

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

**COMPUTER & NETWORK TECHNOLOGY**

Tuesday 27<sup>th</sup> September 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).

**Answer the Section A questions you attempt in Answer Book A**  
**Answer the Section B questions you attempt in Answer Book B**

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**

The most popular question A section questions were A1 and A3. The most popular B section questions B5 and with B7 the least popular.

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

**SECTION A**

**Answer 2 questions (out of 4). Each question carries 30 marks.**

**A1** A digital circuit has 4 inputs D, C, B, A representing the binary values 0000 to 1111 (0 to 15 decimal). The output F is true if the input falls in the range 8 to 10 (inclusive), or if the input is divisible by 3, or if the input is divisible by 7. It is false otherwise. Zero is considered as indivisible by 3 or 7.

- a) Construct a truth table for this system (7 marks)
  
- b) From the truth table write down a Boolean equation for F in terms of D,C,B,A (7 marks)
  
- c) Using either Boolean algebra or Karnaugh maps, obtain a simplified expression for F. (8 marks)
  
- d) Draw a circuit to implement the circuit for F using NAND gates only. (8 marks)

## Answer Pointers

a)

D	C	B	A	Decimal	Range 8-10	Divisible by 3	Divisible by 7	F
0	0	0	0	0	0	0	0	0
0	0	0	1	1	0	0	0	0
0	0	1	0	2	0	0	0	0
0	0	1	1	3	0	1	0	1
0	1	0	0	4	0	0	0	0
0	1	0	1	5	0	0	0	0
0	1	1	0	6	0	1	0	1
0	1	1	1	7	0	0	1	1
1	0	0	0	8	1	0	0	1
1	0	0	1	9	1	1	0	1
1	0	1	0	10	1	0	0	1
1	0	1	1	11	0	0	0	0
1	1	0	0	12	0	1	0	1
1	1	0	1	13	0	0	0	0
1	1	1	0	14	0	0	1	1
1	1	1	1	15	0	1	0	1

b) From the truth table

$$F = D!C!BA + D!CBA! + D!CBA + DC!B!A! + DC!B!A + DC!BA! + DCB!A! + DCBA! + DCBA$$

c)

$$F = D!C!BA + D!CBA! + D!CBA + DC!B!A! + DC!B!A + DC!BA! + DCB!A! + DCBA! + DCBA$$

$$F = D!C!BA + D!CB + DC!B! + DC!BA! + DCB!A! + DCB$$

$$F = D!B(C!A + C) + DC!(B! + BA!) + DC(B!A! + B)$$

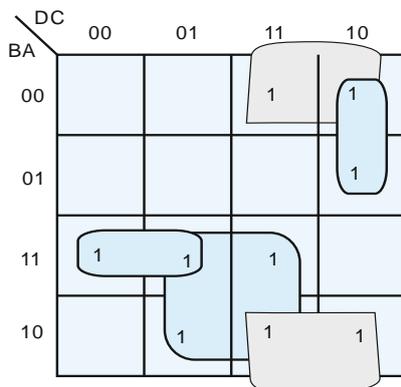
$$F = D!B(A + C) + DC!(B! + A!) + DC(A! + B)$$

$$F = D!BA + D!CB + DC!B! + DC!A! + DCA! + DCB$$

$$F = D!BA + D!CB + DCB + DC!B! + DC!A! + DCA! = D!BA + CB + DC!B! + DC!A! + DCA!$$

$$F = CB + DC!B! + D!BA + DC!A! + DCA! = CB + DC!B! + D!BA + DA!(C! + C)$$

$$F = CB + DC!B! + D!BA + DA!$$



From K-Map  $F = CB + DA! + DC!B! + D!BA$

d)

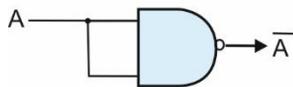
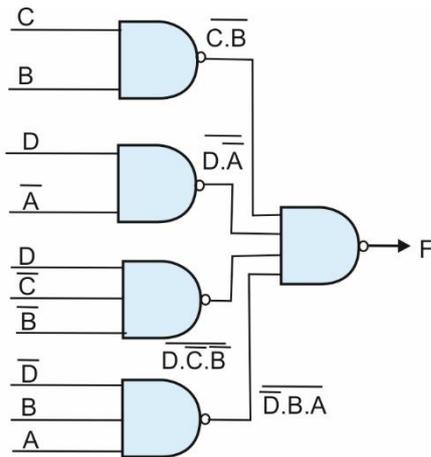
To convert to NAND logic, we need to remove the OR (+) operator. We can do this with double negation and then apply deMorgan's theorem. That is

## NAND logic

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

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

$$F = C.B \cdot D.\bar{A} \cdot D.C.\bar{B} \cdot \bar{D}.B.A$$



Generating an inverse with a NAND gate

## Examiner's comments

The evidence shows that a number of candidates interpreted "Zero is considered as indivisible by 3 or 7" as zero **is** divisible by 3 or 7. The equation for F given by the vast majority of candidates accurately reflected their truth table. If the candidate's truth table was incorrect, candidates still gained marks for correctly translating their truth table to the equation. A small number of candidates used boolean algebra to simplify the equation for F. Those who used a Karnaugh map, the majority, tended to get a more accurate answer than those via boolean algebra.

Section d), involving NAND gates was poorly answered.

## A2

- Draw the block diagram of a computer's CPU at the level of registers, buses, and functional units. Your diagram must include a Program Counter, PC. (8 marks)
- What is the purpose of a Program Counter (PC) in a computer? (4 marks)

c) Starting with the Program Counter (PC), explain how an instruction is fetched and executed.

(10 marks)

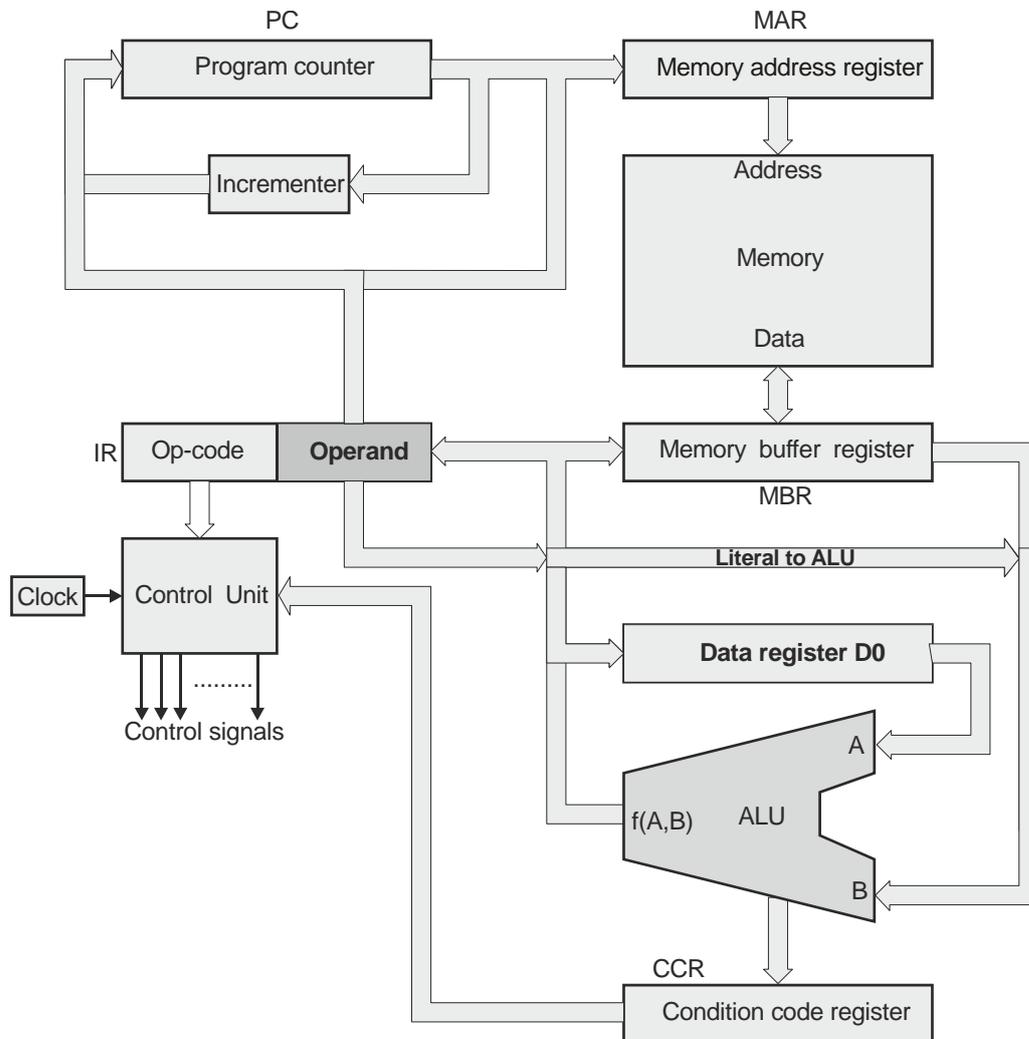
d) Computer instructions at the machine level, or assembly language level, are expressed in various ways depending on whether the computer has a RISC architecture or a CISC architecture, and on the particular manufacturer of the processor. Describe the structure of two different instruction set formats in terms of the fields of an instruction.

(8 marks)

### Answer Pointers

a)

The figure below gives the classic textbook structure of a PC. Many variations are acceptable. There should be a clear flow of information from PC to memory to instruction register; and data paths between memory, data register(s), and ALU,



b) The program counter is used to fetch an instruction from memory. After an instruction has been fetched, the program counter is automatically incremented to point to the next

instruction. If the current instruction is a branch, the program counter is loaded with the branch target address (assuming that the branch is taken).

- c) The program counter is copied to the memory address register and used to access an instruction. The PC is then incremented ready to fetch the next instruction.

The instruction in the instruction register is decoded into its operation and operand fields (i.e., registers and constants).

The control unit interprets the instruction and uses the bus to move data between registers and the ALU, and between the ALU and registers (or the memory buffer register).

Branch operands are implemented by changing the contents of the PC either by loading it from the instruction register or from a register.

d)

Many instruction formats are possible and no two computers are identical. In general, CISC processors have variable length formats; for example, some CISC processors support 16-bit, 32-bit and 48-bit instructions. This allows CISC instruction formats of:

Operation:address (e.g., clear location xyz)

Operation:address,literal (e.g., load literal into a memory location).

Operation:address1,address2 (e.g., add contents of address1 to address2 and put result in address1)

In general CISC instructions allow register to memory operations (e.g., add contents of D0 to memory location pointed at by A0).

CISC instructions can be very complicated with several operands. In general, their format is not regular.

RISC instruction sets are invariably 32 bits or longer. Equally, all instructions are the same size and there is relatively little variation in instruction formats. In other words, RISC architectures are very regular.

A key feature of RISC instruction sets is that they support only register to register operations; that is, you cannot use a location in memory as a source or destination operand.

Data is loaded into a register usually by a pointer based operation (e.g. LDR r0,[r1]). Similarly, data is stored in memory by a store register operation. For this reason, RISC processors are also called load/store machines because those are the only two memory operations permitted.

### **Examiner's comments**

There is evidence that many candidates mixed up parts b) and c) and partially repeated in c) what was already written in b).

Very few candidates attempted part d).

### A3

- a) The ISO Open Systems Interconnection model, OSI, divides a communication system into seven levels or layers. Briefly define each of these layers and explain its function in the design of a network. Note that this is also called the *OSI reference model*. (14 marks)
- b) Why was the ISO model for OSI developed, and how can it be used to aid the design of networks? (8 marks)
- c) Briefly explain the difference between the OSI reference model and the TCP/IP reference model used to implement the Internet. (8 marks)

### Answer Pointers

- a) These are the seven layers top-down beginning with the highest level of abstraction (the user/application) and ending with the bottom layer (the layer that actually moves the bits from point to point).

#### **The Application Layer**

The highest layer of the ISO reference model is the application layer that is concerned with protocols for applications programs (e.g., file transfer, electronic mail). This layer represents the interface with the end-user. It works with end applications such as domain name service (DNS), file transfer protocol (FTP), hypertext transfer protocol (HTTP), Internet message access protocol (IMAP), post office protocol (POP), simple mail transfer protocol (SMTP), Telenet, and terminal emulation.

Layer 7 – application: This layer works with the application software to provide communications functions as required. It verifies the availability of a communications partner and the resources to support any data transfer.

#### **The Presentation Layer**

The application layer in one system passes information to the presentation layer below it and receives information back from this layer. This layer checks the data to ensure that it is compatible with the communications resources. The presentation layer's principal function is the translation of data from one code to another. However, this layer performs other important functions such as data encryption and text compression.

#### **The Session Layer**

The session layer (layer 5) organizes the dialogue between two presentation layers. It establishes, manages and synchronizes the channel between two application processes. It handles authentication and authorization functions. This layer provides dialogue control. The session layer resolves collisions between synchronization requests and verifies that the data is delivered.

### **The Transport Layer**

The transport layer isolates the session and higher layers from the network itself. The transport layer is responsible for the reliable transmission of messages between two application nodes of a network and for ensuring that the messages are received in the order in which they were sent. The transport layer isolates higher layers from the characteristics of the real networks by providing the reliable economic transmission required by an application independent of the characteristics of the underlying facilities (for example, error detection/correction, multiplexing to reduce cost, splitting to improve throughput, and message reordering). The transport layer doesn't have to know anything about how the network is organized. The transport layer must assemble packets in the correct order, which involves storing the received out-of-sequence packets until the system is ready for them.

### **The Network Layer**

The network layer serves the transport layer above it by conveying data between the local transport layer and the remote transport layer. The network layer is system-dependent unlike the layers above it. Complex communications systems may have many paths between two points. The network layer chooses the optimum path for a message to cross the network or for the establishment of a virtual connection. As an analogy, consider the postal system. Mail sent to a nearby sorting office might be directed to a more distant sorting office if the local office is congested and cannot cope with the volume of traffic. Similarly, in a data transmission network, transmission paths are chosen to minimize the transit time of packets and the cost of transmission

### **The Data Link Layer**

The data link layer establishes an error-free (to a given probability) connection between two adjacent points in a network. Information may be transmitted from one end of a network to the other end directly or via intermediate nodes in a series of hops. The data link layer also detects faulty messages and automatically asks for their retransmission.

### **The Physical Layer**

The lowest layer, the physical layer, is unique because it provides the only physical connection between any two points in a network. The physical layer handles the physical medium (e.g., wire, radio, and optical fibre) and ensures that a stream of bits gets from one place to another.

- b) The history of software engineering has been a history of top-down design, abstractions, and compartmentalization. The OSI is a tool for network design and not a model. It allows different designers to work on different layers. Each layer must perform the functions required by the layer above it using the functions provided by the layer below it. Just as importantly, any layer can be replaced by a new layer (performing the same functions) that uses more advanced technology.

For example, the data link layer that transports bits from point to point can replace a wireless link by a fibre-optics link without the need to modify layers above it.

- c) First, the OSI is a design tool. It is not an actual communications system. You can use it to construct a practical system. The TCP/IP is an actual communications protocol (a protocol that was designed independently of the OSI model and a protocol that does not match exactly the OSI's seven layers).

The TCP/IP (transmission control protocol/Internet protocol) is a very widely used communications protocol. It is a layered protocol but does not use all of the OSI layers, though the layers are equivalent in operation and function (*Fig. 2*). The network access layer is equivalent to OSI layers 1 and 2. The Internet Protocol layer is similar to layer 3 in the OSI model. The host-to-host layer is equivalent to OSI layer 4. These are the TCP and UDP (user datagram protocol) functions. Finally, the application layer is similar to OSI layers 5, 6, and 7 combined. Note that several other key Internet protocols, such as the Hypertext Transfer Protocol (HTTP), the basic protocol of the Web, and the Simple Mail Transfer Protocol (SMTP), the core email transfer protocol, are built on top of TCP. The User Datagram Protocol (UDP), a companion to TCP, sacrifices the guarantees of reliability that TCP makes in return for faster communications.

	OSI	TCP/IP
7	Application	Applications (FTP, SMTP, HTTP, etc.)
6	Presentation	
5	Session	
4	Transport	TCP (host-to-host)
3	Network	IP
2	Data link	Network access (usually Ethernet)
1	Physical	

### Examiner's comments

The evidence shows that very few candidates produced the figure of the classic OSI/ISO 7-layer architecture with two 7-layer end-hosts and two 3-layer middle nodes between them. Very many just jumped to TCP/IP instead. Very few candidates demonstrated understanding of importance of top-down design, abstractions, and compartmentalisation. Many candidates produced a figure similar to the above. Some candidates claimed that OSI is a "better system than TCP/IP", "faster", "has higher performance", "better security", etc.

**A4** A computer system has a wide variety of memory systems from cache to optical storage and to magnetic tape. Each of these memory systems has its own characteristic, such as speed, bit-size, cost-per-bit, and so on.

- a) Explain why computers implement such a wide range of memory technologies. (10 marks)
- b) Briefly describe the basic operating principles and characteristics of any FOUR memory technologies. (16 marks)
- c) What trends do you expect to see in memory technology over the next few years? (4 marks)

### Answer Pointers

- a) Ideally, one single memory technology would be a great advantage. This would greatly simplify the design of computers and reduce the cost of memory systems. Such a memory would be:

**Fast (low-access time).** We need to access data from memory in approximately one clock cycle. At the moment we use static RAM for this (in cache memories).

**Non-volatile (retains data).** Main store is composed of DRAM. This loses data when you turn the power off. It cannot be used to archive data and programs.

**Low-power.** Memory should consume as little power as possible.

**Density (number of bit stored).** A physically small memory is required (especially for portable applications). At the moment, magnetic memory offers the highest density (bits/cm<sup>3</sup>)

**Cost.** Memory should be cheap. Magnetic memory is very cheap per bit whereas cache memory is very expensive.

Today, we use static RAM for its speed, magnetic memory for its non-volatility and low cost, DRAM for main store (compromise between price and performance), and flash memory for firmware (bios) and portability (digital cameras, cell phones, tablets). No single technology is able to provide an ideal memory system.

- b) This was an open-ended question as candidates could choose any technology (magnetic, optical, DRAM, static RAM, flash).

Candidates were expected to define its properties (access time, volatility, density, cost, and significant characteristics) and provide a paragraph or two highlighting its means of operation (but great depth was not necessary).

- c) Again an open-ended, with candidates expected to be aware of significant trends. DRAM is slowly increasing in speed, but not dramatically – DRAM performance has not kept step with the increase in CPU performance. DISC drives are certainly not increasing in performance (access time) but their density is still increasing with 8TB disks now available.

One of the biggest changes has been the replacement of magnetic memory by flash memory in the form of SSDs (solid state drives). It can be reasonably expected that this will continue over the next few years with the hard drive gradually disappearing in the laptop world.

### Examiner's comments

The evidence shows that some candidates produced a figure depicting hierarchy of the memory. The majority described all what they knew about memory.

Most students chose magnetic memory and static or dynamic memory. NOTE – although cache memory is not a memory technology as such, it does use high-speed static RAM and was accepted as an answer. Some candidates answered this question well, referred to various memory types, etc. Some others partially repeated their (reworded) answers to part a).

Not too many candidates answered part c). Some repeated their answers to part a) and b) (reworded). Candidates repeating their answers did not gain any extra marks.

## SECTION B

Answer 5 questions (out of 8). Each question carries 12 marks.

**B5** When selecting a laptop computer, explain why each of the following is important:

- a) Processor speed
- b) RAM size
- c) Wireless connection
- d) Display resolution

(4 x 3 marks)

### Answer Pointers

- a) The clock speed is the most common way to measure a processor's speed. It is expressed as hertz, which is the number of times per second that the electrical voltage in the processor switches back and forth between low and high. The processor uses these oscillations to physically carry out the calculations - low and high peaks correspond to the zeroes and ones that make up binary computer instructions. Most computers today have a processor that works at several gigahertz: one gigahertz is a million hertz.
- b) RAM size refers to the amount of data that can be stored in the Random Access Memory (volatile memory) of the computer. It is expressed and measured in terms of Megabytes or Gigabytes. The more RAM in a computer means more data can be stored and processed by the CPU. With modern software and gaming, PCs (and laptops) are seen to have large amount of RAM
- c) Wireless is the term used to describe any computer network where there is no physical wired **connection** between sender and receiver, but rather the network is **connected** by radio waves and/or microwaves to maintain communications. Wireless connection is used to connect a range of devices such as laptops, tablets, smart phones, etc.
- d) In principle, the higher the maximum brightness spec the better, but people often set the screen brightness too high, which causes eye strain and wastes power (and reduces battery running time). The optimum screen brightness varies with the current level of ambient lighting. Many displays have automatic brightness controls that should appropriately adjust the screen

### Examiner's comments

Answers to this question were good. Candidates were able to provide detailed descriptions of these basic computing terminologies.

**B6** In the context of printing technology, differentiate between

- a) 3D printer
- b) Laser printer
- c) Ink jet printer
- d) Dot matrix printer

(4 x 3 marks)

**Answer Pointers**

- a) 3D printing (or additive manufacturing) is a process of making three dimensional solid objects from a digital file. In an additive process an object is created by laying down successive layers of material until the entire object is created.
- b) Laser printer uses similar technology as a photocopier to produce output. Light and toner are used to print images on plain paper. It is a non impact printer which has grown in popularity.
- c) Ink jet printer uses different print cartridges and a 'nozzle' type device to produce output. It tends to be slower than a laser printer.
- d) Dot matrix printing (or impact matrix printing) uses a print head that moves back-and-forth across the page and prints by impact, striking an ink-soaked cloth ribbon against the paper, much like the print mechanism on a typewriter. The printer uses columns of dot hammers. The more hammers, the higher the resolution. For example, 9-pin heads produce draft quality text, while 24-pin heads can produce typewriter quality output.

**Examiner's comments**

Answers to this question were weak. Candidates were not able to fully appreciate these output devices. There is evidence that most candidates were not aware of dot matrix printers.

**B7**

- a) Briefly explain how IP addressing is used in network connectivity. (8 marks)
- b) Describe the purpose of a packet in the transfer of data in a computer network. (4 marks)

**Answer Pointers**

- a) An Internet Protocol address (IP address) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication. An IP address serves two principal functions: host or network interface identification and location addressing. IP addressing enables devices to be located and managed in a network.
- b) Packet switching is a digital networking communications method that groups all transmitted data into suitably sized blocks, called packets, which are transmitted via a medium that may be shared by multiple simultaneous communication sessions. Each packet is then transmitted individually and can even follow different routes to its destination. Once all the packets forming a message arrive at the destination, they are recompiled into the original message.

### Examiner's comments

Answers to this question varied. The evidence shows that most candidates were able to describe IP addressing in detail with relevant examples. However in the second part of the question candidates did not fully describe the purpose of packets during data transfer.

### B8

- a) Describe FOUR types of malware products which affect computers. (8 marks)
- b) Suggest suitable methods to protect against these malware products. (4 marks)

### Answer Pointers

Typical malware products include:

Virus, Trojan horse, Worm, Adware

Protection methods include:

Up to date antivirus software, properly configured firewall, Updates/Patches of software/OS, Regular change of passwords.

### Examiner's comments

Answers to this question were in general good. Candidates were able to describe a range of malware. Some managed to relate their answers to their workplace or college.

**B9** Explain the following the meaning and purpose of each of the following:

- a) Executable file (3 marks)
- b) PDF file (3 marks)
- c) System file (3 marks)
- d) Archive file (3 marks)

### Answer Pointers

- a) An executable file is a computer file that contains instructions in a form that a computer's operating system or application can understand and follow. Computers must use executable files to carry out the tasks that you give to them. Every application you run starts off with an executable program.
- b) Portable Document Format (PDF) is a file format used to present documents in a manner independent of application software, hardware, and operating systems.
- c) A system file in computing is a critical computer file without which a computer system may not operate correctly. These files may come as part of the operating system, a third-party device driver or other sources.
- d) An archive file is a file that is composed of one or more computer files along with metadata. Archive files are used to collect multiple data files together into a single file for easier portability and storage, or simply to compress files to use less storage space.

### Examiner's comments

Answers to this question were weak. There is evidence that candidates were not able to provide accurate explanations to the different type of files. Answers were inaccurate and confusing.

### B10

- a) Explain the difference between an intranet and an extranet. (8 marks)
- b) What is the purpose of a MAC address? (4 marks)

### Answer Pointers

a) An intranet is a computer network that uses Internet Protocol technology to share information, operational systems, or computing services within an organization. This term is used in contrast to extranet, a network between organizations, and instead refers to a network within an organization.

In a business-to-business context, an extranet can be viewed as an extension of an organization's intranet that is extended to users outside the organization, usually partners, vendors and suppliers, in isolation from all other Internet users.

b) MAC - short for Media Access Control address, a hardware address that uniquely identifies each node of a network. A media access control address (MAC address), also called physical address, is a unique identifier assigned to network interfaces for communications on the physical network segment.

### Examiner's comments

Answers to the first part of the question were good. The evidence shows that most candidates were able to differentiate between intranet and extranet. Some candidates referred to their own organisation intranet services. Part b) was poorly attempted. Few candidates provided a clear and accurate answer to MAC address.

### B11 Differentiate between the following devices:

- a) Switch (4 marks)
- b) Router (4 marks)
- c) Hub (4 marks)

### Answer Pointers

a) A network switch (also called switching hub, bridging hub, officially MAC bridge) is a computer networking device that connects devices together on a computer network, by using packet switching to receive, process and forward data to the destination device.

b) A router is a networking device that forwards data packets between computer networks. Routers perform the "traffic directing" functions on the internet. A data packet is typically forwarded from one router to another through the networks that constitute the internet until it reaches its destination node.

- c) A hub is a common connection point for devices in a network. Hubs are commonly used to connect segments of a LAN. A hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.

**Examiner's comments**

Answers to this question were generally good. The evidence shows that candidates provided reasonable answers to the different devices. Some candidates provided illustrations of the devices via diagrams.

**B12** Describe FOUR functions of a typical operating system.

(4 x 3 marks)

**Answer Pointers**

Resource Manager  
Provides a user interface  
Multi user services  
Security services e.g. firewall

**Examiner's comments**

Candidates provided varied answers to this questions. The evidence shows a range of functions were put forward. Overall, these were relevant. Candidates showed a good understanding of these functions.