

**THE BCS PROFESSIONAL EXAMINATION
Certificate**

April 2001

EXAMINERS' REPORT

Technology

QUESTION ONE

The low-level programmer's view (or assembly language programmer's view) of a computer is known as the computer's architecture. Computer architecture is concerned with a computer's instruction set, its addressing modes, register set, and all the other aspects of its programming model.

- a) Briefly describe the meaning of the terms register set, instruction set, and addressing modes as they are used in today's world. In each case, you should use appropriate examples. (10 marks)
- b) Describe the architecture of any computer (microprocessor) with which you are familiar. Discuss the strengths and weaknesses of its architecture. (20 marks)

Most candidates were able to answer the first part satisfactorily, although a significant number were unable to differentiate between the Instruction Set and Instruction Format.

Many candidates were able to identify the components inside a microprocessor, but not exactly how they interconnect or any strengths and weaknesses.

Answer Pointers

Assembly Language:

Register set – temporary working areas in a CPU, e.g. instruction register, program counter, index register.

Instruction set – different instructions that the CPU can execute, e.g. Load, Add, Store.

Addressing mode – different modes of accessing computer memory, e.g. immediate, direct, indirect, register.

CISC vs. RISC – a description of components and operation including a diagram. Disadvantages and advantages of each. Generic von Neumann architecture is also acceptable.

QUESTION TWO

People have now been using personal computers for over 20 years. A personal computer can be defined as a machine that can be used at home and which includes a range of peripherals from the display and printer to the modem and the scanner.

However, the personal computer in 2001 is a very different machine from the so-called personal computer of 1981.

- a) Explain how the personal computer has developed over the last 20 years. We are not interested in particular brand names or in specific interfaces and peripherals. We are interested in the way in which processors and peripherals have developed, the change in their characteristics, and their performance. (14 marks)
- b) How has the role of the personal computer developed over the last 20 years? (8 marks)
- c) How do you think that the personal computer will develop over the next 5 years in terms of its role and functionality? This question does not ask you to state the obvious (i.e., computers will get faster and memories larger); it asks you to consider the way it will develop to both exploit new technology and fulfil new applications. (8 marks)

A significant proportion of candidates could only say that speeds of computers and memory sizes had increased, but not give any indication of the scale of improvement.

Most candidates could say how the role had changed, in terms of applicability of computers.

This question required an insight into computer development. Many candidates could state the obvious – e.g. faster speeds; quite a number thought that artificial intelligence would play a bigger role in future developments.

Answer Pointers

Development of Computers:

Processor speed, memory sizes, peripherals.

From a specialist's tool to a family appliance. Applications – from limited number-crunching and word-processing, to a small office equipment, to communication and information exchange.

Disappearing computer – computer applications will be embedded in many household appliances and tools. e.g. mobile phones, PDAs, TVs. The use of computers will be also widespread in many tasks, banking, e-commerce.

QUESTION THREE

You are sitting at a computer in Singapore using the Internet to find the best place to get a cup of coffee in Seattle, Washington State, in the USA. Explain how your request leaves your computer and travels to the web server in the USA and how the reply is returned. Your answer should briefly cover the I/O techniques used by the computer, the way in which your computer is connected to the Internet, and the way in which the messages travel across the Internet.

You are not expected to describe every possible I/O system and communications technology. Choose a reasonable scenario to describe.

(30 marks)

Most candidates failed to consider all the requirements of this question. Consequently most answers only offered simplistic considerations, such as, surfing the web for the required information. The question was attempted by a very large proportion of candidates.

Answer Pointers

Means to connect: direct to a LAN or dial-up to an ISP. Required – computer with modem and TCP/IP software, and Internet address of required site, e.g. search engine. Description of 7-layer or 4-layer architecture desirable.

SEND: The Application layer forwards a request-message plus its destination address to the Transport layer. The Transport layer breaks the message into packets and attaches address to each. The Transport layer relies on “name-servers” to create Internet – compatible addresses. Each packet is passed to the Network layer. The Network layer appends an intermediate address to each packet received, and passes to the Link layer. The Link layer is responsible for physical communication within the relevant network. Local addressing is added to received packets to identify local machine or router.

RECEIVE: The Link layer receives the message from the communication medium, and unwraps the address appended by the Network layer in the originating machine, and passes to its Network layer. The Network layer unwraps the address off the received and passes to its Transport layer. The Transport layer reconstructs the original request by combining incoming packets, and passes to the Application layer. The application layer handles communication with application software on host machine. The required information is obtained and replied using the SEND process.

QUESTION FOUR

Ideally, all computer memory would be *non-volatile*, have an *access time* less than 1 ns, a *density* of 1000 Gbytes/mm², consume no power, and cost almost nothing to manufacture.

In practice, life is not so simple. Optimising one memory parameter is often achieved at the expense of another parameter; for example, fast memory is invariably expensive.

Real computers have dealt with the problem of conflicting memory parameters by employing a *memory hierarchy* with registers and cache memory at the top of the hierarchy and CD-ROMs and magnetic tape at the bottom.

- a) Explain the meaning of the four terms in italics in the above three paragraphs.
(10 marks)
- b) Explain how the operating system uses memory management to make a collection of different types of memory (cache, DRAM, and hard disk) appear as a homogeneous memory that is as large as the disk space and almost as fast as the cache memory.

(20 marks)

Many candidates could clearly respond to the question in this part.

Only a minority of candidates could clearly describe the use of OS in memory management.

Answer Pointers

- a) *non-volatile* – does not lose contents when power is switched off.
access time – the time to read from or write to memory.
density – the number of bytes per unit area of recording medium.
memory hierarchy – organisation of available storage devices in terms of performance (cost/speed/capacity)
- b) *OS memory management* – Swapping, Segmentation and Paging. Virtual Memory: Main memory is divided into frames. Secondary memory is divided into pages. Demand paging operation.

QUESTION FIVE

Write a short note on each of the following:

- a) **Computer hacking** (6 marks)
- b) **Computer viruses** (6 marks)

Include in your answer details of how each of these can be guarded against.

Most candidates answered this question and had a good knowledge of computer hackers and computer viruses, and how to protect against both.

Answer Pointers

Hacking (Cracker) – computer enthusiasts who cracks through network security to gain unauthorised access to computer networks. Firewalls and encryption.

Viruses – a malicious program aimed to cause damage to software on unsuspecting computers. Anti-virus software and firewalls; care in downloading and copying software and opening unsolicited e-mails.

QUESTION SIX

- a) **Describe the main components of a compiler.** (6 marks)
- b) **Explain, with the use of an example, how the stack is used to support the subroutine call/return mechanism and the passing of parameters.** (6 marks)

Few candidates had any knowledge of what a compiler is.

Few candidates were able to state how a stack is used in subroutine calls. Just one or two could identify it has a role in passing parameters or evaluation of expressions.

This question was attempted by the least number of candidates.

Answer Pointers

Compiler – a program that translates source code (high-level) into machine executable code. Comprises syntax checker, lexical analyser, code generator, linker.

Stack – last-in-first-out list. On subroutine call address of next instruction is pushed onto the stack, popped on subroutine return. Arithmetic operations use the top two items on the stack as operands for dyadic operators. When expressed in postfix format, an expression is evaluated by simple scan: push variables onto stack; pop top two items when an operator is found. Result is held as top item of the stack.

QUESTION SEVEN

Given the decimal number –634.4375 convert it to:

a) a 2s compliment binary number

(6 marks)

b) a Binary Coded Decimal (BCD)

(6 marks)

Show all workings and state any assumptions made.

Many candidates were able to convert the decimal to a binary equivalent, but few were able to convert to two's compliment. A few candidates were able to convert to a floating point IEEE format.

Few candidates were able to convert or explain to the BCD representation. Many answers comprised of the binary equivalent of the decimal digits.

Answer Pointers

Fixed or floating point representation should be assumed for 2's compliment. Fixed point for BCD.

QUESTION EIGHT

A company that sells motor car insurance is thinking about installing a network of 50 PCs to support its office staff. It has been told it should think about *performance, capacity planning, reliability, and resilience* of the network but does not know what these terms mean. Write a brief document for the company explaining these terms and why they are important.

(12 marks)

Most students could not explain the terminology used in the question.

Answer Pointers

Performance – efficiency/throughput of network;

Capacity planning – amount of data traffic load, storage capacity, expansion;

Reliability – failure rate, down time and time between failures;

Resilience – ability to cope with failure.

QUESTION NINE

With the use of examples, briefly describe the uses operating systems make of interrupts.

(12 marks)

Most candidates could only identify the different types of interrupts, but not how the OS manages them.

Answer Pointers

Interrupts - to accommodate interrupts an interrupt cycle is added to the instruction cycle. The processor checks to see if the interrupt signal is active. If not continues with execution of the next cycle. If an interrupt is pending it suspends the execution of the next instruction in the program, by saving the contents of the PC onto a stack or some other register (plus any related data). The program proceeds to execute another program called the interrupt service routine, normally part of the OS. The ISR may also be interrupted in a similar manner. When the ISR is completed, the program resumes by retrieving the saved PC contents.

QUESTION TEN

a) Given the boolean function

$$f = \overline{A}\overline{C}(\overline{B}D + BD) + \overline{B}(\overline{A}CD + A\overline{C}D) + \overline{B}CD + AD(\overline{B}C + \overline{B}\overline{C})$$

derive the truth table for the function f.

(6 marks)

b) Express the function f as a simplified Standard Sum of Products.

(6 marks)

Most candidates could derive the truth table for the given function.

A mixture of techniques were used for the simplification.

Answer Pointers

Expand expressions (or not) and show full truth table. Simplify by whichever method the candidate decides; e.g. systematic reduction, Karnaugh map.

QUESTION ELEVEN

Write brief notes on the following pairs of topics:

- a) **synchronous and asynchronous serial data transmission** (6 marks)
- b) **A-D and D-A converters.** (6 marks)

Many candidates noted the use of start and stop bits in transmission but were unable to identify whether this related to asynchronous or synchronous transmission. Most could tell, however, that synchronous involved transmission of “large” amounts of data.

Most candidates could not tell what A-D or D-A converters were, and invariably stated that both were the same as “modems”!

Answer Pointers

Synchronous transmission – sender and receiver are synchronised to transfer large amounts of data.

Asynchronous transmission – data is transferred at irregular intervals. Start/Stop bits are used.

Digital-Analogue converters – Analogue signals are amplitude values, within limits. Digital signals are represented by a sequence of binary values. A-D/D-A converters translate between the two types of representations.

QUESTION TWELVE

***Client side* and *server side* are two terms often used with respect to Web technology. What do you understand by these terms? What is the difference between *static* and *dynamic* web pages? Give examples.** (12 marks)

Many candidates were able to differentiate between client-server computers, and static and dynamic web pages.

Answer Pointers

Client – computer that requests a service from another computer.

Server – a computer that performs a service for other computers, e.g. running an application.

Static web pages contain unchanging data (text, image, etc).

Dynamic pages have data updated by the user