

**THE BCS PROFESSIONAL EXAMINATION  
Certificate**

**October 2002**

**EXAMINERS' REPORT**

**Technology**

**SECTION A**

**Answer TWO questions out of FOUR. Each question carries 30 marks.**

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

**Question 1**

- 1. The von Neumann computer consists of a program and data memory, registers, buses, and functional units (e.g., adders, shifters, ALUs) and operates in a two-cycle, fetch/execute mode.**
  - a) Briefly explain the contributions made to a computer by the memory, the registers, the functional units, and the buses. (10 marks)**
  - b) By means of suitable diagrams, explain the meaning of the fetch/execute cycle and show how an instruction is read from memory and executed. Your answer should show the sequence of actions and the flow of address and data information during the reading and execution of an instruction. Your answer does not have to cover advanced topics such as pipelining. (20 marks)**

*Most candidates were able to identify the functions served by the different components. Many were able to show reasonable connections between the components in a diagram. The majority could not explain the sequence of actions during a fetch-execute cycle, with reference to the internal components.*

**Answer Pointers**

- a) The von Neumann architecture is based on the stored program concept: memory is used to store instructions and data before execution. Primary memories are used during program execution (Registers, Cache, RAM); Secondary memories are used for long-term storage of programs (Disks, CDROMs, Tapes). Buses are used to fetch instructions and data, and apply commands: Address Bus is used to reference locations of data/instructions; Data Bus is used to carry actual data/instructions and Control Bus is used to carry execution commands. The functional units perform arithmetical and logical operations.**
- b) A diagram showing connections between the major components in the CPU: PC, MAR, MDR, IR, ALU, Registers and Memory.**

Typical sequence of actions: assume an ADD instruction with a memory access (e.g. ADD memory contents to the ALU). Other reasonable assumptions acceptable.

Fetch:

MAR  $\leftarrow$  PC;

MBR  $\leftarrow$  M[MAR]; PC  $\leftarrow$  PC+1;

IR  $\leftarrow$  MBR;

Decode/Execute:

CU  $\leftarrow$  IR

PC  $\leftarrow$  Addr[CU]; The address part of the instruction is transferred to the PC

MAR  $\leftarrow$  PC;

MBR  $\leftarrow$  M[MAR];

ALU  $\leftarrow$  ALU+MBR;

## Question 2

**2. Computers store information in their memories. However, a modern PC or workstation may have eight or more individual memory systems using as many different memory technologies.**

**a) Why does a computer have so many different memory systems? (10 marks)**

**b) What are the major memory technologies (i.e., memory construction, fabrication, and operating principles) found in a typical modern state-of-the-art PC? Briefly describe the characteristics of each technology. (10 marks)**

**c) Describe the characteristics (capacity, price, access time, etc.) of the various memory subsystems found in a modern PC. (10 marks)**

*Many candidates who attempted this question were knowledgeable of the required answers. However, there seemed to be general confusion on the expected responses to parts (b) and (c), and similar answers were interchangeably given to the two parts.*

## Answer Pointers

- a) Selection of memories is a compromise between speed, capacity, and cost. e.g. Faster access time  $\rightarrow$  greater cost; Greater capacity  $\rightarrow$  lower access time. Volatility (permanence) is also a consideration. Show/discuss memory hierarchy.
- b) Memory Technologies
  - Internal memories (Semiconductor memories) - RAM (SRAM, DRAM), ROM (PROM, EPROM)
  - External Memories - Magnetic Disks; Optical Disks, Magnetic Tapes
- c) Memory Characteristics (given by Table)

	Capacity	Access Speed	Access method	Physical	Price
Registers	Very Low	Very High	Random	Volatile	Very High
Cache	Low	Very High	Random	Volatile	High
RAM	Moderate	High	Random	Volatile	Moderate
Optical Disk	High	Low	Direct	Non-volatile	Low
Magnetic Disk	High	Low	Direct	Non-volatile	Low
Magnetic Tape	Very High	Very Low	Sequential	Non-volatile	Very Low

### Question 3

3. The British Computer Society (like the ACS, IEEE CS, and the ACM) has published a code of conduct (i.e., a set of rules and guidelines) dealing with the ethical considerations concerning computing professionals.

It could be argued that ethical considerations have never been as important as they are to today's computer designers. For example, the CD writer and scanner introduce issues of copyright, the modem introduces issues of hacking, and removable storage introduces issues of computer viruses.

Write an essay on the ethical considerations of computer design and operation.

You are expected to explain how the various elements of a computer raise ethical considerations, what these considerations are, and to briefly state how they affect the professional life of a computing professional. You may make reference to the BCS's code of conduct but you are not expected to discuss the code of conduct in depth.

(30 marks)

*Only a minority of candidates attempted this question. None seemed to be aware of the BCS Code of Conduct, and most had only a very limited comprehension of what constitutes an ethical issue. It is important to remember that professional bodies have professional codes.*

### Answer Pointers

Ethical issues in computer design: Computer interfaces: disadvantages to the disabled (physical and cognitive abilities); the aged (slowed responses); different cultures (e.g. context and perception of colours); gender (e.g. stereotypes in GUI design). Health and safety considerations.

Ethical considerations in computer operation: The use of software – all computer software is licensed rather than sold (allowing someone else to copy software you have legitimately purchased becomes a crime). The internet presents the greatest ethical and moral issues. Fraud, pornography (paedophilia), racism, terror, etc are typical issues. Suggestions for international cooperation in dealing with such issues.

#### Question 4

4. Modern peripherals, faster processors, and low-cost mass storage have led to the growth in multimedia applications of the computer.
- a) What, in the context of home computing or the small business is the meaning of the term “multimedia”? (5 marks)
  - b) Specifically, what developments in computer technology (CPU, memory, and peripherals) over the last few years have lead to so much progress in multimedia applications? (9 marks)
  - c) In what ways is multimedia technology affecting the small home/office and the small business computer users? (9 marks)
  - d) What developments in multimedia technology are likely to appear over the next two years and how do you think they will affect the computer user? (7 marks)

*Many candidates attempted this question, and most were able to give satisfactory answers.*

#### Answer Pointers

- a) Multimedia: the use of computers to present text, graphics, video, animation, and sound in an integrated way.
- b) Increases in performance and decreases in price of computer hardware: CPU (and co-processors), video adapters, sound cards, larger memories, high resolution video screens, peripherals (e.g. digital cameras).
- c) Small Home/Office refers to the use of computers (and the internet) to work from home. Multimedia can be used to create a variety of material for strategic marketing, direct mailing and sales, publicity. Communication via e-mail, voice-mail and teleconferencing.
- d) Next few years: reduction in hardware cost and improvement in performance should lead to more powerful multimedia applications. New applications will also emerge as a result of inventions in speech and image recognition, expert systems and artificial intelligence.

## SECTION B

Answer FIVE questions out of EIGHT. Each question carries 12 marks.

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

5. a) In digital logic, state the difference between combinational and sequential circuits. (4 marks)
- b) Describe the functions of the following digital devices. (8 marks)
- i) Multiplexer
  - ii) Decoder
  - iii) Shift Register
  - iv) Counter

*This question was attempted by a very large majority, most of whom did not give satisfactory answers.*

### Answer Pointers

- a) Combinational circuits - output depends only on the current inputs. Sequential circuits - output depends on current inputs and current output.
- b) i) Multiplexer - routes one of several inputs to the single output, using control inputs
- ii) Decoder - has a number of inputs (n) and outputs ( $2^n$ ) of which only one output is active, depending on the input pattern.
- iii) Shift registers - accepts and transfers data serially. On each clock pulse the output pattern is shifted to the left or right.
- iv) Counter - a register whose value is incremented by 1 on each clock pulse.

### Question 6

6. A Boolean function is given by:

$$F = \overline{A}\overline{B}\overline{C}\overline{D} + \overline{A}\overline{B}C\overline{D} + \overline{A}B\overline{C}\overline{D} + \overline{A}BC\overline{D} + \overline{A}B\overline{C}D + \overline{A}BCD + AB\overline{C}\overline{D} + ABCD$$

- a) Reduce the function to its simplest form. (8 marks)
- b) Draw the reduced circuit implementation of the function using logic gates. (4 marks)

*A surprising minority of candidates were able to give the correct answer to part (a) but not show how it was derived (or a wrong reduction process that still gave the correct answer!!).*

### Answer Pointers

- a)  $BD + \overline{B}\overline{D}$
- b) The simplest implementation is an inverted XOR ( $\overline{XOR}$ ). Implementation of (a) with NOT, AND and OR is acceptable.

### Question 7

7. a) Describe the data access modes in microprocessor addressing. Give an example in each case, showing clearly memory and register access cycles. (12 marks)
- i) Direct Addressing
  - ii) Indexed Addressing
  - iii) Indirect Addressing

*Most candidates who attempted the question gave satisfactory answers.*

### Answer Pointers

Direct addressing - operand field of the instruction gives the memory location where data for the instruction is held. One extra memory access (after fetching the instruction) is required.

Indexed addressing - the operand field gives the address of a memory location and an index register contains a displacement value from that address where the data for the instruction will be found. One extra memory access (after fetching the instruction) is required.

Indirect addressing - operand field gives the memory location which in turn contains another address where data for the instruction is held. Two extra memory accesses (after fetching the instruction) are required.

### Question 8

8. Briefly describe the main distinctions between the following:
- a) short-distance and long-distance data transmission.
  - b) point-to-point and shared medium computer networks.
  - c) synchronous and asynchronous data transmission
  - d) serial and parallel data transmission
- (12 marks)

*The majority of those who attempted the question could differentiate between the concepts. Most gave the difference between short and long distance transmission in terms of the distance between sender and receiver, which is not a satisfactory answer.*

## Answer Pointers

short/long distance transmission: long distance - requires the use of a carrier wave

point-point/shared medium: point-point has dedicated communication links between any two computers

synchronous/asynchronous: asynchronous - single character transferred with start/stop bits; synchronous - block of characters transferred with special control characters at the beginning and end

serial/parallel: serial - data transferred on one channel; parallel - data transferred on several channels

## Question 9

**9. a) A stack can be used to support the subroutine call/return mechanism and the passing of parameters. Explain with the use of examples how a stack works. (6 marks)**

**b) Briefly describe the operation of virtual memory. (6 marks)**

*Many candidates were aware of the use of a stack as a LIFO storage area, and its use in subroutine calls. Only one candidate mentioned its use in evaluation of arithmetic expressions. Many candidates were able to explain the operation of virtual memory.*

## Answer Pointers

- a) Storage devices (or memory area) where the item last-in is first-out (LIFO). In subroutine calls, the contents of the program counter (PC), which is the next instruction to be executed, are pushed onto the stack, and the address of the subroutine instruction is placed in the PC. After subroutine is completed the stack contents are popped back into the PC to continue the program. For evaluation of arithmetic expressions the reverse polish notation can be used with the stack. e.g.  $A+B$  is written as  $AB+$ . The number A and B are pushed onto the stack. When the + operator is encountered, they are popped, added in the ALU and the result pushed back onto the stack. The reverse polish notation can be used for any complexity of expressions.
- b) Virtual Memory is a technique for handling very large program within smaller available RAM. Secondary memory (where the programs are held) is divided into pages. The RAM is divided into equal sized frames. Program instructions when demanded are loaded into RAM frames for execution. Since RAM is limited frames which are not required are sent back into the secondary storage.

### Question 10

10. The following are pairs of terminologies that are commonly used in similar circumstances. Define and differentiate each pair of terminologies:
- a) Internet, and World Wide Web
  - b) Domain Name, and Uniform Resource Locator
  - c) IP address, and Internet Address
- (12 marks)

*The majority of candidates could not clearly distinguish between these terms, with the exception of the "internet".*

### Answer Pointers

Internet is a massive interconnection of computers world-wide. The world-wide-web is a service on the internet for sharing information, using "hypertext" mark-up languages.

Domain name identifies one or more networks on the internet, e.g. bcs.org.uk. The URL is used to identify web pages on the internet and includes the domain name and the path to the files.

IP address identifies every computer or other device on a network. Internet addresses are registered IP addresses which enable private networks to be connected to the internet.

### Question 11

11. a) Describe what is meant by Direct Memory Access (DMA) and state the benefits of DMA. (8 marks)
- b) Define what is meant by Address(able) Space and show how it is related to the size of the Address Bus. (4 marks)

*A large number of candidates thought DMA is a type of computer memory.*

### Answer Pointers

- a) DMA is used to transfer large amounts of data between memory and I/O without directly involving the CPU.

The CPU sends a read/write request to the DMA module

The address of I/O device involved

The starting address of memory location to be read or written to

The number of bytes transferred.

The DMA uses the system bus only when the CPU does not need it or forces the CPU to suspend operation during transfer.

- b) The addressable space is the memory capacity of the computer system. If the address bus has N lines the addressable space is  $2^N$



### Question 12

12. a) Describe the ASCII character representation format. (2 marks)  
b) Convert the decimal number 2002 to binary, octal and hexadecimal formats. (6 marks)  
c) Convert the numbers -41 and 37 to two's complement binary and find the two's complement form of the two numbers. (4 marks)

*Most candidates got the right answers to the questions, with evidence of their working. A small minority were able to provide answers without showing any working.*

### Answer Pointers

- a) ASCII - a code for representing characters with binary coded numbers from 0-127  
b) binary 111 1101 0010; octal 3722; hex 7D2  
c) 37 is 0100101 (using 7 bits); -41 is 1010111 (using 7 bits)