BCS PROFESSIONAL EXAMINATIONS
BCS Level 4 Certificate in IT

April 2008

EXAMINERS' REPORT

Computer and Network Technology

This report is for Sections A and B of the paper and consists of two sections:

1. Overall comments
2. Detailed questions' report

1. Overall Comments

The most popular question was 11 and the least popular was 1.

As in previous sittings, many candidates did not follow instructions and accordingly did not encircle the question numbers at the front of their scripts. Candidates failed to write the question number at the top of every page of the scripts. Centres and course providers must impress this rule on their candidates as omission of vital information causes problems during marking. The level of English was bad in some centres, hence the inability for candidates to express themselves clearly.

While marking scripts from various centres, it was felt that candidates did not seem to have studied the various topics well. Course providers must endeavour to explore this syllabus in depth. Computer and Network Technology is a core aspect of an IT Professional. Gap in knowledge with regards to this area can pose serious problems in understanding more advanced and specialist IT concepts. If in doubt, course providers must seek clarification from the BCS examinations office.

Overall, the pass rate during this examination session has improved compared to previous sessions.

2. Detailed Questions' Report

It is very unfortunate to note that many candidates and course providers did not analyse past trends for this paper. Some elements of the paper have been examined during previous sittings. If candidates had paid attention to this, they would have been better prepared, and accordingly written good answers. It is also worth mentioning that candidates seemed to ignore the amount of marks allocated to questions in section A and B. When writing answers, candidates must carefully keep in mind that questions 1, 2, 3 and 4 each carries 30 marks. Accordingly, candidates must write sufficiently in-depth answers to attract these marks. Short answers which lack depth did not enable candidates to score well in section A.

Below are answers pointers to each question.

Section A

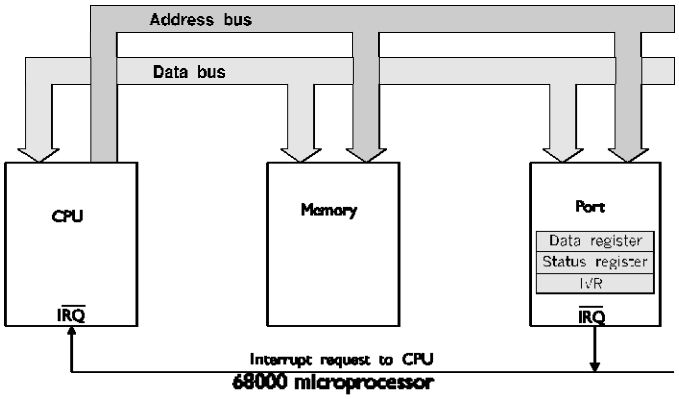
Question 1

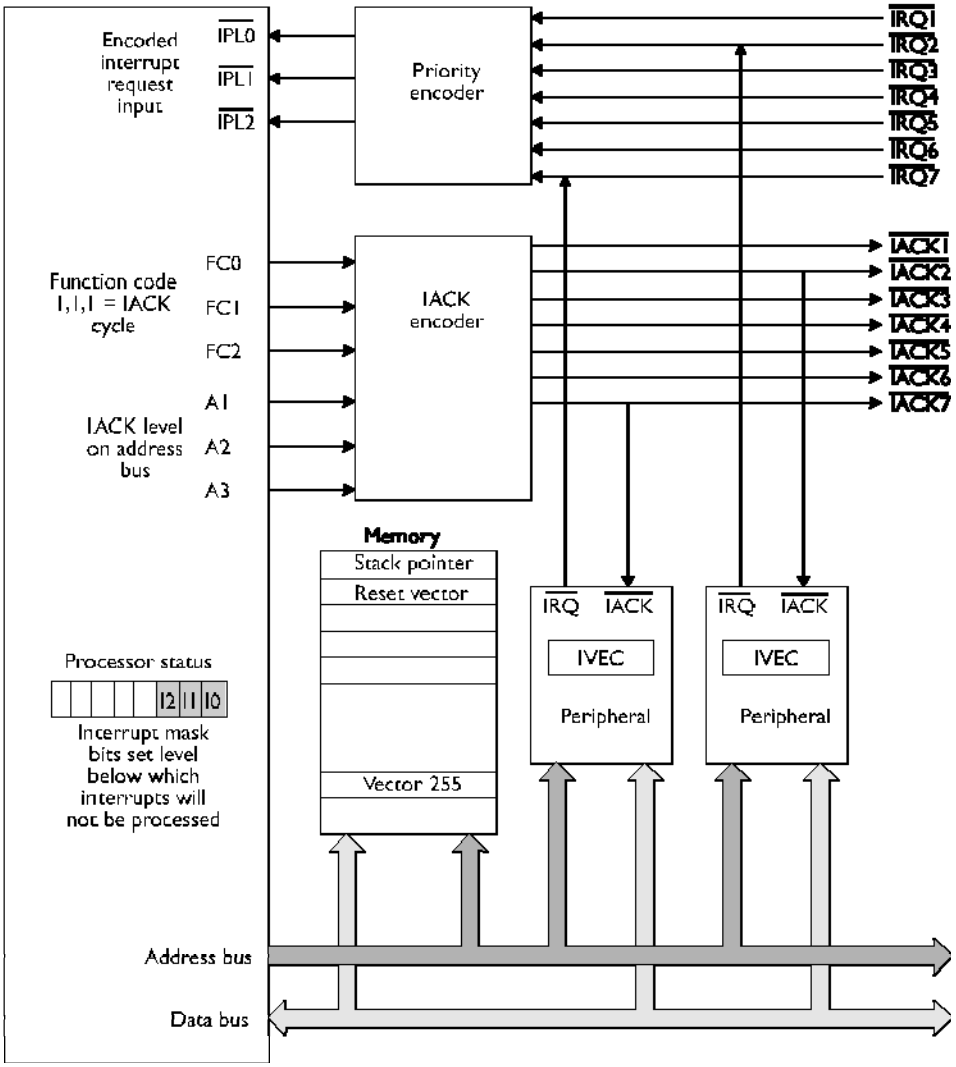
a) There are three ways of moving information into or out of a computer: polled input/output, interrupt-driven input/output and DMA.

Describe, with the aid of diagrams, how a computer may implement **interrupt-driven** input/output. Your answer should describe the advantages and disadvantages of this method with respect to the two other input/output methods. Your answer should also include descriptions of **vectored interrupts** and **prioritized** interrupts.

(20 marks)

Answer Pointers

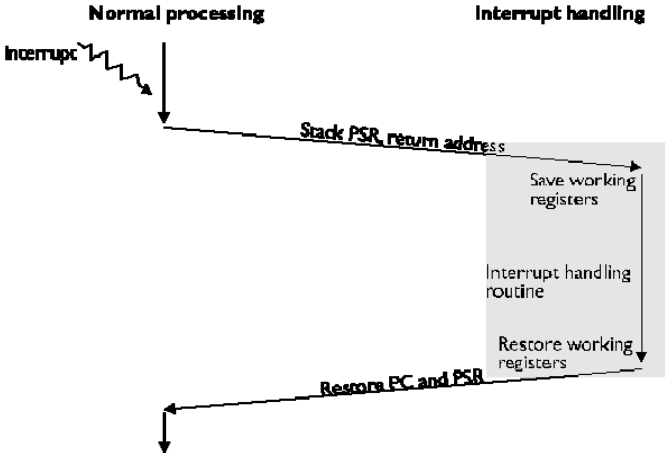




The above two diagrams describe an interrupt driven I/O system. The top figure is a very simple diagram showing only an interrupt request line from peripheral to CPU. The lower figure gives the full diagram of an interrupt system with prioritized vectored interrupts. The lower diagram is more complex than required. The upper diagram is the absolute minimum required for this question and would lead to a basic pass mark.

In a system with interrupt-drive I/O, each peripheral capable of taking part in an I/O transaction is connected to an interrupt request line that goes to the processor (CPU). When the processor detects the interrupt, it finishes it current instruction and jumps to the interrupt handling routine.

However, first it must save the return address (typically on the stack) and the processor status.



The above diagram illustrates the sequence of operations during an interrupt. The interrupt is processed by the appropriate software (usually part of the operating system) and then the program counter and machine status is restored to return the processor to its pre-interrupt status.

SEQUENCE OF EVENTS
1. The interrupt is detected. It may be masked (deferred) and is not dealt with until the mask in removed. It may be prioritized in which case it will be accepted only if it has a priority greater than the current priority (this allows important interrupts to take precedence over less important ones).
2. The machine state is saved (typically on the stack)
3. A jump to the appropriate interrupt handling routine is made. In a simple/basic system, each possible interrupting device is polled in software and its interrupt status bit read. This polling loop continues until all devices have been polled or the source of the interrupt located (note – important devices are checked first).
4. If the system used vectored interrupts, the polling sequence does not take place – the processor sends an interrupt acknowledge to all peripherals and the one that generated the interrupt returns a pointer to its interrupt handing routine. This mechanism is far faster than polling.

b) A computer transmits data to a peripheral at 400 Mbits/s. Information is transmitted in the form of 1024-byte blocks of data followed by a 128-byte block of control data. It is necessary to transfer the contents of an 8-Gbyte flash card to a computer using this data transfer mechanism. If we assume that the access time of the flash card is negligible, how long does it take to transfer the contents of a full 8-byte card to the computer? Is the assumption of negligible access time reasonable?

(10 marks)

Answer Pointers

The total data transmitted is 1024 x 8 + 128 x 8 bits per block = 9216 bits.
Data is transmitted at 400 Mbits/s = 2.5 ns/bit.
The time to transmit the block is 9,216 bits x 2.5 ns = 23,040 ns = 23.04 μs.
In practice this result would not be achieved because the access time of flash memory is relatively slow (Typically over 100ns per word.)

Question 2

a) A computer's architecture is composed of its register-set, instruction set, and addressing modes (that is, the architecture represents the assembly language programmer's view of the computer).

Define the terms **register-set**, **instruction set** and **addressing modes** and give examples of each of these terms (you may use a real processor or you may use a 'hypothetical' computer with which to illustrate your answer). Note – you should also make clear the difference between register storage and memory storage and explain why it is necessary for a computer to have both internal registers and external store).

(20 marks)

Answer Pointers

A register set is made up of a computer's architecturally visible (or user visible) registers that can be accessed by an assembly language.

Typical registers are general-purpose registers, data register, address registers, the program counter, stack pointer, and condition code (status) registers.

Computers usually have memory-to-memory instruction sets (architectures) or register to memory architectures. In the former, all data operations take place on registers – in the latter operations take place between a memory location and a register. Typical instructions are ADD R1,R2,R3 (register to register) or ADD PQR,D1 (memory to register).

In principle there is no difference between memory storage and register storage. Both hold user data. However, on-chip storage (registers) are far faster than external memory. Moreover, it takes only a few bits of addressing to select a register (typically 3 for 8 registers) whereas it takes typically 32 bits to access a location in memory.

ADDRESING MODES Addressing modes define the mechanisms used to define the operands that are loaded into memory or registers. Here are three fundamental addressing modes:
Literal – the actual operand is part of the instruction – used to access constants that do not change at run time
Absolute/direct – the actual address of a location in memory – used to access variables
Address register indirect (indexed or pointer based) – this mode is used to access memory via a pointer. It is used to deal with data structures such as arrays and tables because the pointer is a variable.

A typical microprocessor might implement the following code:

```
MOVE Table,A0  Memory direct addressing – set up the pointer
MOVE #10,D0    Immediate addressing – do 10 cycles
Loop  CLR  (A0)      Pointer based addressing – clear a location
ADD  #1,A0     Immediate addressing – increment the pointer
SUB  #1,D0     Decrement count – immediate addressing
BNE  Loop      Continue until all done
```

b) Year after year computers (CPUs or microprocessors) have steadily become faster in accordance with the empirical law known as **Moore's law**. This law has held for approximately four decades.

State, with reasons, whether you expect this law to hold true for the next two decades or whether computers are reaching limitations to their performance.

(10 marks)

Answer Pointers

Moore's law is formulated in various ways – the original observation was that the maximum number of devices per chip doubled every 18 to 24 months. It is often taken to mean that performance doubles every 18-24 months.

This question is intended to test whether a student is aware of the trends in computing. It should be marked liberally – award marks if the answer makes sense and is well argued – there is no correct single answer. Some points to note are:

Transistors and interconnections are getting smaller and smaller – because photolithography is used to make the chip devices cannot be made smaller than the projection of that device onto the chip. Features are already smaller than visible light. UV, Ion beams and X-rays have been used.
An electric current is a statistical entity. Normally, a current involves the flow of vast numbers of electrons. As transistors get smaller, there is a limit to how small a current can be – ultimately statistical fluctuations will cause errors.

As the number of transistors on a chip increases, the probability of one of them failing also increases. Eventually it is possible that it may be difficult to manufacture working chips.

Chip manufacturers are attempting to use multi-core or multi-CPU solutions. However, there is a limit to how well such parallelism can be exploited by software.

Advances in memory technology are lagging those in CPU technology in the sense that CPU cycle time is getting relatively faster than memory cycle time year by year. Processors spend more and more time waiting for memory.

For these reasons, there is a strong possibility that Moore's law will cease to be an accurate predictor of performance in the next few years.

Question 3

A circuit has four inputs, P, Q, R, S, representing the natural binary numbers 0000_2 = 0_{10}, to 1011_2 = 11_{10}. P is the most-significant bit.

The input code represents a month of the year with 0000 = January, 0001 = February, …, and 1011 = December. The circuit has one output, X, that is true if the number represented by the input is a month with 31 days. Note that months with 31 days are January, March, May, July, August, October, and December.

a) Construct a truth table for this circuit.

(7 marks)

Answer Pointers

Value PQRS		Month	F=31 days
0000	0	Jan	1
0001	1	Feb	0
0010	2	Mar	1
0011	3	April	0
0100	4	May	1
0101	5	June	0
0110	6	July	1
0111	7	Aug	1
1000	8	Sept	0
1001	9	Oct	1
1010	10	Nov	0
1011	11	Dec	1
1100	12	X	X
1101	13	X	X
1110	14	X	X
1111	15	X	X

Note that values 1100 are undefined because there are no months after 1011 and the output is labeled as X. This may be used as a don't care state.

b) Hence (or otherwise) obtain a Boolean expression for X in terms of inputs P, Q, R, and S.

(8 marks)

Answer Pointers

We can draw a Karnaugh map for this table. Below are two (one with and one without don't care conditions)

RS \ PQ	00	01	11	10
00	1	1	X	
01			X	1
11		1	X	1
10	1	1	X	

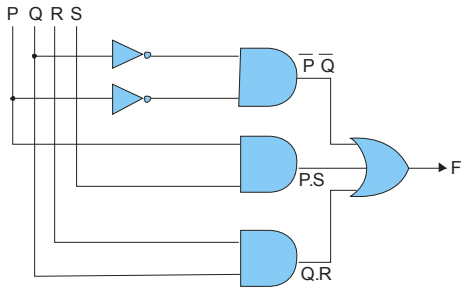
RS \ PQ	00	01	11	10
00	1	1		
01				1
11		1		1
10	1	1		

Using don't care conditions F = ~~P.S~~ + P.S + Q.R

c) Give the circuit diagram of an arrangement of AND, OR and NOT gates to implement this circuit.

(7 marks)

Answer Pointers



This is the circuit of the don't care version

d) Modify the Boolean expression of part (b) so that the output is true if the month has 31 days or is February (which can be 28 or 29 days).

(8 marks)

Answer Pointers

In this case, when PQRS is 0001, the output is also 1. That is, the expression for part b) needs to have PQRS added and then simplified.

Question 4

a) A modern operating system running on a PC or workstation provides two types of function. One function is the control of the physical hardware (processor, memory, discs, I/O, communications). The other function is the user interface; for example, Windows™.

Describe, in some detail (with diagrams where necessary) these two elements of the operating system. In particular, you should explain the range of both hardware control and user interface functions that are typically available today.

(20 marks)

Answer Pointers

The first function of an operating system is control of hardware (and software) resources. In particular, the operating system controls input/output mechanisms (printer, keyboard, mouse, display) and any communications or network interface.

The operating system also controls memory resources. In particular, it is responsible for controlling the disk (virtual memory) and ensuring that data needed by a program is on memory. The operating system also implements multi-tasking and allows several program to run at one.

The second function of an operating system is to act as the user interface; for example Windows. The user interface makes it easy for the user to operate the computer without having to understand the internal details of the operating system. This is the function of a GUI interface.

This aspect of the operating system is expanding as programs that were once considered applications are now integrated into the operating system (e.g., the internet browser). The operating system is also responsible for security – for example Windows now includes the function of a firewall.

b) Progress in computer hardware over the last few years has been immense (processor speed, memory capacity and speed, the increasing use of non-volatile flash memory, USB and FireWire serial interfaces, WiFi, and so on).

Using your knowledge of the progress that has been made in the past few years, describe (with reasons) what type of advances and progress you might reasonably see in operating systems design over the next decade.

(10 marks)

Answer Pointers

This is an entirely open-ended question and there is was an expectation of the student's ability to comment on trends and make coherent arguments. Students may concentrate on many areas – for example, the increased integration of the personal computer with domestic entertainment systems (usually networked via WiFi). Integrating entertainment systems would make it possible to, for example, use all the facilities of a GUI system to record video (the actual recording may be local or on other parts of the domestic system).

It is not impossible that operating systems could become more adaptive – responding to the needs of an individual user – a non-technical user may require a less sophisticated interface than a more sophisticated user.

Question 5

Network technology has developed rapidly over the past few years. Organisations are using state of the art equipment to conduct their business activities. Using suitable examples, describe the following network technologies :

a) Virtual Private Network (VPN)

(6 marks)

b) Intranet

(6 marks)

Answer Pointers

a) A network that is constructed by using public wires to connect nodes. For example, there are a number of systems that enable you to create networks using the Internet as the medium for transporting data. These systems use encryption and other security mechanisms to ensure that only authorised users can access the network and that the data cannot be intercepted

Using a public network, usually the Internet, to connect securely to a private network, such as a company's network is the basis of a VPN. Companies and organizations will use a VPN to communicate confidentially over a public network and can be used to send voice, video or data. It's an excellent option for remote workers and organizations with global offices and partners to share data in a private manner.

b) A network based on TCP/IP Protocols (an internet) belonging to an organization, usually a corporation, accessible only by the organization's members, employees, or others with authorisation. An intranet's website looks and acts just like any other website, but the firewall surrounding an intranet fends off unauthorised access.

Like the internet itself, intranets are used to share information. Secure intranets are now the fastest-growing segment of the Internet because they are much less expensive to build and manage than private networks based on proprietary protocols.

Question 6

The computer's memory is crucial to its operation. There are different types of memory which enable various tasks to be executed.

a) Describe and explain the need for Virtual Memory in a computer.

(6 marks)

b) *Paging* or *Swapping* is a technique used for Virtual Memory. Explain what Paging is. When does an Invalid Page Fault occur?

(6 marks)

Answer Pointers

a) An imaginary memory area supported by some OS; e.g. Windows in conjunction with the hardware. Virtual Memory is an alternate set of memory addresses. Programs use these virtual addresses rather than real addresses to instructions and data. When the program is actually executed, the virtual addresses are converted into real memory addresses.

The purpose of virtual memory is to enlarge the address spaces, the set of addresses a program can utilize. For example, virtual memory might contain twice as many addresses as main memory. A program using all of virtual memory, therefore, would not be able to fit in main memory all at once. Nevertheless, the computer could execute such a program by copying into main memory those portions of the program needed at any given point during execution.

b) A technique used by virtual memory operating systems to help ensure that the data is available as quickly as possible. The OS copies a certain number of pages from storage devices to main memory. When a program needs a page that is not in main memory, the operating system copies the required page into memory and copies another page back to the disk. One says that the operating system *pages* the data. Each time a page is needed that is not currently in memory, a page fault occurs. An invalid page fault occurs when the address of the page being requested is invalid. In this case, the application is usually aborted.

Question 7

BCS Students can access the BCS website and make use of various resources.

a) 'To access the BCS website, students need to know BCS's URL'. Explain this statement using BCS website as an example.

(6 marks)

b) BCS Examiners' reports are available on the website as PDF files. Describe the characteristics of a PDF file.

(6 marks)

Answer Pointers

a) ***URL : U****niform* ***R****esource* ***L****ocator,* the global address of documents and other resources on the World Wide Web. The first part of the address indicates what protocol to use, and the second part specifies the IP address or the domain name where the resource is located.

For example

http://www.bcs.org.uk or ftp://www.bcs.org.uk/file.pdf

b) PDF : Short for *Portable Document Format,* a file format developed by Adobe Systems. PDF captures formatting information from a variety of desktop applications, making it possible to send formatted documents and have them appear on the recipient's monitor or printer as they were intended. To view a file in PDF format, Adobe Reader is needed, a free application distributed by Adobe Systems

Question 8

Various techniques are available for network security. Briefly describe each of the following terms:

a) Data Encryption
b) Digital Certificate
c) SSL
d) S-HTTP

(3 marks each)

Answer Pointers

a) The translation of data into a secret code. Encryption is the most effective way to achieve data security. To read an encrypted file, you must have access to a key or password that enables you to decrypt it.

b) An attachment to an electronic message used for security purposes. The most common use of a digital certificate is to verify that a user sending a message is who he or she claims to be, and to provide the receiver with the means to encode a reply.

c) and d) SSL is designed to establish a secure connection between two computers; S-HTTP is designed to send individual messages securely.

The OSI model and TCP/IP protocol suite are crucial in enabling interoperability of hardware and software components from different manufacturers.

Question 9

The OSI model and TCP/IP protocol suite are crucial in enabling interoperability of hardware and software components from different manufacturers.

a) Describe what TCP/IP protocol suite is

(3 marks)

b) Compare and contrast the TCP/IP layers to those of the OSI model

(9 marks)

Answer Pointers

Coverage of both OSI model and TCP/IP as major standards for interoperability of hardware and software from various manufacturers.

TCP/IP has only 4 layers and OSI has 7 layers.

TCP/IP	OSI
Layer 1 – Network Interface	Layer 1 and Layer 2 - Physical and Data Link
Layer 2 – Internet	Layer 3 – Network
Layer 3 – Transport	Layer 4 – Transport
Layer 4 – Application	Layer 5, 6, 7 – Session, Presentation and Application

Question 10

With reference to wireless computing, explain each of the terms below :

a) Wi-Fi

(4 marks)

b) Bluetooth technology

(4 marks)

c) GPS

(4 marks)

Answer Pointers

This question require explanations of the terms and simple reference to their uses in day to day activities.

Question 11

With wider access to the internet, computer users face increasing security threat. Describe each of the security threats and suggest possible ways of dealing with these.

a) Trojan Horse
b) Hacking
c) SPAM
d) Phishing

(3 marks each)

Answer Pointers

Trojan Horse – The term derives from a classical Greek story and, in computing terms, relates to the instance where code appears to undertake a desired function but contains hidden malicious code that can take control or damage a machine.
Hacking – where an individual illegally attempts get round, or exploit gaps, in the security defences of a system.
SPAM – unsolicited email
Phishing - The act of sending an email to a user falsely claiming to be an established legitimate enterprise in an attempt to scam the user into surrendering private information that will be used for identity theft. The e-mail directs the user to visit a website where they are asked to update personal information, such as passwords and credit card, social security, and bank account numbers, that the legitimate organization already has. The website, however, is bogus and set up only to steal the user's information.

Question 12

Input-Output devices have become very sophisticated over the past few years.
Compare and contrast the following devices.

a) Plasma display and LCD monitors

(6 marks)

b) Laser-jet and Ink-jet printers.

(6 marks)

Answer Pointers

Answers must take into account recent development in technologies around input and output devices. Quality of output, Volume, Cost of Purchase, Running costs and typical uses are some features that are required.