THE BCS PROFESSIONAL EXAMINATION
Certificate

October 2003

EXAMINERS' REPORT

Technology

General Comment

The performance in this examination was rather poorer than in the previous sittings particularly in section A. The standard of the answers was poor across the venues.

Many candidates performed well on questions that required brief description of concepts, but not where some analysis or insight was required. A significant proportion of candidates did not attempt the requisite number of questions, while some attempted more questions than was required.

A number of candidates were unable to express their ideas clearly.

The completion of the front page of the Answer Book continues to cause confusion to a number of candidates.

Question 1

A typical high-performance personal computer employs a wide variety of memory subsystems, many of which use a different storage technology (for example, semiconductor dynamic memory and optical storage).

a) Why don't computer manufacturers use one single memory technology? **(6 marks)**

b) Describe the characteristics (brief principle of operation, speed and capacity, cost) of the memory technologies found in a typical high-performance personal computer. **(18 marks)**

c) A hard disk has a rotational speed of 15,000 rpm. A track contains 128 sectors and each sector holds 1,024 bytes. Derive an algebraic expression for each of the following and calculate their values.
   i) The rotational latency.
   ii) The time taken to read a sector once it has been located.
   iii) The rate at which data is read from a sector. **(6 marks)**

Answer Pointers

Candidates were not able to explain the reasons why a single memory technology is required. Few candidates explained that both RAM and hard disks are needed with details such as cost, power and access time. Some candidates described the memory hierarchy (answer for part b) without explaining why single memory technology is suitable.

Whilst some candidates provided sufficient details on different memory types, others simply mentioned them. Answers lacked accurate details of such comparison between the different technologies. Some candidates mentioned magnetic tapes. Few candidates provided a correct hierarchy.

Candidates were not able to derive a correct formula. Some candidates managed to produce an answer without deriving the formula.

Question 2

The Internet has created one of the most powerful tools imaginable for a wide range of people. Academics can use it to carry out research without having to go to a library. People can use it at home to keep in touch with friends round the world. Some can book flights and hotels on-line.

a) Unfortunately the Internet is vulnerable to a range of attacks or abuses from those who would commit mischief. Some threats are from malicious programs and some from those who would use the Internet to carry out fraudulent activities.

Describe the various types of malicious threats to the Internet. **(18 marks)**

b) What can be done to deal with such threats to the Internet? **(12 marks)**

Answer Pointers

Candidates provided various general threats to the internet. It was very unfortunate to note that candidates were more inclined to discuss issues such as pornography, terrorism and racism as 'threats to the Internet'. The real threats, i.e. virus, worm and trojan horse were simply mentioned by candidates. Candidates failed to describe the operating principles of these. Some candidates mentioned that a virus can infiltrate a computer system through a floppy disk (in a stand alone system), hence deviating completely from the threat to the internet. Many candidates mentioned hacking. Unfortunately, candidates failed to relate hacking during the use of internet.

Once again, answers lacked depth and breadth. Anti virus software and firewalls were simply mentioned by candidates. Very few candidates demonstrated a good knowledge of how to deal with threats to the internet. Unfortunately, policing the net and tough laws for criminals were favourite answers from candidates. At least one candidate was aware that professional organisations such as the BCS promote professional codes of practice.

Question 3

Consider the calculation $S = \sum x_i \cdot y_i$.

This expression takes pairs of elements in two vectors, multiplies them together and adds them to a total. This expression is also called an *inner-product*.

With the aid of appropriate diagrams describe how such an expression is evaluated by a computer at the machine level.
HINT: What addressing mode is made use of during the evaluation of this expression?
Your explanation should include a discussion of the von Neumann computer, its buses, register, functional units, machine-level instructions and addressing modes. **(30 marks)**

Answer Pointers

Candidates were required to describe the Von Neumann Machine via a problem.

Candidates who attempted this question failed to specify whether they were using a real or teaching machine. Most answers started with a sketch showing the various components of the computer. Candidates then either listed down various registers or provided brief explanations of these. Very few answers showed the relation between the registers, the functional units, machine-level instructions and addressing modes of the Von Neumann machine. Above all, the actual problem which required an evaluation was ignored. No candidate was able to provide assembly language codes for the problem.

Question 4

All computers provide input and output systems in order to communicate with devices ranging from the video display to the mouse, modem, and scanner.

a) A common I/O mechanism is the so-called "interrupt". Explain what an interrupt is and how it is used to implement an I/O mechanism. **(15 marks)**

b) A particular computer takes 5 μs to call an interrupt handler in response to a peripheral. It takes the peripheral 10 μs to set up a data transfer and then information can be transferred across a 16-bit parallel data bus at the rate of 2500 transfers in 10 ms. It takes the computer a further 15 μs to return from the interrupt.

If this computer does nothing other than respond to interrupts from the peripheral, what it the maximum sustained data rate that can be achieved? Carefully explain all your workings and assumptions. **(10 marks)**

c) Why has the USB interface proved to be so very successful? **(5 marks)**

Answer Pointers

Answer to this part of the question lacked proper explanation. Few candidates knew what an interrupt is and that it allows a computer to respond to request for attention from a peripheral. Candidates were unable to give a proper explanation of how the processor handles an interrupt from a peripheral device. Some candidates mentioned that the processor prioritise interrupts.

Candidates were unable to provide a correct to this question. Very few candidates managed to work through the given data to obtain an answer. Some candidates were able to calculate the total time to process interrupt as 30 μs. Little explanation and assumptions were available in the answers.

Most candidates knew what a USB interface is. Candidates were unable to explain the reasons why the interface has proved to be successful. The most common answers included the plug and play feature.

Question 5

Give a brief description of each of the following, and state their functions in a computer system:

a) cache memory
b) main memory
c) registers
d) virtual memory **(4 x 3 marks)**

Most candidates answered this question quite well and showed an understanding of their functionality in a computer system, for example by illustration of different levels of cache or virtual memory techniques.

Answer Pointers

a) Cache memory – a buffer memory used to hold copies of instructions and data that are likely to be required soon by the processor;
b) Main memory – storage used to hold data and instructions currently been used by the program under program.
c) Registers – high speed memory inside the CPU that are used during the instruction cycle.
d) Virtual memory – a technique for running larger program than main memory can hold, by swapping between main memory and secondary memory.

Question 6

Perform the indicated operations.

a) Convert the following numbers to twos complement and find their difference using twos complement arithmetic: 125, -34.
b) 010001 AND 101010
c) 100110 XOR 110011
d) Write the following hexadecimal number as a binary number: ABDE **(4 x 3 marks)**

Most candidates were able to perform the arithmetic correctly, with a few exceptions.

Answer Pointers

a) A minimum of 8 bits are required to represent the numbers in 2's compliment; 1 bit for the sign. 125 = 01111101. 34 = 00100010, which means -34 = 11011110? The sum of the two numbers is 01011011 (ignoring the overflow). Can be checked decimal arithmetic (ans. 91)

Most candidates did not recognise that a sign bit was required and derived -34 without accounting for the sign bit, which results in an incorrect answer.

b) 010001 AND 101010 = 000000
c) 100110 XOR 110011 = 010101
d) ABDE = 1010101111011110

Question 7

Write short notes on each of the following:

a) Computer viruses
b) Search engines
c) Web browser
d) IP address **(4 x 3 marks)**

A large number of candidates did not show a deep knowledge of the issues but could give a satisfactory description of each.

Answer Pointers

a) Computer viruses – malicious program codes design to cause damage to computer data, operating system or other software.
b) Search engines – software tools for access and retrieval of information from the vast sources available through the Internet.
c) Web Browsers – software for viewing hypertext and multimedia documents.
d) IP address – a unique description (address) of any device connected on a computer network.

Question 8

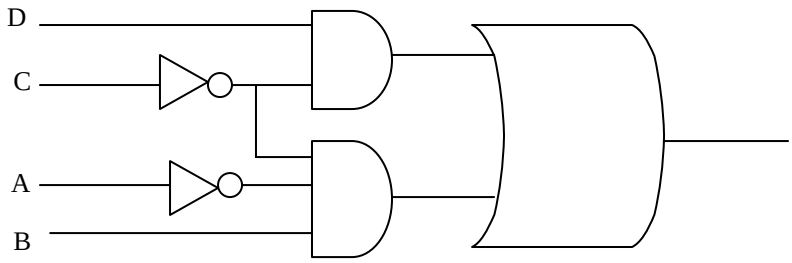
Simplify the following function and draw a circuit for the reduced function.

$$\overline{A}\,\overline{B}\,\overline{C}D + \overline{A}B\overline{C}D + AB\overline{C}D + A\overline{B}\,\overline{C}D + \overline{A}B\overline{C}\,\overline{D} + AB\overline{C}D \quad \textbf{(12 marks)}$$

Few candidates reduced the function to the required form. A number of candidates could not identify symbols for the logic devices to be used in drawing.

Answer Pointers

By use of a Karnaugh map (easiest) or step-by-step reduction the reduced function is: C'D+A'BC'



Question 9

Briefly explain the purpose of a personal computer's operating system and, in particular, its interaction with the hardware.

Most candidates could state most of the functions of the OS, but without explanation of the actual functions.

Answer Pointers

The OS is the interface between the hardware and software (any command to the hardware is managed by the OS); these include memory management, file management, time-sharing, peripheral management, and is also the interface between computer and users.

Question 10

a) Outline the stages of the compilation process. State the purpose of each stage. **(8 marks)**

b) How does a compiler differ from an interpreter? **(4 marks)**

Only a few candidates attempted this question, and answered it satisfactorily.

Answer Pointers

Syntax analysis checks valid instructions, identifiers and language grammar; Lexical analysis derives tokens from identifiers and instructions, which are used as references; Code generations produces object code; Linking combines object code with run-time libraries to generate executable code.

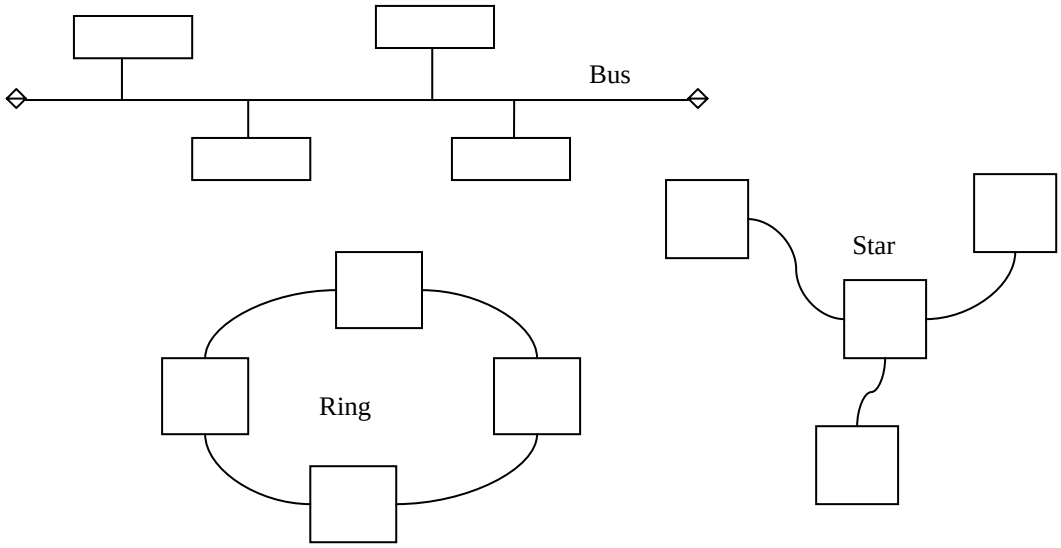
Compiler analyses the whole source code and translates into object code before execution. Translator analyses source code line-by-line and executes immediately. Compiled object is faster to run, but any change to source code will mean re-compiling.

Question 11

11. With the aid of diagrams, compare and contrast Bus, Ring and Star network topologies. **(12 marks)**

Most candidates could provide a graphical representation of each topology, but the comparisons seemed to restrict only to the failure of the respective computers in the networks.

Answer Pointers



Bus – cheaper and easier to implement; limited in distance so suitable for LAN, slow because of possible collisions in sending messages; if one station fails does not affect the rest of the network.

Ring – cheaper and easier to implement; not limited in distance since messages are re-generated, suitable for WAN; fast; if one station fails the whole network down unless FDDI.

Star – more expensive and difficult to implement (expensive cabling, switch and control software); fast; if switch breaks network down, if stations break down the rest of the network is not affected.

Question 12

12. Describe the following addressing modes and state how references to memory are needed for each.

a) immediate
b) direct
c) indirect
d) indexed **(4 x 3 marks)**

Most candidates provided satisfactory answers to the question.

Answer Pointers

a) Immediate – the data is contained in the instruction. No reference to memory required.
b) Direct – the instruction refers to the memory location where data can be obtained. 1 memory ref.
c) Indirect – instruction refers to a location holding the address of the data. 2 memory references.
d) Index – the instruction contains the memory location and a register holds a displacement from that address. 1 memory reference.