M11/5/COMSC/HP1/ENG/TZ0/XX

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International Baccalaureate®
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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 1

Thursday 19 May 2011 (afternoon)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Section A: answer all the questions.
- Section B: answer all the questions.

SECTION A

*Answer **all** the questions.*

1. State **two** ways in which the functioning of a compiler differs from that of an interpreter. *[2 marks]*

2. Outline **one** application for each of the following methods of data input.

(a) OCR (Optical Character Recognition) *[2 marks]*

(b) touchscreen *[2 marks]*

3. Outline the following functions of an operating system.

(a) memory management *[2 marks]*

(b) security *[2 marks]*

4. (a) Convert the decimal number 17 into 6-bit two's complement. *[1 mark]*

(b) Convert the decimal number –17 into 6-bit two's complement. *[1 mark]*

5. Outline **one** reason for using defragmentation software. *[2 marks]*

6. Consider the method `test()` shown below.

```
public static double test(int x, int y)
{
  if (y != 0)
  {
    return (double)(x % y) / y;
  }
  else
  {
    return 0;
  }
}
```

(a) State the value that would be returned after the call `test(11, 2)`. *[1 mark]*

(b) Identify a reason for the line **`if`** `(y != 0)`. *[1 mark]*

(c) Suggest a reason for the code `(`**`double`**`)` that appears in the line

`return` `(`**`double`**`)(x % y) / y;`. *[2 marks]*

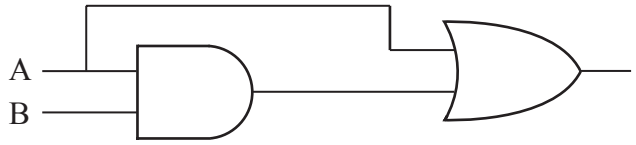
7. Explain **two** ways of reducing the time required to transmit data in a computer network. *[4 marks]*

8. (a) Define the term *truncation error*. *[2 marks]*

(b) Outline a situation in which a truncation error might occur. *[2 marks]*

9. (a) Construct the truth table for a 2-input **nand** operation. *[2 marks]*

(b) State the Boolean expression that corresponds exactly (without simplification) to the following circuit. *[1 mark]*



(c) Simplify the expression from part (b). *[1 mark]*

10. Within a computer system, state where the processing might utilize

(a) a *stack*; *[1 mark]*

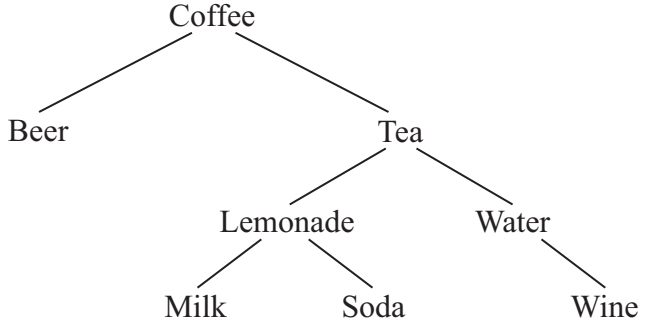
(b) a *queue*. *[1 mark]*

11. Outline the role of a *gateway* in a Wide Area Network. *[2 marks]*

12. (a) Define the term *handshaking*. *[2 marks]*

(b) Define the term *polling*. *[2 marks]*

13. Perform a *pre-order traversal* on the binary tree shown below, stating the name at each node as it is traversed. *[2 marks]*



SECTION B

*Answer **all** the questions.*

14. A business is considering computerizing its operations and has employed a team of system analysts to investigate possible solutions. The first task of this team is to clearly define the problem.

(a) Outline the benefits of **two** methods of data collection that will help them to clearly define the problem. *[4 marks]*

Once the problem is defined, the analysis team will produce different types of documentation.

(b) Outline the documentation that would be presented to

(i) the business; *[2 marks]*

(ii) the design team. *[2 marks]*

(c) Outline **one** additional piece of documentation that would be produced after the analysis stage. *[2 marks]*

15. A single machine instruction takes a value from the memory and adds it to another value stored in one of the processor's registers.

(a) With reference to the above instruction, explain the roles of the following registers.

(i) the *accumulator* *[2 marks]*

(ii) the *instruction register* *[2 marks]*

(iii) the *program counter* *[2 marks]*

(b) Describe the roles played by the buses in the operation of the above instruction. *[4 marks]*

16. Consider the algorithm shown below, which performs a *recursive binary search* on the integer array `nums`.

```
public int binarySearch(int target, int[] nums, int low, int high)
{
  // Starts with low = 0, high = nums.(length - 1).
  // If found, returns the index, else returns -1.
  int middle = (low + high) / 2;
  if (low > high)
  { return -1; }
  else if (target == nums[middle])
  { return middle; }
  else if (target < nums[middle])
  { return binarySearch(target, nums, low, middle - 1); }
  else
  { return binarySearch(target, nums, middle + 1, high); }
}
```

(a) Identify the feature in the code that shows it to be recursive. *[1 mark]*

(b) By copying and completing the table started below, trace the algorithm for the following call,

```
binarySearch(9, nums, 0, 6);
```

where `int[nums] = {3, 8, 9, 10, 13, 15, 18}`. *[3 marks]*

target	low	high	middle	return value
9	0	6		

(c) Explain why the method's parameters must change each time that the method is called. *[2 marks]*

(d) State the BigO notation for

(i) a binary search; *[1 mark]*

(ii) a linear search. *[1 mark]*

(e) Suggest why a binary search is more efficient than a linear search when searching an array with a large number of sorted values. *[2 marks]*

17. A modern hospital has extensive computer systems controlling all parts of the hospital's operations, including staff and patient affairs and the monitoring of different equipment.

(a) For **each** of the following, outline a hospital system that would make use of this type of processing.

(i) batch processing *[2 marks]*

(ii) on-line (interactive) processing *[2 marks]*

(iii) real-time processing *[2 marks]*

(b) Discuss the implications of systems failure on the systems identified in your answer to part (a). *[4 marks]*

18. *Fixed-point* binary numbers can be used to represent fractions. Consider a fixed-point representation that uses 8 bits in total, 6 bits for the integer part and 2 bits for the fraction part.

For example:

010001.01 would represent the decimal (base 10) number $17\frac{1}{4}$.

(a) Express the decimal number $6\frac{3}{4}$ as a binary fraction, using the representation described above. *[1 mark]*

(b) Explain, with the help of an example, how the use of this representation can lead to a loss of precision. *[2 marks]*

(c) Describe the effects of increasing the number of bits in the fraction part (the total number of bits remains at 8). *[2 marks]*

An alternative system is *floating-point* representation.

(d) Convert to decimal the floating-point binary number 010011 0100, if 6 bits are allocated to the mantissa and 4 bits to the exponent. *[2 marks]*

(e) Convert the decimal number $2\frac{1}{4}$ to a normalized floating-point binary number, if 6 bits are allocated to the mantissa and 4 bits to the exponent. *[3 marks]*

19. *Packet switching* over the Internet makes use of *standard protocols* during its operation.

(a) Define the term *standard protocol*. *[2 marks]*

(b) Outline the main differences between *data security* and *data integrity*. *[2 marks]*

(c) Outline how packet switching

(i) helps to provide better security for the data being sent; *[2 marks]*

(ii) is less likely to be affected by network failure. *[2 marks]*

(d) Describe how the packets are correctly reassembled by the receiving computer. *[2 marks]*