

**BCS THE CHARTERED INSTITUTE FOR IT**  
**BCS HIGHER EDUCATION QUALIFICATIONS**  
**BCS Level 4 Certificate in IT**

**COMPUTER & NETWORK TECHNOLOGY**

Tuesday 29<sup>th</sup> March 2016 - Morning

Time: TWO hours

Section A and Section B each carry 50% of the marks. You are advised to spend about 1 hour on Section A (30 minutes per question) and 1 hour on Section B (12 minutes per question).

The marks given in brackets are **indicative** of the weight given to each part of the question.

Calculators are <b>NOT</b> allowed in this examination.
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**General comments on candidates' performance**

Note that the answer pointers contained in this report are examples only. Full marks were given for valid alternative answers.

**SECTION A**

(Candidates were required to answer **TWO** out of the four questions set)

**A1**

- a) What is an operating system and why is it necessary? Your answer should include a discussion of the facilities that they provide. **Note that your answer need not be limited to mainframe/desktop computers but may extend to portable devices.**  
**(20 marks)**
  
- b) Using your knowledge of existing and past operating systems (e.g., Windows, MAC OS, Unix), what changes do you expect to see in the next few years? Your answer may include anticipated changes in technology, communications, and peripherals.  
**(10 marks)**

## Answer Pointers

- a) This was an open-ended question. Credit was given for all relevant comments.

The core of the question asks what an operating system is and why we need it. The essence of the answer should be that the operating system sits between the user and the hardware and applications software. The operating system provides an interface that allows a user to interact with the system. Candidates should mention how the interaction has gone from early command-line languages, to windows-based graphical interfaces using a screen and a mouse. Today's operating systems now support touch screens.

Operating systems control memory. An answer should include references to the memory system and the way in which the computer allocates storage to programs. In particular, virtual memory should be mentioned and a very brief discussion of how the operating system handles page faults and transfers data between main store and disk store.

Operating systems control input/output operations. An operating system provides the software that interfaces input devices (keyboard, mouse, and network) to systems software. Similarly, it interfaces the system to output devices such as the display and the net. This software is also responsible for controlling how the computer handles interrupts and exceptions.

- b) This section is entirely open-ended. It is designed to allow a student to display his or her knowledge of trends in computing. Such trends may include the user interface; for example, voice control, gesture control (i.e., using body language such as hand movement), touch control. It may include the integration of more personal functions (e.g., diaries, contact lists). It may include artificial intelligence (anticipating the user's needs and behaviour).

## Examiner's comments

- a) Candidates wrote everything they knew about operating systems. Virtual memory was not touched upon by many of the candidates.
- b) Candidates wrote everything they knew about current trends. There was evidence that some candidates partially repeated (in the reworded form) their answers to part a).

## A2

- a) Why do computers use binary arithmetic, instead of the conventional base-10 arithmetic that people use? **(3 marks)**
- b) What is floating-point arithmetic and why is it necessary for scientific and engineering calculations? **(5 marks)**
- c) Explain how a floating-point number is stored in binary form. **(5 marks)**
- d) What steps are necessary to convert a number such as the decimal value 12.0012 into a binary floating-point value? You need only describe the steps – you do not have to perform any calculation. **(7 marks)**
- e) Why is floating-point addition far more complicated than integer addition? **(5 marks)**

- f) Operations on integer values normally yield an exact result with no error. Floating-point operations do not always yield an exact result and there is often a difference between the calculated result and the true result. Why is this so? **(5 marks)**

### Answer Pointers

- a) Computers use binary arithmetic because it is far cheaper to build two-state devices than to build 10-state devices. The use of binary is a decision imposed by digital electronics. Although decimal system arithmetic using binary coded decimal with conventional logic is possible, it is inefficient because the arithmetic is slower than binary and because only logic states 0 to 9 are used in a 4-bit digit and states 10 to 15 are ignored.
- b) Floating-point arithmetic (or scientific notation) used a format like  $+1.00101010 \times 2^{1001}$ , that is, it uses a significand (once called mantissa) and an exponent to define a number. The advantage of floating-point arithmetic is that it can handle very small values (e.g., the mass of an electron) and very large values (e.g., the mass of a star). Floating-point arithmetic is necessary for the vast majority of scientific and engineering calculators.
- c) The question does not ask for a specific format (although the IEEE standard is now universal). Any variations on this answer are acceptable.

A floating-point number is stored as a sign, significand, and exponent. The significand is stored as a normalized value of the form  $1.0000\dots00$  to  $1.1111\dots11$ . For this reason, the leading 1 is not stored in the actual floating-point value, but reinserted during calculation. The exponent is stored in a biased form by adding a bias to ensure that the most negative exponent is stored as zero. For example, if the true range of an exponent is  $-127$  to  $+127$ , it would be stored as 0 to 254. In IEEE 32-bit format, a floating-point number is stored as  $S$  EEEEEEE FFFFFFFFFFFFFFFFFFFFFFFF where  $S$  is the sign bit,  $E$  the exponent bits and  $S$  the significand bits (without the leading 1).

- d) The decimal integer part is converted to binary integer. The fractional part is converted to a binary fraction. Then the number is normalised to be of the form  $1.bbbb \times 2^E$ . The number is then stored as a sign bit ( $0 = +$  and  $1 = -$ ), an exponent (after adding the bias), a significand after dropping the leading 1.
- e) Binary integers can be added together simply in one operation. Floating-point values can be added only if their exponents are the same. This means that the two numbers must be examined. If their exponents differ, one must be denormalized and the significand shifted until both numbers have the same exponent. Then the significand can be added. Finally, the result may no longer be normalised (of the form  $1.bbb\dots$ ) so it must be renormalized. This takes longer than conventional integer addition.
- f) First, when a decimal floating-point value is converted to binary floating-point form there may be an error (because not all decimal fractions can be represented in binary form in a finite number of bits). Performing arithmetic can compound this error.

Second, suppose two nearly identical numbers are subtracted. The number of bits of precision can be very much reduced. For example, in decimal, if we subtract 1.12345 and 1.12322 we get 0.00023 (we go from six digits of precision to two digits of precision).

### Examiner's comments

- a) There was evidence that candidates mostly misinterpreted the question on the reason for the use of two-state devices rather than 10-state devices (e.g. cheaper implementation). This implied that candidates were not aware of the principles of Computer Architecture in a sense of designing it.
- b) Candidates often demonstrated poor understanding of the floating point arithmetic and mostly referred to the humans' abilities vs. computers handling 0s and 1s. It was rare that the advantage of floating-point arithmetic to handle very small values and very large values was mentioned.
- c) Some candidates answered this question pretty well, referred to IEEE standard, etc. Some other partially repeated their answers as in part b).
- d) Many candidates missed the steps necessary to produce a result. Some candidates answered this question much the same as part c). e.g. referred to IEEE standard, etc. This implied that candidates had little knowledge in this area.
- e) The evidence suggests that candidates for the most part missed the point of this question.
- f) The evidence suggests that candidates for the most part missed the point of this question.

### A3

A computer can use several different memory technologies such as *flash memory*, *DRAM*, *static RAM*, *magnetic memory*, and *optical storage* (DVD, Blu-ray).

- a) For each of the memory technologies in italics, briefly describe the technology in terms of its operating principles, give the typical characteristics of the memory technology, and explain that particular technology's role in a computer system. **(25 marks)**
- b) A computer makes 95% of its memory accesses to cache memory with an access time of 10 ns, it makes 4.9% of its accesses to DRAM with a 50 ns access time, and it makes 0.1% of its accesses to a disk drive with a 4 ms access time. What is the average memory access time? **(5 marks)**

### Answer Pointers

- a) Flash memory is a form of read-only memory (it is non-volatile). More precisely, it is read-mostly memory because it can be read from many times and occasionally written to. Flash memory is used to store firmware in computers (e.g., the bios). It is also used to store data in digital cameras, MP3 players, tablets and cell phones. Flash memory operates by injecting a charge onto an insulated gate in a semiconductor; the charge cannot leak away and is retained. However the charge can be removed (for erasure and reprogramming) by using an electrostatic field to drag electrons off the gate. This process is destructive and the flash memory will eventually fail (after many thousands of erase/write cycles). Flash memory has a slower access time than main store and is very slow to write.

DRAM provides the bulk of main store in a computer. It is the cheapest form of memory and is fast (typically 50ns). This memory uses one transistor per bit to save data and is the most dense form available. It operates by storing a charge in a transistor. The charge eventually

leaks away in milliseconds and the data must be rewritten every few milliseconds (hence the term 'dynamic'). DRAM is most efficient when successive values are written or read from it (that is, it is well suited to transferring data between itself and cache rather than between itself and the CPU).

Static RAM is a form of immediate access memory (like DRAM) that stores data in the form of cross-coupled transistors (like a flip-flop). A static RAM cell may require six transistors per bit and it is far less dense than DRAM. It is much more expensive than DRAM. Static RAM does not need to be refreshed but it is volatile (it loses data when the power is off). Static RAM has an access time of about 10ns and is used to fabricate fast cache memory.

Magnetic memory describes disk and tape drives. In a disk drive a rotating platter is coated with a magnetic material. A read/write head on a moving arm can step in or out above the surface of the disk. Data is written by magnetizing the surface and read because the magnetized bits can be detected by the read head. Modern technology now allows up to 8T bytes of data to be stored on a magnetic disk. The cost per bit is very low (much lower than other forms of memory). However, the access time is very high (several milliseconds). Magnetic storage is used to store programs and data that are currently not in main store. Magnetic memory is also intrinsically unreliable (because of its mechanical nature) and it is necessary to keep backups. Magnetic disks are being replaced by solid state disks that use flash memory.

Optical storage technology is very similar to magnetic memory. Optical storage uses a rotating disk of plastic. However, data is stored by modifying the surface of a layer buried in the plastic. This may be one only (at manufacture) or write once or write many times. Data is read using a laser beam that detects changes to the surface (pits and land ... or 'bumps'). Optical storage is used to store music and movies for distribution, as well as programs. However, because it is much slower than magnetic storage and has a lower capacity, some believe that it is in decline (programs, music, and movies are increasingly being distributed via the internet).

b) The total access time is cache access plus main store access. This is:

$$95\% \times 10 \text{ ns} + 4.9\% \times 50 \text{ ns} + 1\% \times 4\text{ms} = 9.5 \text{ ns} + 2.45\text{ns} + 4\text{ns} = 15.95 \text{ ns}.$$

### **Examiner's comments**

- a) Some candidates answered this question well, referred to all mentioned memory types, etc. Some others partially repeated their answers as in A1 a) and A1 b) (reworded).
- b) A minority of candidates answered this part and only a few were able to answer it correctly. Evidence suggests that the majority of those who attempted this part misunderstood the need to convert values to the same base before making additions. This indicates a lack of understanding of how memory works.

#### A4

- a) Input/output devices have changed immeasurably over the decades. Write a short account of recent advances in computer input/output technology (that is, the I/O devices themselves and NOT the I/O strategies such as interrupts). You do not have to go into the details of a device's operation – a few words describing its basic principles are sufficient. In order to get full marks for this section you should describe at least four I/O devices. **(25 marks)**
- b) Explain how modern I/O devices have changed the face of modern computing. **(5 marks)**

#### Answer Pointers

- a) This was an open-ended question.

Early computers had minimal input/output devices. The first significant I/O device was the teletype. This was a mechanical typewriter and printer. It was a slow device printing monospaced text (no graphics). Teletypes also have paper-tape readers and writers that could read data from paper tape or print tapes. This was suited only to very small programs.

Card punches were used to handle data (e.g., statistics) and programs. Like paper tape, these devices were slow, prone to jamming and are no longer used.

The CRT and electronic keyboard became standard I/O devices in the 1980s. Unfortunately, low-cost hard copy devices did not appear until about the 1990s.

Hard-copy devices in computer centres were often line-printers. These are still used but are expensive and provide (by today's standards) poor quality monospaced text output.

The development of two low-cost devices took place in the 1990s. The laser printer used an electrostatically charge drum to pick up toner particles which are then imprinted on paper and then fused onto the paper. By using a laser beam, the charge on the drum can be changed and an image written in terms of charge. Since only charged areas attract toner, we can create an image. Unlike earlier mechanical printers, the laser printer can use any type-font and also print graphics.

The inkjet printer was developed at the same time as the laser printer. This uses tiny drops of ink that are injected onto the paper. In general, the inkjet printer can produce higher quality than the laser printer. However, it can be prone to clogging and the cost of ink can be relatively expensive.

The development of windows-based operating systems led to the creation of a range of new input devices: the mouse, joystick, touchpad, stylus. All these devices detect the motion of a hand and use it to input data (in conjunction with a screen). The mouse is a hand held device that detects motion on a flat surface. The joystick uses a rod whose position can be determined – it's a fixed-position mouse. The touchpad uses a finger as a mouse by detecting its position on a pad. The stylus pad used a fine point like a mouse but its positioning is very accurate making it possible to input artistic work such as drawings. All these devices use capacitive, resistive, or optical technology to detect position.

Some modern versions of the mouse do not need a flat surface; they can be moved around in space (for example, when you are giving a presentation). These devices use accelerometers to determine the position of the hand and then a wireless link to communicate with the computer.

Most laptop PCs and tablets now include a camera that permits users to engage in two-way video links and the computer becomes as much a communications device as a computing device.

As desktop technology had migrated to hand held devices (e.g., tablets), tablets have become increasingly powerful. This has been reflected in their I/O technology with the use of touch screens for both display and input. Software defined keyboards can be used on the screen to allow the use of any human alphabet or even specialized non-textual input. Tablets often contain accelerometers, electronic gyroscopes, and GPS receivers to calculate their absolute position and their movement.

- b) High-performance low-cost and high-quality printers have provided almost anyone with all the facilities of an office. This has created the ability to work at home and to massively increase productivity. Furthermore, I/O devices coupled with modern operating systems make it relatively easy for non-computer experts to access this technology. Computing is moving from the realms of a specialist activity into the public domain.

### **Examiner's comments**

- a) Some candidates answered this question well, referred to variety of new devices and technologies, etc. Some partially repeated their answers as in A1 a) and A1 b) (reworded).
- b) Some candidates answered this question well, referred to variety of new devices and technologies, etc. Some partially repeated their answers as in A1 a) and A1 b) (reworded).

## **SECTION B**

(Candidates were required to answer **FIVE** out of the eight questions set)

### **B5**

Explain each of the following terms of a typical computer specification.

- a) Dual core processor
- b) 3 MB Cache
- c) 1 TB HDD
- d) 1366 x 768 screen resolution

**(4 x 3 marks)**

### **Answer Pointers**

Each of the terms is important when a user is planning to purchase and use a computer.

Dual core (multi core) processor enables a larger amount of data handled by the CPU. This also leads to multi processing (and multi threading). The overall effect is faster computer running concurrent applications.

Cache memory increases the speed of the computer by prioritising its contents for quick access. Cache holds copies of recently accessed data such as web pages. This data can be accessed and loaded onto the computer screen.

HDD (Hard Disk Drive) refers to permanent (non volatile) storage space of the computer. With faster processors and sophisticated software, hard disks are increasing in size. 1 TB (Terabyte) is commonly available on most laptops today.

Screen resolution gives an indication of the computer display and images produced. Pixels per Inch is used to measure the resolution of the screen. A high resolution screen displays more pixels per inch and enables better quality pictures to be produced by the computer.

### **Examiner's comments**

Evidence suggests that answers to this question were weak. Candidates were not able to fully appreciate the basic computing terminologies.

### **B6**

- a) Briefly explain what is meant by 'Cyber security'. **(6 marks)**
- b) Outline THREE methods to protect computer resources against cyber attacks. **(6 marks)**

### **Answer Pointers**

- a) With increased use of the internet, users now face more attacks online. Cyber security is needed to monitor and protect against online attacks. Some issues to be considered are hacking, phishing, snooping, online spying.
- b) Methods that may be used to protect computers against attacks include use of internet anti viruses, firewalls, updating/upgrading operating systems, changing one's passwords regularly.

### **Examiner's comments**

Candidates focused on the second part of the question. Few answers were around cyber security. There were detailed explanations of security measures in place.

### **B7**

Describe and explain how each of the following can affect a computer's performance.

- a) Disc fragmentation
- b) Updating/Upgrading software files
- c) Encryption

**(4 x 3 marks)**

### **Answer Pointers**

- a) Defragmentation is the process of grouping together files that are stored in fragments across a storage device; e.g. a hard disk. Files can then be read faster by the processor and this in turn can increase the speed of the computer.
- b) By updating/upgrading software files (e.g. MS Windows), computers have the latest tools and utilities to execute instructions. Newer and faster processors require up to date software to achieve maximum efficiency.

c) Data compression is the process of reducing the electronic space required by data/information. Compression ratios (e.g. 1:10, 1:20 or higher) are available to store data in a much smaller space in a computer. The process therefore leads to faster data communication between devices leading to an overall increased performance of the computer.

### **Examiner's comments**

Candidates showed a good understanding of how computer performance could be increased by the various methods. Weaker answers lacked sufficient explanation of disc fragmentation.

### **B8**

Briefly explain each of the following networking terms:

- a) FTP
- b) SMTP
- c) POP
- d) DHCP

**(4 x 3 marks)**

### **Answer Pointers**

FTP – File Transfer Protocol divides files into several segments and assigns a reference number to each one. These segments are transmitted in a sequence which the receiving computer reassembles as an exact copy of the original. FTP also performs automatic error detection and correction in file transfers.

SMTP – Simple Mail Transfer Protocol refers to a set of standards that regulate the transfer of email over networks such as the internet. SMTP transfers mail in plain text, without any security (encryption) support, and from server to server only. The mail recipient must use post office protocol (POP) to transfer messages to his or her computer. For enhanced text, and secure data transmission, advanced protocols such as multipurpose internet mail extensions (MIME) and secure mime (S/MIME) are used.

POP – Post Office Protocol - Internet email standard that specifies how mail is transferred from a mail server to the user's computer. This is one of the most important and widely used protocols. It, however, does not send the email (which is the job of SMTP).

DHCP - Dynamic Host Configuration Protocol (DHCP) is a client/server protocol that automatically provides an Internet Protocol (IP) host with its IP address and other related configuration information such as the subnet mask and default gateway. The DHCP server maintains a pool of IP addresses and leases an address to any DHCP-enabled client when it starts up on the network. Because the IP addresses are dynamic (leased) rather than static (permanently assigned), addresses no longer in use are automatically returned to the pool for reallocation.

### **Examiner's comments**

Good answers provided detailed explanations of these networking terms. Some candidates misunderstood SMTP and POP.

## B9

Describe and explain FOUR services offered by an Internet Service Provider (ISP).  
(4 x 3 marks)

### Answer Pointers

Most ISPs provide the following services:

- Telephone line and access to the telephone network.
- User account, username and login
- Modem or router
- Access to the internet
- Security systems
- Back up of data
- Access to the Cloud

### Examiner's comments

Good answers covered a range of services offered by ISPs. Candidates also included examples of their own home/work ISPs. Few candidates were able to explain modern services offered e.g. access to Cloud.

## B10

- a) Explain each of the following:
- i) Program Counter
  - ii) Memory Address Register
  - iii) Memory Buffer Register

(3 x 2 marks)

- b) Explain how each of the above registers is used in the Fetch Execute Cycle. (6 marks)

### Answer Pointers

The program counter is a register in a computer processor that contains the address (location) of the instruction being executed at the current time. As each instruction is fetched, the program counter increases its stored value by 1.

The Memory Address Register (MAR) is a CPU register that either stores the memory address from which data will be fetched to the CPU or the address to which data will be sent and stored. In other words, MAR holds the memory location of data that needs to be accessed.

The Memory Buffer Register (MBR) is the register in a computer's processor, or central processing unit, CPU, that stores the data being transferred to and from the immediate access store.

The Fetch Execute Cycle is the basic operation cycle of a computer. It is the process by which a computer retrieves a program instruction from its memory, determines what actions the instruction requires, and carries out those actions. In order for the CPU to process instructions, the Fetch Execute cycle depends on a range of registers.

### Examiner's comments

Candidates made a good attempt answering part a) of the question. However, evidence suggests that part b) was poorly answered. Candidates were unable to explain how the registers can be used in the Fetch Execute Cycle.

## **B11**

Explain each of the following types of computer ports

- a) VGA
- b) USB
- c) Ethernet
- d) HDMI

**(4 x 3 marks)**

### **Answer Pointers**

A Video Graphics Array (VGA) connector is a three-row 15-pin DE-15 connector. The 15-pin VGA connector is found on many video cards, computer monitors, and high definition television sets. On laptop computers or other small devices, a mini-VGA port is sometimes used in place of the full-sized VGA connector.

A USB port is a standard cable connection interface on personal computers and consumer electronics. USB ports allow stand-alone electronic devices to be connected via cables to a computer (or to each other).

An Ethernet port is a jack or socket on a computer that allows the use of an Ethernet connector. These ports are essential in allowing the creation of local area networks (LANs). An Ethernet port is usually found on networking devices, including computers, routers, video game consoles, modems, and televisions. Ethernet is a communication system that allows multiple local devices to share information and work together.

HDMI (High Definition Multimedia Interface) Holding the resolution quality of the monitor, projector, or television constant, HDMI will share and reproduce the computer's screen quality better than VGA. Most HDMI cables also send the audio to the external screen as well, this means with one connection port can reproduce the screen and send sound to something like a television making it a convenient and good quality choice for most users.

### **Examiner's comments**

Overall, candidates showed a good understanding of these terms. Weaker answers were not clear on the use of an Ethernet port.

## B12

Briefly describe the operation and use of the following:

- a) Wireless router
- b) Proxy server
- c) Repeater

**(3 x 4 marks)**

### Answer Pointers

A wireless router is a device in a wireless local area network (WLAN) that determines the next network point to which a packet should be forwarded toward its destination. A wireless router works in the same way as the router in a hard-wired home or business local area network (LAN), but allows greater mobility for notebook or portable computers. The individual computers are equipped with small wireless transceivers that can be plugged into either a Universal Serial Bus (USB) port or a PC card slot.

A proxy server is a dedicated computer or a software system running on a computer that acts as an intermediary between an endpoint device, such as a computer, and another server from which a user or client is requesting a service. The proxy server may exist in the same machine as a firewall server or it may be on a separate server, which forwards requests through the firewall.

An advantage of a proxy server is that its cache can serve all users. If one or more internet sites are frequently requested, these are likely to be in the proxy's cache, which will improve user response time. A proxy can also log its interactions, which can be helpful for troubleshooting. A repeater is a device that receives a digital signal on an electromagnetic or optical transmission medium and regenerates the signal along the next leg of the medium. In electromagnetic media, repeaters overcome the attenuation caused by free-space electromagnetic-field divergence or cable loss. A series of repeaters make possible the extension of a signal over a distance.

### Examiner's comments

Most candidates were able to write about wireless router. Answers on proxy server and repeater were not so clear.