INTERNATIONAL BACCALAUREATE
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COMPUTER SCIENCE
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PAPER 1

Thursday 9 November 2000 (afternoon)

2 hours

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all of Section A.
- Answer four questions from Section B.

SECTION A

*Answer **all** questions in Section A.*

1.   State the function of a router in a network.   *[1 mark]*

2.   Define the term *buffer*.   *[2 marks]*

3.   (a)   Define the term *queue*.   *[2 marks]*

         (b)   Describe an application that uses a queue in a computer system.   *[2 marks]*

4.   State the efficiency of the quicksort in BigO notation.   *[1 mark]*

5.   Memory in a certain random access secondary storage device is allocated
         using a hash algorithm.

         (a)   State why clashes sometimes occur.   *[1 mark]*

         (b)   Outline **one** method of dealing with clashes.   *[2 marks]*

6.   Program construction (which includes testing and debugging) is one of the
         stages in the software life cycle. Outline **three** other stages.   *[6 marks]*

7.   Discuss whether parameters passed into a function should be pass-by-value or
         pass-by-reference.   *[4 marks]*

8.   Outline the terms *encapsulation* and *polymorphism* with respect to
         object-oriented programming.   *[4 marks]*

9.   Explain **two** benefits of sharing a database on a local area network.   *[6 marks]*

10. Identify the truth table for A `xor` B and state the Boolean expression for A
         `xor` B using only `and,` `or` and `not` operators.   *[5 marks]*

11. When a document needs to be sent from one country to another, it is much
         faster to send it by email rather than by normal mail. Outline **one** further
         advantage of email over normal mail, and **one** disadvantage.   *[4 marks]*

SECTION B

*Answer **four** questions.*

12. Below is an algorithm fragment which is part of a procedure, ABC, which uses three parameters. An example call to the procedure is ABC(DATA,LENGTH,COUNT).

```
HALF <-- LENGTH div 2
MIDDLE <-- HALF + 1
for POSITION <-- 1 upto HALF do
    SAME <-- DATA[MIDDLE+POSITION] = DATA[MIDDLE-POSITION]
    if SAME then
        COUNT <-- COUNT + 1
    endif
endfor
```

Where:

DATA is an integer array containing

9	3	1	0	1	4	9
[1]	[2]	[3]	[4]	[5]	[6]	[7]

LENGTH is an integer variable containing 7, and
COUNT is an integer variable initially containing 0.

(a) State the data type of SAME. *[1 mark]*

(b) Trace the algorithm fragment with the data given, using the following trace table format:

HALF	MIDDLE	POSITION	SAME	COUNT
3	4	1		

[3 marks]

(c) Explain the purpose of the algorithm. *[2 marks]*

(d) Explain why COUNT should be a pass-by-reference parameter. *[2 marks]*

(e) Explain why ABC could be declared as a function, rather than a procedure. *[2 marks]*

13. When two numbers are added together, the sign of the result depends on whether either, or both, of the numbers are negative, and whether the absolute value of the first number is larger than the absolute value of the second number. Some examples are:

$$
\begin{array}{rcrcr}
7 & + & 5 & = & 12 \\
5 & + & 7 & = & 12 \\
7 & + & (-5) & = & 2 \\
5 & + & (-7) & = & -2 \\
-7 & + & 5 & = & -2 \\
-5 & + & 7 & = & 2 \\
-7 & + & (-5) & = & -12 \\
-5 & + & (-7) & = & -12
\end{array}
$$

A test is used in a program using the Boolean values F, S and B, where:

F is true if the first number is negative;
S is true if the second number is negative;
B is true if the absolute value (**abs**) of the second number is larger than the absolute value of the first number.

Based on the values of F, S and B, the Boolean value N is set to true if the result of the addition is negative, and false otherwise. (The absolute values of the two numbers are never equal within this program and neither are zero.)

(a)   Construct the truth table for N in relation to F, S and B.   *[4 marks]*

(b)   From the table given in (a), state a Boolean expression for N in terms of F, S and B.   *[1 mark]*

(c)   Simplify the expression for N given in (b).   *[3 marks]*

(d)   When performing the above addition using 8-bit two's complement storage of integers, the answer –96 is output for 80+80. Explain why this occurred.   *[2 marks]*

14. A bank pays a bonus once a year to customers. Customers receive money for each year they have stayed with the bank. All year data is still saved in databases as a 2-digit number. For example, 87 for 1987.

The algorithm for calculating the number of years, YEARS, used to include the calculation:
```
    YEARS <-- NOW - JOIN
```
where NOW is the current year and JOIN is the year that the customer joined the bank.

This calculation was changed a year ago to:

```
if NOW < JOIN then
    YEARS <-- NOW + 100 - JOIN
else
    YEARS <-- NOW - JOIN
endif
```

(a) (i)   Outline why the algorithm was changed.   *[2 marks]*

     (ii) Deduce the conditions for which the new algorithm will work, and
           identify data to support your answer.   *[4 marks]*

The bank used a qualified software engineer to construct the initial program, who supplied user documentation, system documentation and a test plan. The program used a number of small modules.

(b) Explain **two** ways in which the system documentation would have
     helped the bank amend the YEARS algorithm.   *[4 marks]*

15. A machine has a rotating part that works under high temperatures. Three sensors are used to measure the temperature at one place in the machine.
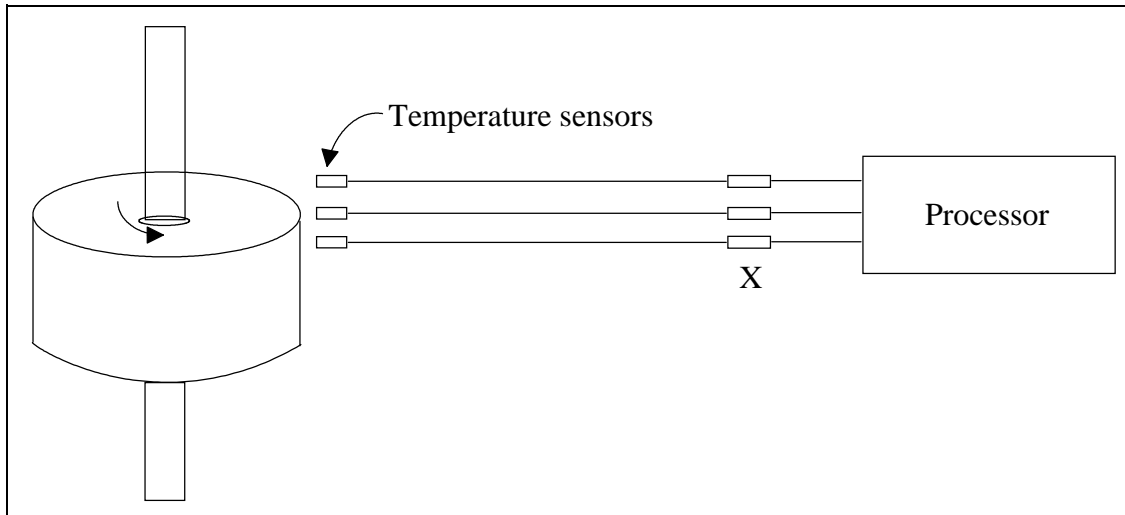
(a)   Suggest why three sensors are used, rather than one.   *[2 marks]*

(b)   State what process is taking place at X.   *[1 mark]*

(c)   Outline how polling is used by the processor to read the temperatures.   *[3 marks]*

The sensors can be linked to the processor with either serial or parallel connections.

(d)   Compare **two** features of serial and parallel connections.   *[4 marks]*

16. A business has a local area network. In one office a secretary is using a word processor whilst the local disk is being defragmented. In another office the finance manager is accessing payroll data from the central files. Both users are connected to the LAN.

(a) Outline why a disk needs to be defragmented.   *[3 marks]*

(b) Explain how the secretary's terminal can be executing two programs apparently at the same time.   *[3 marks]*

(c) Explain how an email message is sent from the finance manager to the secretary.   *[4 marks]*