THE BCS PROFESSIONAL EXAMINATIONS BCS Level 4 Certificate in IT

October 2007

EXAMINERS' REPORT

Computer & Network Technology

General Comments

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.

It is also 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 carry 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.

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. Gaps in knowledge with regards to this area can pose serious problems in understanding more advanced and specialist IT concepts.

Section A

Question 1

a) Compare and contrast the use of magnetic and optical disk storage systems in a high-performance personal computer, work station, or business machine.

Your answer should cover the characteristics and performance of modern state-of-the art optical and magnetic storage devices.

(15 marks)

- (b) A hard disk rotates at 15,000 revolutions per minute. A track contains 63 sectors.
 - i) For this disk calculate the average rotational latency.
 - ii) Calculate the time taken to read a sector once it has been located.
 - iii) Calculate the rate at which data is read from a sector (the speed at which data comes from the disk which a sector is being read the units are bits/second). Assume that a sector contains 4,096 bits.

(15 marks)

Answer Pointers

a)

A few years ago, hard disks had small capacities (well below 1 GBytes) and the CD ROM had a relatively large capacity (600 Mbytes) but was read-only except in a few very expensive writable systems. In those days, the hard disk was used to hold programs and data and the CD was largely a means of transporting programs.

Today, the situation has changed considerably. The highest capacity magnetic hard drives available in 2007 are 750 GBytes, which is three orders of magnitude larger than the CD. A modern hard disk has an access time of the order of 4 ms. On-board caching (4 or 8 Mbytes) is used to increase disk performance. Note that the access time of hard disks has not increased significantly over the years because of their electro-mechanical nature.

There has also been significant improvement in optical storage technology over the last decade in terms of cost, capacity and functionality (read/write), although optical storage systems (like their magnetic memory counterparts) have not become significantly faster over the years.

Magnetic disks record information by magnetizing tiny regions of the surface under the read/write head. Data is recorded along concentric circular tracks. The time to step from track-to-track is far faster in a magnetic disk than an optical disk.

All optical storage uses a sequence of bumps (pits and land) that are stored along a helical track on a disk. A laser light follows the track and uses light reflected from the disk surface to detect the stored data. Optical storage is intrinsically unreliable and sophisticated error-correcting codes are used to deal with relatively large numbers of dropped (corrupt) bits. Seeking data in an optical store is slow because of the mass (inertia) of the head.

The CD has a capacity of about 600 Mbytes. The DVD is a replacement for the CD which uses virtually identical technology. However, modern manufacturing processes have allowed the system to be scaled down to fit more bits on the disk (typically 4.7 GBytes). Sophisticated focusing mechanisms have allowed two planes of data (dual layer) within a DVD which has doubled the capacity to over 9 GBytes.

In recent yeas, the cost of writable (usually write once) disks and readers has declined. A disk can be written by using a laser to ablate the surface leaving an underlying reflective layer visible. Re-writable disks are also available and these exploit a magneto-optical property of the surface (rotatable polarization).

Unfortunately, there is no single standard for the DVD. Fortunately, most readers and writers are multistandard.

The DVD is largely used to transport large programs (e.g. those with large databases or maps) and to archive data. This is particularly important in the world of digital photography and digital video which have unlimited storage requirements.

At the moment, two new optical storage mechanisms are becoming available (both are modified DVDs). Blu-ray has a capacity of 50 GByte/disk and high density DVD, HD-DVD, has a capacity of 15-45 GBytes. Unfortunately, these mechanisms are mutually incompatible. Such large storage mechanisms are required for both high definition video and backing up the increasingly low-cost large magnetic disk drives.

- b) i) The average rotational latency is $\frac{1}{2}$ period of revolution. 15,000 rpm is 15,000/60 = 250 revolutions/second. The latency is $1/250 \div 2 = 2$ ms.
 - ii) If there are 63 sectors along a track and it takes 1/250 s for all sectors to move under the head, it takes $1/250 \div 63 = 0.063$ ms to read one sector.

iii) During this time 4096 bits are read. Consequently, the bit rate is bits/time = 4096/0.063ms = 65,015 Mbits/s

Question 2

A circuit has four inputs, P, Q, R, S, representing the natural binary numbers $0000_2 = 010$, to $1111_2 = 15_{10}$. P is the most-significant bit. The circuit has one output, X, that is true if the number represented by the input is divisible by three or 7. (Regard zero as being indivisible by three).

a)	Construct a truth table for this circuit.	(8 marks)
b)	Hence obtain an expression for X in terms of P, Q, R, and S.	(8 marks)
c)	Give the circuit diagram of an arrangement of AND, OR and NOT gates to implement this circuit.	(8 marks)
d)	Construct a Boolean equation for this circuit using NAND gates only.	(6 marks)

Answer Pointers

i. The following truth table describes this problem.

Inputs			S		
Ρ	Q	R	S	Number	Х
0	0	0	0	0	0
0	0	0	1	1	0
0	0	1	0	2	0
0	0	1	1	3	1
0	1	0	0	4	0
0	1	0	1	5	0
0	1	1	0	6	1
0	1	1	1	7	1
1	0	0	0	8	0
1	0	0	1	9	1
1	0	1	0	10	0
1	0	1	1	11	0
1	1	0	0	12	1
1	1	0	1	13	0
1	1	1	0	14	1
1	1	1	1	15	1



ii. The Karnaugh map for this truth table is

The right hand side gives the grouped terms.

From the K-map X = P.R.S + P.Q.S + Q.R + P.Q.S

iii. The following gives the circuit diagram of an implementation using AND, OR and NOT gates.





X = P.R.S . P.Q.S . Q.R . P.Q.S

Question 3

a) The architecture of a microprocessor is defined in terms of its recourses (e.g. registers), instruction set (i.e., the operations it can carry out), and its addressing modes (i.e., the way in which it can access data).

Although there are many different computer architectures available (e.g., the Intel Pentium, the Power PC, the ARM, MIPS), the instruction sets of most computers are fairly similar in terms of the basic operations provided.

Describe the various classes of instruction provided by typical computers (for example, the arithmetic class includes operations like add and subtract).

(15 marks)

b) The following terms all describe the same addressing mode in assembly language:

Indexed addressing Pointer-based addressing Indirect addressing Address register indirect addressing

Describe the meaning of this addressing mode and explain how it is used by means of an example of your own choice.

(15 marks)

Answer Pointers

a)

A computer executes a relatively small number of instruction classes. The actual way in which instructions can be subdivided is not fixed (different people may categorize instructions in different ways). However, the basic classes are:

Data Movement

This is the class of instruction that copies data from one place to another, for example, the simple move (also called LOAD or STORE depending on the direction of the data – memory-to-register or register-to-memory). Other data movement instructions are those that swap (or permute) the individual bytes of a word.

Arithmetic

Arithmetic operations treat data as a numeric value (offer 2's complement if it is integers). The basic arithmetic operations are add, subtract, multiply and divide. Many computers include special operations that support extended operation (e.g. 64-bit addition on a 32-bit machine by adding in any previous carry out).

Logical

A logical operation is applied bit-wise to pairs of bits in two words. Typical logical operations are AND, OR and NOT. Some computers implement the XOR operation.

Some computer provide bit operations that act on a single bit of a word (set, clear or toggle)

Shift

Some writers include the shift as part of the arithmetic operations and some regard it as a logical operation. A shift operation moves the bits of a word one or more places left or right. Shifts are characterized by what happens to the bits shifted in at one end and shifted out at the other. Typical shifts are logical, arithmetic, and circular. Shifts divide or multiply by 2 and are used to re-arrange the pattern of bits.

Flow of control

This group of instructions are those that determine which instruction is to be executed next. Typically, these are branch (goto or jump) and subroutine calls and returns.

b)

All these addressing modes specify the location of a variable by means of a pointer stored in a register; for example, MOVE D0,(A0) means move the contents of data register D0 to the memory located at the address given by the contents of register A0. In this case, the variable in A0 is an address (pointer).

Because an address is a variable you can operate on it create an address that changes at run time. This means that you can step through data structures such as lists, tables and arrays. Some computers include automatic pointer updating; for example the 68K has the operation MOVE (A0)+,Do that reads the element pointed at by register A0 and then increments the pointer to point to the next element.

Suppose you have a table of N values to clear and the first element is stored at location P. You can write

MOVE #P,0 Register A0 is loaded with P to point at the table.
MOVE #N,D0 D0 contains the loop counter
MOVE #0,(A0) Clear an element
ADD #1,A0 Point to the next location (advance the pointer)
SUB #1,D0 Decrement loop counter
BNE Loop Continue until all done

Question 4

Today's personal computers are often interconnected, either by means of a local area network or via the Internet.

a) Explain how a PC can be connected to the Internet or to other PCs. Discuss the characteristics of the mechanisms used to link computers to each other and to the Internet.

(14 marks)

b) Data transmission in inherently error prone (particularly over the public switched telephone system). Briefly describe how a computer's hardware and software is able to reliably transmit information across a network.

(8 marks)

c) The introduction of the Internet, high-speed networks and large-capacity storage systems have proved to be problematic for those who create music and video (e.g. content providers such as Hollywood). Modern technology is making it increasingly easy to bypass the copyright law (that is, it is easy to make illegal copies of copyrighted material).

Briefly describe the problems posed by modern technology to content providers (music and video) and outline some of the ways in which the content providers can 'fight back' and deal with the problem.

(8 marks)

Answer points

a)

Students can discuss a range of technologies. Some students may describe connections via modems and the switched telephone network. A discussion of the local area network based on hubs and/or WiFi would also be expected. Some students may also describe other linking mechanisms such as Bluetooth or even IR. I expect students to discuss links to the Internet via the modem, via ADSL and via cable.

The characteristic of modern small scale networks vary. However, typical PC-based systems have use either 10 MBit/s Ethernet or 1GBits/s connections, or they use wireless WiFi systems operating at either 11 MBits/s or 54 MBit/s.

Credit for an answer that describes a typical network that links two or more computer together and to the Internet was also given.

b)

The physical medium at the lowest level of the ISO standard for OSI provides a physical connection between adjacent nodes and is inherently unreliable. Errors can be introduced by noise and electrical interference.

Errors can be dealt with by two techniques or by a combination of them. In forward error correction the data is encoded so that errors can be corrected by means of redundant bits. Other error correction mechanism use check bits that are transmitted with the data. The check bits are regenerated locally. If the transmitted and received check bits do not match, an error is assumed and a request is made for a retransmission.

C)

When storage capacity was low and data transmission rates were at the levels imposed by modems, the problem of the illegal copying of large-scale works such as movies was small. The cost of down-loading a movie or storing it was in excess of the DVD itself.

Today, the situation has changed. High-speed cable links to the Internet are common, hard disk of up to 750 GBytes are available and writable DVD media are cheap. Moreover, the development of peer-to-peer file copying protocols makes it even easier to share video material.

Manufacturers have responded to the threat in several ways. One approach is via is legislation. The DMCA (Digital Millennium Copyright Act) has not only made it illegal to copy copyrighted material; it has made it illegal to bypass or to overcome copy-protection mechanisms. This means it is illegal to write software that reads protected files.

Another technique to reduce copying has been to introduce regional encoding of DVDs. This mechanism has been implemented by both the media suppliers and the DVD-reader manufacturers. DVD players operate only with DVD encoded according to certain regional standards (e.g. North America, Europe, Japan etc). Regional encoding is also used to stop the free movement of pre-recorded media between different markets. It ensures that prices remain high in certain markets and these prices cannot be undermined by cheap imports.

DVDs are also encoded so that they cannot be copied (again, this is due to an agreement between software and hardware suppliers). However, software that will copy (illegally) DVDs and strip their encoding is widely available.

It has been suggested that copyrighted data should be marked with a digital watermark and equipment designed not to copy of play the data unless the user has purchased a key to unlock the data.

Section B

Question 5

Copy and complete the table below. Clearly show all your workings.

Binary	Decimal	Hexadecimal
	155	
111110011	499	
	40	
		2E
101001010		
		1FB

(2 marks each)

Answer Pointers

Most candidates attempted this question. It was however noted that many candidates did not show their workings. The question clearly required candidates to <u>show all workings</u>. Failure to comply with the examiner's instructions resulted in marks being deducted.

Binary	Decimal	Hexadecimal
10011011	155	9B
111110011	499	1F3
101000	40	28
101110	46	2E
101001010	330	14A
111111011	507	1FB

Question 6

The Central Processing Unit (CPU) of the computer contains several registers. Describe the purpose of each of the registers below.

a)	Sequence Control Register (also called Program Counter)	
, h)		(3 marks)
U)		(3 marks)
C)	Memory Address Register	(3 marks)
d)	Memory Buffer Register	(3 marke)
		(S marks)

Answer Pointers

This question tests the candidates' knowledge on the CPU and in particular registers. The answer could start with a brief definition of a register. Each of the four registers will then need to be described. Below are key points that must be included for each register.

- a) Sequence Control Register (SCR), also known as the Program Counter (PC); Holds the address in memory where the next program instruction can be found; Incremented by 1.
- b) Instruction Register (IR) Holds the program instruction that the CPU is executing at present.

- Memory Address Register (MAR)
 Holds the address of a location in main memory; CPU puts the address in the MAR when it wants to transfer from the main memory to another part of the system.
- d) Memory Buffer Register (MBR) Holds the data that is to be transferred to or from the main memory.

Question 7

b)

In the context of networking, differentiate between each of the following pairs of terms:

a) router and switch

(6 marks)

(6 marks)

Answer Pointers

DTE and DCE

a) A router is a device that forwards data packets along networks. A router is connected to at least two networks, commonly two LANs or WANs or a LAN and its ISP's network. Routers are located at gateways, the places where two or more networks connect.

A switch is a device that filters and forwards packets between LANs segments. Switches operate at the data link layer (layer 2) and sometimes the network layer (layer 3) of the OSI Reference Model and therefore support any packet protocol. LANs that use switches to join segments are called switched LANs.

b) DTE short for Data Terminal Equipment, a device that controls data flowing to or from a computer. The term is most often used in reference to serial communications defined by the RS232 standard. This standard defines the two ends of the communications channel as being a DTE.

DCE short for Data Communications Equipment is used to refer to the connection of a device to the computer. A DCE is usually a modem.

Question 8

Over the past few years, there has been lot of development in the areas of network protocols. Describe and explain the following terms:

a)	IP address	(6 marks)
b)	VoIP (Voice over IP)	

(6 marks)

Answer Pointers

a) IP address

An identifier or a computer or device on a TCP/IP network. Networks using the TCP/IP protocol route messages based on the IP address of the destination. The format of an IP address is a 32-bit numeric address written as four numbers separated by periods. Each number can be zero to 255. IP addresses are assigned at random as long as each one is unique. However, connecting a private network to the Internet requires using registered IP addresses (called Internet addresses) to avoid duplicates.

b) VoIP

This is a category of hardware and software that enables people to use the Internet as the transmission medium for telephone calls by sending voice data in packets using IP rather than by traditional circuit transmissions of the PSTN. One advantage of VoIP is that the telephone calls over the Internet do not incur a surcharge beyond what the user is paying for Internet access, much in the same way that the user doesn't pay for sending individual e-mails over the Internet.

There are many Internet telephony applications available. VoIP also is referred to as Internet telephony, IP telephony, or Voice over the Internet (VOI)

Question 9

a) Differentiate between computer virus, spyware and Trojan horse

(6 marks)

(b) Describe the possible strategies you would take in protecting a computer system against the threat of viruses.

(6 marks)

Answer Pointers

a) A computer virus attaches itself to a program or file so it can spread from one computer to another, leaving infections as it travels.

Spyware has become a nuisance with the rapid development of internet. Spyware infiltrate internet users' computers and monitor their activities.

The Trojan horse, at first glance will appear to be useful software but will actually do damage once installed or run on your computer. Those on the receiving end of a Trojan horse are usually tricked into opening them because they appear to be receiving legitimate software or files from a legitimate source. When a Trojan is activated on your computer, the results can vary.

b) The first steps to protecting your computer are to ensure your operating (OS) is up-todate. This is essential if you are running a Microsoft Windows OS. Secondly, you should have anti-virus software installed on your system and ensure you download updates frequently to ensure your software has the latest fixes for new viruses, worms, and Trojan horses. Additionally, you want to make sure your anti-virus program has the capability to scan e-mail and files as they are downloaded from the Internet. This will help prevent malicious programs from even reaching your computer. You should also install a firewall as well.

Question 10

Answer Pointers			
b)	Briefly describe the 7 layers of the OSI Model	(10 marks)	
a)	What do you understand by the ISO's OSI Reference Model	(2 marks)	

This question has been set in previous sittings. The topic is core to Computer networking.

- a) A brief description of the OSI Reference Model and its use in interconnecting devices from different manufacturers.
- b) Brief description of the each of the 7 layers of OSI Model.

Question 11

Mobile Communications Technology has become very popular over the past few years.

(a)	Describe the advantages and disadvantages of mobile communications	
	technology.	
		(6 marks)

(b) Explain how you think mobile technology may develop in future.

(6 marks)

Answer points

- a) Advantages of mobile communications technology :
 - Cable free convenience for the home and personal user, mobile provides convenience. Internet access can be provided anywhere in the home. Wires are needed. While travelling, it is possible to connect to the internet and read emails.
 - Increased efficiency it is possible to be away from the office and still keep in touch with colleagues. Work can be more efficient and more up date information may be available. Less time spent on travelling.
 - Greater flexibility it is possible to allow users to work more flexibly, in and out of the office using a computer (e.g. a laptop).

Disadvantages of mobile communications technology :

- Security Mobile systems are more vulnerable to security breaches due to their broadcast. Users need to be aware of the dangers and take necessary actions to make sure their wireless communications are secure.
- Effective range All mobile communications systems have limits on their range and this can be frustrating for users. This means that if you are planning to make a call, you can't do so,
- Perceived health hazards There is also much debate on the fact that excessive usage of mobile phones can cause health problems.

b) Development in Wi-Fi network is highly promising and will impact on mobile communications technology. Currently, cost of accessing the internet is quite high. In addition, the lack of suitable devices that have sufficient battery life are posing serious problems. With development in this area, users will have fuel cell batteries for laptops which would mean longer usage. There is also scope for development in PDAs. Until now, PDAs have not been popular although they provide a compromise between a mobile phone and a laptop.

Question 12

As an IT Support Staff member, you must be fully aware of the functions of Operating Systems.

a) Describe three main functions of an Operating System you are familiar with. Include in your answer relevant practical issues around each function.

(6 marks)

(b) Compare and contrast between Command Line Interface (CLI) and Graphical User Interface (GUI). As the IT Support Staff, explain when and why you would use CLI.

(6 marks)

Answer Pointers

- Any 3 main functions of the OS such as acting as a resource manager, memory manager, multiprocessing, multitasking, etc. A relevant example must be given e.g. Microsoft Windows
- b) GUI refers to a program interface that takes advantage of the computer's graphics capabilities to make the program easier to use. Well-designed graphical user interfaces can free the user from learning complex command languages. On the other hand, many users find that they work more effectively with a command-driven interface, especially if they already know the command language. For example, Microsoft Windows provides a suitable GUI. Typical components of the GUI include pointers, pointing device, icons, menus, desktop and windows.

CLI is a user interface common to MS-DOS computers. The user sees the command line on the monitor and a prompt that is waiting to accept instructions from the user. The user types in the command, the computer acts on that command and then issues a new prompt for the next instruction from the user.

CLI operating systems are becoming less used as GUI operating systems gain in popularity. In a GUI operating system, such as Windows, the user responds to graphic images on the screen instead of typing in commands in response to a prompt.

As an IT Support Staff, knowledge of CLI is important. In order to 'troubleshoot' hardware and software, commands can be used. It is possible to create more versatile commands and hence deal with a larger number of problems.