star: advantages - easy expansion, easy maintenance; disadvantages - high cost if switch breaks then the whole network is down

Ring: advantages - fast, low cost; disadvantages - if any node breaks the whole network is down (unless FDDI).

Question 9

- a) Define each of the following number representations: *fixed-point*, *floating-point*, *sign-magnitude*, *two's compliment*. (8 marks)
- b) Convert the following base-ten number to hexadecimal: 462 (4 marks)

This question was surprisingly poorly answered. Part b) was very straightforward but remarkably few candidates checked their answer by quickly converting their answer back to a base 10 number.

Answer Pointers:

Fixed point: binary number with a fixed radix point (fractional part); Floating point number does not have a fixed radix and is stored in three parts: *sign* (plus or minus), *mantissa* which are the digits that are meaningful, and *exponent* or order of magnitude of the mantissa, which determines the place to which the radix point floats.

462 to the base 10 is 1CE to base 16.

Question 10

- a) Write a Boolean expression for the exclusive-OR (XOR) operation. Show how it can be implemented with AND, OR and NOT gates.

(6 marks)

Note: The XOR operation is true if either input is true but not both.

- b) A three-input digital circuit gives a TRUE output when a majority (i.e. 2 or more) of the inputs are TRUE. Draw the circuit implementation.

(6 marks)

Two very simple answers were required. Candidates appeared to either know how to tackle this type of question or did not really know how to approach the topic.

Answer Pointers:

- a) $AB' + A'B$
b) $AB + BC + AC$

Question 11

Data transfer to and from peripherals may be handled in one of three modes: Programmed I/O, Interrupt-driven I/O and Direct Memory Access (DMA). Describe the characteristics of each transfer mode.

(12 marks)

Most candidates knew one or sometimes two approaches but few knew all three.

Answer Pointers:

Programmed I/O - data is exchanged between CPU and I/O; No other activity is possible during data exchange; CPU has to sense I/O device status.

Interrupt-driven I/O - CPU issues I/O command and continues to execute other instruction; is interrupted by I/O device when it is ready.

DMA - I/O and main memory exchange data without CPU involvement. Extra hardware (DMA controller) is required.

Question 12

- a) Define what is meant by a page, a frame and a page-fault in the operation of virtual memory. (6 marks)
- b) A virtual memory system has an address space of 256K words, a memory space of 16K words and a frame size of 4K words. How many pages and frames are there? (6 marks)

The least popular question on the paper by a long way and the weakest answered question. Candidates clearly had little knowledge of virtual memory.

Answer Pointers:

- a) Page - a partition (proportion) of secondary memory that is transferred to main memory as a block; Frame - a partition of RAM into which pages are loaded; Page fault - reference to a memory address that is not contained in RAM
- b) No of pages - $256/4$; No of frames $16/4$.