IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
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COMPUTER SCIENCE
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PAPER 1

Tuesday 2 May 2006 (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. Define the terms *client* and *server* in terms of a computer network.　　*[2 marks]*

2. Identify and outline **three** types of computer program errors.　　*[6 marks]*

3. Calculate the value of the INTEGER represented by the following 5 bit binary number that is written in 2's complement format.　　*[2 marks]*

$$10111_2$$

4. Outline the function of a *linker*.　　*[2 marks]*

5. Define the terms *function argument* and *function parameter*.　　*[2 marks]*

6. Define *virtual memory* and give an example of when it might be used.　　*[2 marks]*

7. State **two** activities that a systems analyst would undertake during the analysis stage of the *system life cycle*.　　*[2 marks]*

8. Consider the following Java data structure.

   ```
   A[ ] = {34,56,67,78,1,2,3,99};
   ```

   (a) State the name of the data structure.　　*[1 mark]*

   (b) Outline how the data value 78 can be directly accessed.　　*[1 mark]*

   (c) Explain why all elements of an array must be of the same data type.　　*[2 marks]*

9. State **two** functions included in a network data communications *protocol*.　　*[2 marks]*

10. Outline **three** main methods of systems implementation.　　*[6 marks]*

11. State the type of computer processing system most likely to be used in the following applications.

(a) Booking of a plane flight via the Internet. *[1 mark]*

(b) Control of an alarm system attached to an industrial process. *[1 mark]*

(c) Daily backup process of a computer system conducted at night. *[1 mark]*

12. State the efficiency of the general algorithm used for a:

(a) *Linear Search* of an array *[1 mark]*

(b) *Binary Search* *[1 mark]*

13. Calculate the result of the following hexadecimal addition. (Show answer in hexadecimal format.) *[2 marks]*

$$FD_{16} + AB_{16}$$

14. With the use of an appropriate example, outline why *analog* data needs to be converted to *digital* data format in computer systems. *[3 marks]*

SECTION B

*Answer all **six** questions.*

15. Data representing a worker's hourly rate of pay is to be entered into a computer system. The minimum rate is $4.50 per hour and the maximum is $23.45 per hour.

    (a) State the most appropriate data type for the hourly rate. *[1 mark]*

    (b) Define the meaning of the term data validation. *[1 mark]*

    (c) Construct an algorithm for a function `validate( )` to validate the inputted value. Assume that the value is of the appropriate data type. The function should return *false* if the data is invalid and *true* if the data is valid. A call to the function is of the form validate(value). *[4 marks]*

    Assume that a function `getValue( )` exists that captures the input from the keyboard and is used as shown:

    value = `getValue( )`

    (d) Construct the part of the algorithm required to call the validation check and then ask for the value to be re-entered if it is invalid. *[2 marks]*

    (e) By direct reference to this problem, explain how verification could be performed on the hourly rate. *[2 marks]*

16. The following questions **all** relate to a computer that uses 7 bits to represent integers using 2's complement.

    (a)   Calculate the following:

        (i)   minimum integer value that can be represented.   *[1 mark]*

        (ii)   maximum integer value that can be represented.   *[1 mark]*

    (b)   Determine the result of the addition $0111101_2 + 0111110_2$. (Show answer in binary format.)   *[2 marks]*

    (c)   Explain the error that has occurred.   *[2 marks]*

    (d)   Explain the likely impact on the running of a program if this general type of error occurs.   *[2 marks]*

    (e)   Discuss how a Java programmer can prevent such errors.   *[2 marks]*

17. An automated robot is used to cut shapes from steel sheets. If the robot's cutting blade becomes both hot and blunt the robot must stop so that the blade can cool and be resharpened. Sensors S1 (hot state) and S2 (blunt state) are attached to the blade to detect these states. Water from a container is used to keep the blade cool during cutting. If the water level falls below a certain point a sensor S3 detects this state and the robot stops irrespective of the other states.

A logic circuit is required to control the robot so that it stops cutting when the appropriate states occur.

(a) Copy the following truth table and complete it to represent the above logic. *[3 marks]*

A(S1)	B(S2)	C(S3)	Stop
0	0	0	0
0			
0			
0			
1			
1			
1			
1			

(b) From the truth table write the **full** Boolean expression showing **all** terms. *[2 marks]*

(c) Simplify the above **full** Boolean expression (clearly show the method used). *[3 marks]*

(d) Draw the circuit diagram for the simplified Boolean expression in (c). *[2 marks]*

18. An Internet log file is kept by a computer system on a daily basis. Each time a user accesses the World Wide Web (www) the log file is appended to record the user's login name and http address of the web site accessed.

The login name is a fixed 6 character name, i.e. **all** login names are 6 characters long.

The http address on average is 30 characters long.

A sample record for the user name asmith is as shown:
asmithhttp://www.ibo.org

    (a)   State the type of file organisation used. *[1 mark]*

    (b)   State the type of file access that would be needed to access records in the file. *[1 mark]*

    (c)   In a single day there are approximately 1,000,000 transactions written to the log file.

        (i)   Using the average length of an http address estimate the length in BYTES of a typical single record. *[1 mark]*

        (ii)   Determine the approximate length of the file for a single day. *[1 mark]*

    (d)   The manager wants to know how many web sites user 'asmith' has accessed. In terms of accessing the records explain why it does not matter that each record is of variable length. *[2 marks]*

The company that owns the computer system is considering selling the log files to marketing and sales organisations.

    (e)   Discuss the social and ethical implications associated with storing and selling this type of information. *[4 marks]*

19. A direct access file holds records of the format userID, userSurname, accessLevel. The userID and accessLevel are 32bit integer values and the userSurname is a fixed length String of 30 characters.

Some sample disk file data is shown below i.e. Bloggs is in record position 5 on the disk and Smith in record position 1:

123, Smith, 2; 34, Ng, 2; 1, Wong, 3; 321, Brown, 1; 56, Bloggs, 1; 15, Brown, 3

(a) Define the term direct access.   *[1 mark]*

(b) Explain why direct access usually requires records to be of a fixed length.   *[2 marks]*

An index is to be used to enable direct access. The index is to be stored in a binary tree.

(c) Define a suitable class structure for each node in the binary tree.   *[2 marks]*

(d) Using the sample data construct a binary tree representation of the index. Assume that the userID is used to insert into the binary tree.   *[3 marks]*

(e) Explain how the index can be used to gain direct access to the record belonging to a userID.   *[2 marks]*

20. A computerized security system for a building protects against unauthorized access through locked doors by use of a swipe card system. There are 20 doors. Each has a swipe card reader that is connected to the general purpose central computer. A database stores the employee ID and the rooms they are allowed access to.

(a) Construct a systems diagram to show the relationship between components of the system and the direction of interconnections. (Note: include only 3 doors in the diagram.) *[3 marks]*

(b) Compare polling and interrupt and suggest which would be the most suitable way for the swipe readers to interact with the central computer. *[3 marks]*

(c) Outline **two** characteristics of an alternative computerized method that could be used in place of the swipe card readers. *[2 marks]*

(d) Outline **one** advantage and **one** disadvantage of using the method recommended in (c). *[2 marks]*