

**THE BCS PROFESSIONAL EXAMINATION
Certificate**

April 2003

EXAMINERS' REPORT

Technology

General

Section A of the paper continues to be problematic to many candidates. Many are not able to offer answers to the required level of detail, commensurate with the marks awarded for questions in this section. This may be because the students lack the knowledge to answer the questions adequately, or do not understand the required detail of their responses. It is also evident that questions that require an appreciation of recent advances in technology do not get satisfactory answers, which is possibly due to the country backgrounds of the majority of candidates. However, a positive observation is that the breakdown of questions in Section A into three or more parts aided able candidates to give more satisfactory answers.

Question 1

1. Consider the high-level constructs:

```
x = 4;  
y = 5;  
z = x + y;
```

- a) Describe, with the aid of diagrams, a general-purpose digital computer that can perform these operations. Your description should include reference to functional units such as buses and registers. **(10 marks)**

- b) What sequence of events takes place when the above fragment of code is executed on the computer you described in part a)? Your answer should be pitched at the “register transfer level”. **(10 marks)**

- c) All modern computers provide an addressing mode that is sometimes called “memory indirect addressing” or “indexed addressing” or “pointer based addressing”.

Explain what this addressing mode is and how it is used. Give a typical example of the use of this indirect addressing mode. **(10 marks)**

Many candidates were able to offer a satisfactory architecture of a general-purpose computer. The arithmetic algorithm given seems to have been a source of confusion to candidates, while it was evident many candidates were knowledgeable of the sequences within a machine cycle. Many candidates were aware of “indirect addressing” but probably not how it can be used in program execution.

Answer Pointers

For part a) the standard CPU diagram with PC, MAR, MBR, IR, etc and BUSES was expected.

Part b) required a simple explanation of how instructions are executed; a simple example, e.g. $x = 4$, is often helpful to explain the process.

The important point in part c) was for the candidate to understand that the address of the operand is held in a register and that it can be modified at run-time. An example involving adding numbers in a list or stepping through the characters in a string were acceptable examples.

Question 2

2. a) Describe the basic operating principles of a hard disk drive that uses magnetic recording technology. (10 marks)
- b) Briefly describe the progress made by hard disk technology over the past few years (i.e., improvements in capacity, access time, reliability, latency, interface). (8 marks)
- c) What is *flash memory* and why is it so important in computer systems? (6 marks)
- d) Why is flash memory having such an impact on digital systems and computer-based systems generally? Provide appropriate examples. (6 marks)

Knowledge of the construction of hard-drives was limited among most answers and very few candidates were knowledgeable of the recent advances in hard drive technology. Part c) of the question was answered satisfactorily by most candidates. Candidates had difficulty in differentiating what was required in part c) and part d).

Answer Pointers

The first part of the question was once again looking for standard book work answer but this time a description of a hard disc.

An indication of the increase in capacity (e.g. 200Gb) and rate of increase (e.g. 60% per annum), of rotational speeds (7,200 rpm common with 15,000 rpm available), and access time (around 6ms) were being looked for in part b).

FLASH memory is a semiconductor read-mostly memory that uses EPROM technology to store data. Data can be read electronically and written electronically into data cells. It has a fast read access time but a relatively slow write time. FLASH memory can be used to store data (e.g. BIOS).

FLASH memory is now the basis of digital cameras and MP3 memory systems. FLASH memory is important because an entire branch of computing (personal, mobile, pervasive) depends on it.

Question 3

3. The operating system is arguably the most important piece of software that runs on a general-purpose computer.
- a) Why is the operating system considered such a key element of a general-purpose computer? (10 marks)
 - b) Describe how a computer's interrupt-handling mechanism can be used by the operating system to support input/output operations. (10 marks)
 - c) Two operating systems are competing for the world market for personal computers, workstations and servers. These are Microsoft's Windows™ and Linux. What are the fundamental differences between these two operating systems and explain why Windows and Linux are locked in such a gigantic struggle? (10 marks)

Answered by most candidates and satisfactorily in many cases. Part c) required knowledge of current trends, which seemed an obstacle to many candidates.

Answer Pointers

Parts a) and b) were once again book work questions. Mention of how the operating system coordinates the various sub-systems and provides a user interface was expected. A brief description of the types of interrupts and how they operate was expected.

Part c) was looking for the candidates' awareness of trends in the computing industry. A brief comparison of the two systems was expected. The stronger candidates considered the operating systems from the naïve user, the professional user, the corporate user and the computer vendor's perspective.

Question 4

4. Digital information cannot be directly transmitted across the public switched telephone network (PSTN).
- a) Explain why this statement is true. (5 marks)
 - b) What techniques may be used to transform digital information into a form that can be transmitted over the PSTN? (5 marks)
 - c) Describe the characteristics of a modern modem. (5 marks)
 - d) Over the past few years, the maximum rate at which PCs can transmit data across the PSTN has increased. Discuss current developments in data transmission and modem technology that are leading to further improvements in data rates. (7 marks)
 - e) A few years ago, devices such as modems and printers were invariably connected to a computer via an RS 232 data link (now known as EIA 232). Today, the serial interface provided by RS 232 is becoming less popular and is being replaced by the USB (universal serial bus) interface. Explain why USB has become so much more popular than RS 232. (8 marks)

Answers to parts a), b) and c) were overlapping in many cases. Part d) was a problem in many cases, while part e) was only answered satisfactorily in isolated cases.

Answer Pointers

The "last mile" of the telephone network is analogue so it is necessary to convert digital signals to analogue form before transmission.

Part b) expected mention of a modem and a description of modulation.

A short description of a modem (including mention of data rate of up to about 56 kps) was expected.

Data rates are increased by complex modulation (QAM = quadrature amplitude modulation), error detection and correction techniques, and data compression.

RS232 is very limited in terms of data rate, functionality and the large number of control signals (designed only for modems). USB is very fast (over 12Mbps for USB 1) and is simple to implement (only 4 wires and a simple plug). USB incorporates addressing and supports multiple networked devices unlike RS232. USB is also integrated into the "plug and play" technology that supports automatic interface identification.

Question 5

5. a) You are asked to install a PC in a small office. You are told that the computer should be "as reliable as possible" because the effect of down time can be expensive. What steps would you take to ensure that the computer was reliable?

(6 marks)

- b) A computer has a memory system that consists of a hard disk controller card and two hard disk drives. The memory system is usable as long as the controller and at least one of the hard disk drives continues to function.

If the probability of the controller failing in a year is 0.01 and the probability of a hard disk failing is 0.2 in a year, what is the probability of the system failing in a year?

(6 marks)

Not many candidates answered this question. Answers to part a) were non-technical and subjective. Very few candidates offered a reasonable attempt to part b).

Answer Pointers

In order to answer this part of the question candidates had first to define what features they believed affected "reliability" and then say how they might address these issues.

The second part was a simple probability question. The system would fail if either the controller failed or both discs failed together.

Question 6

6. a) Why is an interface necessary to connect an external peripheral to a CPU?

(6 marks)

- b) Define what is meant by *Direct Memory Access* and describe its operation.

(6 marks)

Few candidates offered satisfactory answers to part a) while part b) was better answered.

Answer Pointers

Items such as speed, handshaking etc were looked for in part a). Part b) expected a brief book work definition DMA and its operation.

Question 7

7. Describe the primary use of each of the following memory devices, and state whether the device is volatile or not:
- a) Cache
 - b) Registers
 - c) RAM
 - d) ROM

(12 marks)

The greater majority of candidates answered this question with a very high proportion of satisfactory answers.

Answer Pointers

With only 3 marks per section just a brief explanation of each term was required. A two page description of cache memory, for example, was not expected or required.

Question 8

8. A Boolean expression in four variables is expressed as:

$$F = ABC\bar{D} + ACD + \bar{A}\bar{B}\bar{C}\bar{D} + ABC\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D}$$

- a) Express the function F as a simplified Standard Sum of Products.
- b) Draw a circuit diagram that implements the simplified function F .

(6 marks)

(6 marks)

Similar to question 7, the greater majority of candidates answered this question with a very high proportion of satisfactory answers.

Answer Pointers

The simplified expression was $AB + AC + \bar{B}\bar{C}\bar{D}$

Question 9

9. Carry out the following binary operations:

- a)
- i) 111000
 AND
 101001
- ii) 111010
 OR
 101101
- iii) 111001
 XOR
 111001

(6 marks)

- b)
- i) 111100
 ADD
 101001
- ii) 011100
 ADD
 001001

Comment on the results of the two additions assuming all the numbers are two's complement numbers.

A straightforward question with part a) very well answered.

Answer Pointers

In part b) candidates were expected to comment on whether the values were positive or negative and whether overflow occurred.

Question 10

10. With respect to local area networks, state the meaning of the following terms: *topology, protocol and medium*.

The first part of the question was answered better than the second part.

Answer Pointers

Both parts of the question required standard bookwork answers although a number of candidates struggled to differentiate between peer to peer and client-server.

Question 11

11. Briefly describe the characteristics of each of the following programming languages:

- a) machine language
b) assembly language
c) high-level languages
d) fourth generation languages.

(12 marks)

Many candidates attempted this question, however, the proportion of satisfactory answers was surprising low.

Answer Pointers

The sections of the question were sequenced so that candidates could start by describing the lowest level of language and build up to fourth generation languages.

Question 12

12. The following are part of the instruction-set of a simple computer:

LD0, i - Load accumulator (immediate mode);
LD1, m - Load accumulator (direct mode);
LD2, m - Load accumulator (indirect mode);
AD0, i - Add to accumulator (immediate mode);
AD1, m - Add to accumulator (direct mode);
AD2, m - Add to accumulator (indirect mode);
ST0, m - Store contents of accumulator in specified location;
HLT - Halt

where i is a constant (immediate, literal) and m is a memory location.

Given the contents of the computer's memory shown below, state what happens when EACH of the following instructions are carried out:

- i) LD2, 101
- ii) AD1, 102
- iii) AD0, 103
- iv) ST0, 104

Location No.	Content
101	105
102	104
103	103
104	102
105	101

(12 marks)

Unlike a lot of the questions in this section of the paper, this required candidates to apply information given rather than recall bookwork. It was perhaps due to this different type of question that not many candidates attempted the question although of those who attempted the question the level of satisfactory answers was high.

Answer Pointers

The important point for candidates to recognise was whether the operand of the instruction was a constant or the address of a memory location.