

**THE BRITISH COMPUTER SOCIETY**  
**THE BCS PROFESSIONAL EXAMINATION**  
Diploma

**ARCHITECTURE**

10th May 2001 - 10.00 a.m. - 12.00 p.m.  
Answer FOUR questions out of SIX. All questions carry equal marks  
Time: Two hours.

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

1. The controller for a semi-automatic car windscreen wiper system has four inputs. These comprise the state of the car ignition switch, the state of each of two rain sensors and the state of the manual override switch. The wipers will only operate when the car ignition switch is in the ON position and:

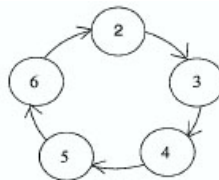
ETITHER          one or both of the rain sensors detects moisture;

OR                  the manual override switch is in the ON position. In this case the wipers will be activated irrespective of the state of the inputs from the rain sensors.

- a) Produce a truth table for the state of the windscreen wipers. **(3 marks)**
- b) Use a Karnaugh map to find a minimised sum of products expression for the state of the windscreen wipers. **(4 marks)**
- c) Draw a logic circuit for the minimised expression using only AND, OR and NOT gates. **(5 marks)**
- d) Manipulate the minimised expression into a suitable form and hence draw a logic circuit using only NAND gates. **(5 marks)**
- e) Briefly discuss the relative merits of implementing the control circuit in a full custom VLSI chip. **(4 marks)**
- f) Assume the manual override switch were a flick switch such that:
  - i) moving it briefly to the ON position would start the wipers;
  - ii) moving it briefly to the ON position a second time would stop the wipers.

Show how you would modify your circuit to accommodate its action. **(4 marks)**

2. Design a synchronous, up/down counter which follows the count sequence in either direction shown in the state diagram below:



Your solution must show detail of the following design stages:

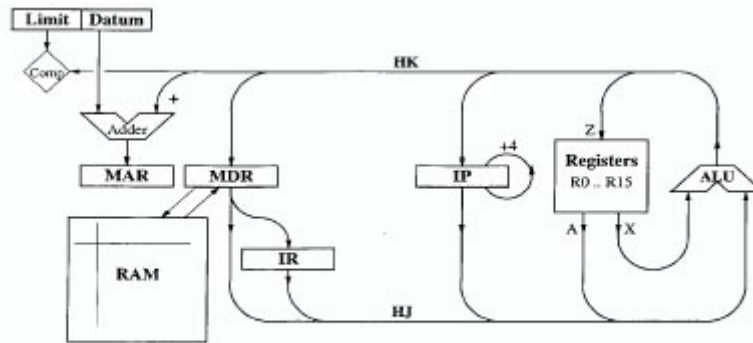
- a) A state table showing both the up and down count sequences; **(8 marks)**
- b) Karnaugh maps for each counter stage; **(10 marks)**
- c) A logic circuit for the complete counter based on JK flip-flops and NOT, AND and OR logic. **(7 marks)**

3.

- a) Discuss the assertion that "The drive to produce computers of ever higher performance is pushing the supporting technology towards its limits". (8 marks)
- b) Several alternative architectures have been proposed to overcome the approaching technological limits faced by conventional computer designs. Outline the principles of operation of ONE such architecture and discuss how it may circumvent such limitations. (17 marks)

4.

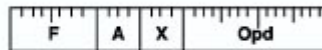
- a) A simple computer is shown diagrammatically in the figure below:



All Data Highways are 32 bits wide

<b>Key:</b>	<b>RAM</b>	Main Memory	<b>IP</b>	Instruction Pointer
	<b>ALU</b>	Arithmetic & Logic Unit	<b>IR</b>	Instruction Register
	<b>MAR</b>	Memory Address Register	<b>HJ</b>	Highway J
	<b>MDR</b>	Memory Data Register	<b>HK</b>	Highway K

The instruction format of this computer is shown below:



Where: **F** is the Opcode  
**A** is the data register (R0 .. R15)  
**X** is the index register (R1 .. R15)  
**Opd** is the Operand field

All data instructions are of the form:

$$Ra := Ra \odot Opd [Rx]$$

Describe the stages in the execution of the instruction:

$$Add \ R6,4[R7]$$

Showing how various data items move around the processor during execution. (15 marks)

- b) If the RAM speed is 66MHz and the CPU clock speed is 100MHz, estimate the instruction execution time of the ADD instruction above. (4 marks)
- c) Describe TWO mechanisms commonly used by processor designers to speed up the execution of such an instruction. Estimate by how much you would expect the execution speed to be improved by each of the (6 marks)

5. a) Explain the terms:

- i) Sector
- ii) Cluster
- iii) Cylinder
- iv) Partition
- v) Partition Table

as applied to hard disk technology.

**(10 marks)**

b) Explain the essential differences between FAT and VFAT file systems. What are the advantages of the VFAT format over the FAT format? What file system problems are not solved by VFAT file systems?

**(10 marks)**

c) Explain why hard disks bigger than 8GB present problems to Personal Computer (PCs) more than three years old. Explain, in simple terms, how modern PCs have overcome this problem.

**(5 marks)**

6. a) What is the OSI 7-layer model. Give a short description of the services provided by each layer of the model.

**(10 marks)**

b) With reference to the Data Link Layer, explain what is meant by a *frame*. What information would you expect to find in a data frame? Use a real protocol, such as HDLC, to illustrate your answer.

**(10 marks)**

c) Explain what is meant by *bit stuffing* and what it entails. What is its purpose?

**(5 marks)**