Student Number: …………..……………….……

2005
HIGHER SCHOOL CERTIFICATE
Sample Examination Paper

SOFTWARE DESIGN AND DEVELOPMENT

General Instructions

- Reading Time – 5 minutes
- Working Time – 3 hours
- Write using blue or black pen
- Write your student number at the top of this page

Section I
20 marks
- Attempt Questions 1–20
- Allow about 35 minutes for this section

Section II
60 marks
- Attempt Questions 21–23
- Allow about 1 hour and 50 minutes for this section

Section III
20 marks
- Attempt either Question 24 or Question 25
- Allow about 35 minutes for this section

Directions to school or college

Section I
20 marks

Attempt Questions 1–20
**Allow about 35 minutes for this section**
Use the multiple choice answer sheet

1   A *CASE* tool that would be used to track the versions of a program throughout an organisation would be:
    A   version database software
    B   configuration management software
    C   configuration application software
    D   version tracking software

2   Angie has chosen a RAD approach for the creation of a customer management system for her client. The most likely reason for her choice of approach is:
    A   she owns appropriate development software
    B   the client wanted the system very quickly
    C   the client could not afford to employ a team of programmers
    D   she had already written a customer management program of her own

3   Software development is often outsourced, even by large organisations. The main reason for this is:
    A   it is uneconomic for a company to employ a full-time team of programmers
    B   programmers change jobs frequently and can steal company secrets
    C   it takes a long time to develop programs
    D   outsourced programmers are more skilful than employed programmers

4   A program has just been implemented by a company. After a few weeks of operation it has been found that the program works very slowly with large amounts of data. The person or people most likely to be responsible for causing this problem are:
    A   operators
    B   systems analyst
    C   programmers
    D   systems managers

5   A new navigation program is to be installed in all aircraft of the *OzAirs* fleet. The most appropriate implementation method would be:
    A   direct cutover
    B   parallel conversion
    C   phased conversion
    D   pilot conversion

6   A system, which is to be used by astronauts in training, is being designed for interactive tours of Mars. The most appropriate diagram to represent this system is:
    A   a dataflow diagram
    B   an IPO diagram
    C   a prototype
    D   a storyboard

7 Chris operates a small home business. So far all records have been kept on filing cards. Chris now wants to create a program that can manage all the records. The best choice of software for this task would be:

A an event-driven language

B a sequential language

C an off-the-shelf database

D a visual language

8 The array of integers 25, 37, 16, 81, 19 is sorted using an ascending insertion sort. After 2 passes, the array is in the order:

A 25, 37, 16, 19, 81

B 16, 25, 19, 37, 81

C 25, 19, 16, 37, 81

D 25, 37, 81, 19, 16

9 In a particular language, a legal array is:

```
BOX * ROW , COLUMN , PAGE , *
```

If BOX, ROW, COLUMN and PAGE are examples of legal language elements defined as *VARIABLE*, which of the following examples in EBNF could be a definition of *ARRAY*?

A ARRAY = <VARIABLE> * [<VARIABLE> ,] *

B ARRAY = <VARIABLE> * <VARIABLE> { , <VARIABLE> }*

C ARRAY = <VARIABLE> * { <VARIABLE> , }*

D ARRAY = <VARIABLE> * <VARIABLE> (, <VARIABLE>)*

10 A cruise company is rewriting their booking system. The best data structure to represent the names of each of the passengers on a particular cruise, their allocated cabin number and their preferred dinner sitting is:

A a record

B an array of records

C a single dimensioned array of strings

D a three-dimensional array of strings

11 A program has been developed for a client by Michelle. When run on Michelle's computer, the program works perfectly in all respects. When Michelle runs the program on the client's computer, it functions properly but will not output to the printer. The most likely cause of this error is:

A a syntax error

B a run-time error

C a need for additional hardware

D inappropriate drivers

12 Break points are placed in object code to:

A stop the program in an endless loop

B to enter new test data items

C to examine the contents of memory

D to print the results of calculations

Use the following algorithm for Questions 13 and 14
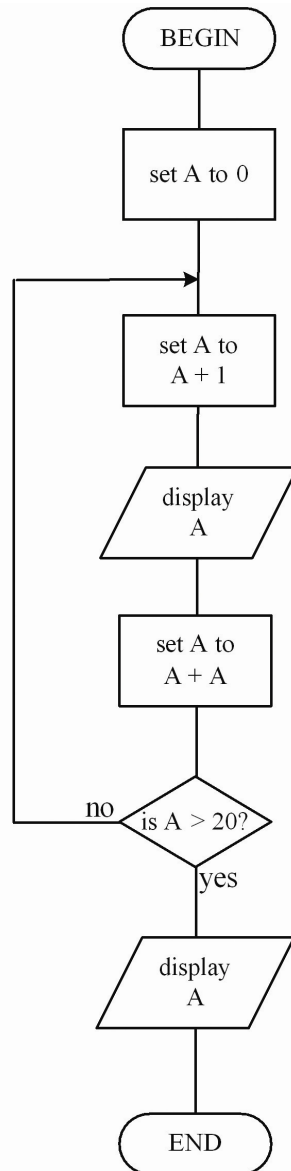
13 The output of the algorithm is:
  A 0, 1, 3, 7, 15, 30
  B 0, 1, 3, 7, 15
  C 1, 3, 7, 15, 30
  D 1, 3, 7, 15

14 The repetition control structure represented by the algorithm is:
  A binary
  B pre-test
  C linear
  D post-test

15 During execution, the two-dimensional array:

$$5 \quad 9$$
$$6 \quad 3$$

was printed out as:

$$5 \quad 6$$
$$9 \quad 3$$

This is an example of:
A   a logic error
B   a compilation error
C   a run-time error
D   a syntax error

16 A member of a development team used live data from the client to test a new system. He kept a copy of the live data which he then gave to a rival of the client to use for training purposes. This is an example of a:
A   copyright issue
B   moral issue
C   social issue
D   legal issue

17 During the maintenance stage of a software system, documentation is modified. The people responsible for keeping the documentation up-to-date are:
A   the systems analyst and management
B   the systems analyst and software engineers
C   the software engineers and users
D   management and users

18 The source code for a program has been lost. Unfortunately, a serious error in the program has been found. To correct this error you would first need to:
A   decompile the program
B   reverse engineer the program
C   use syntactic analysis
D   completely rewrite the program

19 When allocating resources to a project, the project manager would be most likely to refer to the:
A   system requirements
B   project diary
C   Gantt chart
D   feasibility study

20 Maintenance of an end-user developed program is often difficult because the developer:
A   is an inexperienced programmer
B   has forgotten how things work
C   has not properly documented the solution
D   has not properly tested the solution

Section II
60 marks

Attempt Questions 21–23
Allow about 1 hour and 50 minutes for this section

Marks

Question 21 (20 marks)

(a) Health Medical Centres is a company that operates 35 medical practices across NSW. To try to improve patient access to medical services they want to introduce a computerised phone and internet booking system for patients.

(i) Name the people who would be involved in the first stage of the structured approach and briefly describe the role of each of them. **4**

(ii) Each member of the development team has rights and responsibilities. Describe the rights and responsibilities of the systems analyst during the information-gathering stage of development. **4**

Question 21 (a) continues on the next page

Marks

Question 21 (a) (Continued)

(iii) The systems analyst decided that a prototype would be a suitable tool to gather information from users.

Compare and contrast the use of a prototype as an information-gathering tool and its use in developing a fully working program. **3**

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(b) Passengers on a cruise ship are required to pass through a security check each time they get on or off the ship at a port. When first boarding the ship each passenger is digitally photographed. The photograph is stored in the system. At each port, passengers are photographed once as they leave the ship and again as they reboard. These photographs are compared with the stored photographs. On reboarding, the passenger is only allowed to pass through the automatic gate if the three photographs match.

(i) A number of legal, social and ethical issues are raised by the use of this technology. Name and describe two of these issues and explain how they could be addressed. **4**

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Question 21 (b) continues on the next page

Marks

Question 21 (b) (Continued)

    (ii)   In the space below, draw a dataflow diagram to show the main processes of the ship security system and the data items involved.   **5**

End of Question 21

    8

Marks

Question 22 (20 marks)

A timer for school bells is being designed. The timer will connect to a school's network using wireless technology. The timer will be able to be set and adjusted from any computer connected to the school's computer network.
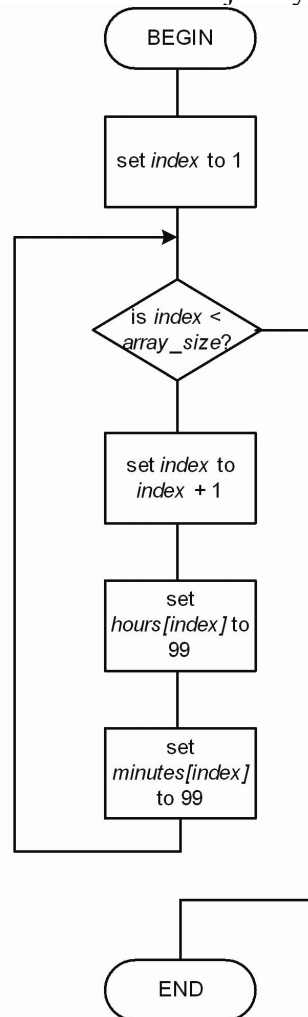
(a)   In the space below, draw a system flowchart that describes this system.   **3**

Question 22 continues on the next page

Marks

Question 22 (Continued)

(b) When programming the bell timer, the required bell time is entered in hours and minutes using 24-hour notation. One array is used to store the hours and a separate array is used to store the minutes. When the timer is started, the value *99* is placed in each of the array elements. The following algorithm has been designed to perform this initialisation task.

(i) Perform a desk check of the algorithm if the constant *array_size* has a value of 4. State whether the algorithm correctly performs this task or not using the results of the desk check to justify your answer. **2**

```
                    ┌──────────────┐
                    │    BEGIN     │
                    └──────┬───────┘
                           │
                    ┌──────┴───────┐
                    │ set index to 1│
                    └──────┬───────┘
                           │
                           ▼
                      ◇ is index <
                        array_size?  ─────┐ (no)
                           │ (yes)         │
                    ┌──────┴───────┐       │
                    │  set index to │       │
                    │  index + 1    │       │
                    └──────┬───────┘       │
                           │               │
                    ┌──────┴───────┐       │
                    │    set        │       │
                    │ hours[index] to│      │
                    │     99         │       │
                    └──────┬───────┘       │
                           │               │
                    ┌──────┴───────┐       │
                    │    set        │       │
                    │ minutes[index]│       │
                    │    to 99       │       │
                    └──────┬───────┘       │
                           │               │
                    (loop back up)         │
                                           │
                    ┌──────────────┐       │
                    │     END      │◄──────┘
                    └──────────────┘
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Question 22 (b) continues on the next page

Marks

Question 22 (b) (Continued)

(ii) You have decided that it would be better to store the bell times as a two-dimensional array. Rewrite the algorithm in pseudocode to use a two-dimensional array to store the set time. Correct any errors that you may have found in the algorithm in part (i) of the question. **3**

Question 22 continues on the next page

Marks

Question 22 (Continued)

(c)   The following algorithm describes the action of the bell timer.

```
BEGIN
        WHILE timer_state is "on"
        check_current_time
        search_for_time_match
        IF bell_to_ring
        THEN
                    ring_bell
        ENDIF
        check_new_time_request
        IF new_time_request
        THEN
                    add_new_time_to_first_available_location
        ENDIF
        ENDWHILE
END
```

(i)   Compare and contrast the linear search and the binary search as applied
to the module *search_for_time_match*.   **3**

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Question 22 (c) continues on the next page

Marks

Question 22 (c) (Continued)

 (ii) Construct an algorithm, using either pseudocode or a flowchart, to search through the array of stored times to find a match for the clock time. If there is a match, then the Boolean variable *bell_to_ring* should be returned *"true"*. **5**

Question 22 continues on the next page

Marks

Question 22 (Continued)

(d)   In the space provided, use the rules for good screen design to create a screen
         layout that is suitable for a teacher to add a new time to the array of stored times.
         The times that are already stored should be visible in the screen so that the
         teacher can read the list of times that have already been stored.   **4**

End of Question 22

Marks

Question 23 (20 marks)

(a)   (i)   Compare and contrast compilation of source code into object code with
           interpretation of source code into object code.   **3**

       (ii)   During the development of a module, Justine has access to both a
           compiler and an interpreter for the language she is using. Justine has
           coded her module for the first time. Which translation method should she
           use and why should she use it?   **3**

(b)   (i)   Describe the role of the program counter register located in the CPU
           during the *fetch* stage of the fetch-execute cycle.   **2**

Question 23 (b) continues on the next page

Marks

Question 23 (b) (Continued)

    (ii)   A program enters a loop during execution. Explain how the program counter is used during the loop.   **3**

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(c)   Thien has written a program that is producing a runtime error. He needs to find the source of the error.

    (i)   Write down an example of a runtime error and use this example to explain the meaning of the term *runtime error*.   **3**

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    (ii)   Name and briefly describe two software debugging tools that Thien could use to help him locate the error.   **2**

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Question 23 continues on the next page

Marks

Question 23 (Continued)

(d)   A module is being written for a security program. Users are to create their own passwords using the following two rules:
*   Passwords must be between 6 and 10 characters long.
*   A password must contain at least two digits and at least two letters.

The module will return *"acceptable"* for a password that follows the rules and *"unacceptable"* for a password that does not.
Create a set of test data that will fully test the module. Use the following table for your answer. You may not need all the rows for a correct answer.   **4**

Test Data Item	Reason for Choice	Expected Output

End of Question 23

Section III
20 marks

Attempt either Question 24 or Question 25
Allow about 35 minutes for this section

Marks

Question 24 Evolution of Programming Languages (20 marks)

(a) The following language examples calculate the factorial of a number.

Examples:
Factorial (1) = 0 and Factorial (5) = 5 * 4 * 3 * 2 * 1

Sample A	Sample B
```function fac(N:integer) : integer; var i : integer; begin if N >= 0 then begin fac := 1 for I := 1 to N do fac := fac * I end end;```	```factorial(0,1). factorial(N,F) :- N>0, N1 is N-1, factorial(N1,F1), F is N * F1.```

(i) Compare and contrast the programming paradigms represented by *the two samples* above. Use code examples from the samples above to justify your choice. **4**

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Question 24 (a) continues on the next page

Marks

Question 24 (a) (Continued)

    (ii)   Modify *Sample B* so that it calculates the triangular numbers where, for example:

            Triangular (1) = 1 and Triangular (5) = 1 + 2 + 3 + 4 + 5   **4**

(b)   Compare and contrast the basic building blocks of the imperative and functional programming paradigms. Use code examples to illustrate your answer.   **4**

Question 24 continues on the next page

Marks

Question 24 (Continued)

(c)   Name and describe two features of object oriented programming that can assist a
team of programmers who have been employed to maintain a program written in
an object oriented language.   **4**

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(d)   Explain how increases in processing speed and storage capacity together with a
decrease in the cost of computers have influenced the design of computer
languages.   **4**

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End of Question 24

Marks

Question 25 The Software Developer's View of the Hardware (20 marks)

(a)   (i)   Perform the following subtraction using five-bit two's complement representation of integers.

$10110_2 - 00111_2$ **2**

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    (ii)   Convert each of the values to a decimal integer. Explain why the answer to the subtraction is not correct as a decimal.   **3**

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Question 25 continues on the next page

Marks

Question 25 (Continued)

(b) In a class test, André was given the following truth table and asked to construct a logic circuit for this truth table:

A	B	C	D
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

(i) Use the truth table to identify the circuit that André was asked to draw. **1**

(ii) For his answer, André drew the following diagram:
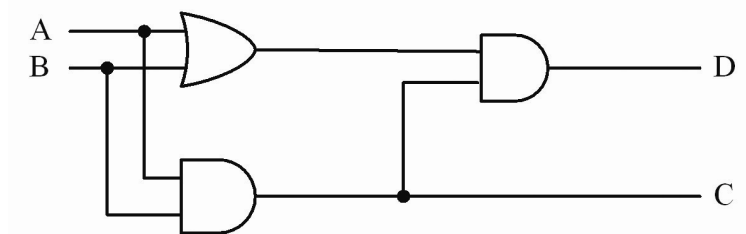
Complete the following truth table for this logic circuit. **2**

A	B	C	D
0	0		
0	1		
1	0		
1	1		

(iii) In the space below, draw the correct logic diagram for the truth table in part (i). **2**

Question 25 continues on the next page

Marks

Question 25 (Continued)

(c) The air conditioning system uses temperature sensors in each of the building's rooms to help control the inside climate. The data from each sensor is transmitted to the control centre once every minute.

Each sensor's position in the building is identified using a pair of coordinates. The first of the coordinates is the floor number and the second is the number of the room. For example, sensor (5, 21) is the sensor in room 21 on floor 5.

The sensors transmit a message that contains one hexadecimal digit for the floor, two hexadecimal digits for the room and two hexadecimal digits that represent the temperature in tenths of a degree above 10°C.

(i) What is the position of the sensor that begins its message with B3C? Show all working out. **2**

(ii) The temperature in room 76 on floor 9 is 21.3°C. Write down the hexadecimal string that would form the data part of the message from this sensor. Show all working. **4**

Question 25 (c) continues on the next page

Marks

Question 25 (c) (Continued)

    (iii)   Describe the structure of the complete data packet that could be sent from a sensor to the controller. Illustrate your answer with a labelled example of a data packet.   **4**

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End of paper

Section I – Multiple choice

Answer sheet

	A	B	C	D
1				
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Mapping grid

Question	Mark	Content	Outcome	Band
1	1	The use of CASE tools and their application to large systems' development	H 5.1	2/3
2	1	Development approaches used in commercial systems	H 1.2	1/2
3	1	Current trends in software development	H 2.2	3/4
4	1	Ensures that relevant ethical and social issues are addressed appropriately	H 3.1	4/5
5	1	Methods of implementation	H 4.2	2/3
6	1	Representing a system using diagrams	H 5.2	5/6
7	1	Compare and determine the most appropriate software development approach for a given scenario	H 5.3	2/3
8	1	Standard algorithms for searching and sorting	H 4.3	5/6
9	1	Use of BNF, EBNF and railroad diagrams to describe the syntax of new statements in the chosen language	H 1.3	5/6
10	1	Design specifications	H 5.2	2/3
11	1	Hardware environment to enable implementation of the software solution	H 1.1	3/4
12	1	The use of software debugging tools	H 4.2	1/2
13	1	The process of detecting and correcting errors	H 4.3	2/3
14	1	Represent a software solution in diagrammatic form	H 4.1	1/2
15	1	Recognise the cause of a specific error and determine how to correct it	H 6.2	3/4
16	1	Concepts associated with piracy and copyright	H 3.1	4/5
17	1	Documentation of changes	H 6.3	3/4
18	1	Location of section of code to be altered	H 4.2	2/3
19	1	Use project management techniques to ensure that the software solution is implemented in an appropriate time frame	H 5.1	1/2
20	1	Completing all user documentation for the project	H 5.2	2/3
21 (a) (i)	4	Describing how the skills of the various personnel contribute to the overall development of a computer-based system	H 6.1	2/3

Question	Mark	Content	Outcome	Band
21 (a) (ii)	4	Rights and responsibilities of software developers	H 3.1	3/4
21 (a) (iii)	3	Compare and determine the most appropriate software development approach for a given scenario	H 1.2	3/4
21 (b) (i)	4	Significant social and ethical issues	H 3.1	2/3
21 (b) (ii)	5	Representing a system using diagrams	H 4.2	3/4
22 (a)	3	Create a diagrammatic representation for a system using an appropriate method	H 1.3	2/3
22 (b) (i)	2	The process of detecting and correcting errors	H 4.2	1/2
22 (b) (ii)	3	Use of data structures, including multi-dimensional arrays, arrays of records, files (sequential and relative/random)	H 4.1	4/5
22 (c) (i)	3	Standard logic used in software solutions	H 4.3	5/6
22 (c) (ii)	5	Recognise the logic in a standard approach	H 4.3	4/5
22 (d)	4	Design and evaluate effective screens for software solutions	H 4.1	1/2
23 (a) (i)	3	Translation methods in software solutions	H 1.3	4/5
23 (a) (ii)	3	Advantages and disadvantages of each translation method	H 5.3	5/6
23 (b) (i)	2	The role of the CPU in the operation of software	H 1.3	4/5
23 (b) (ii)	3	Use of program counter and fetch-execute cycle	H 1.3	5/6
23 (c) (i)	3	Recognise the cause of a specific error and determine how to correct it	H 4.2	2/3
23 (c) (ii)	2	Justify the use of a clear modular structure with separate routines to ease the design and debugging process	H 5.3	2/3
23 (d)	4	Generating relevant test data for complex solutions	H 6.3	2/3
24 (a) (i)	4	Paradigm specific concepts	H 2.1	2/3
24 (a) (ii)	4	Modify fragments of code written using an example of a particular paradigm to reflect changed requirements	H 4.2	4/5
24 (b)	4	Basic building blocks	H 2.1	5/6
24 (c)	4	Effect on programmers' productivity	H 4.1	2/3
24 (d)	4	Historical reasons for the development of the different paradigms	H 2.1	2/3

Question	Mark	Content	Outcome	Band
25 (a) (i)	2	Binary arithmetic	H 1.3	2/3
25 (a) (ii)	3	Interpret the binary representation of data, recognise situations in which data can be misinterpreted by the software	H 1.3	4/5
25 (b) (i)	1	Describe the purpose of a circuit from its truth table	H 1.3	1/2
25 (b) (ii)	2	Generate truth tables for a given circuit	H 1.3	2/3
25 (b) (iii)	2	Design a circuit to solve a given problem and use a truth table to verify the design	H 1.3	2/3
25 (c) (i)	2	Processing of data stream	H 1.1	1/2
25 (c) (ii)	4	Interpret a data stream for a device for which specifications are provided	H 1.1	5/6
25 (c) (iii)	4	Generate a data stream to specify particular operations for a hardware device, for which specifications are provided	H 1.3	4/5

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Answers

Section I – Multiple choice

	A	B	C	D
1		✕		
2				✕
3	✕			
4			✕	
5		✕		
6				✕
7			✕	
8	✕			
9		✕		
10		✕		
11				✕
12			✕	
13			✕	
14				✕
15	✕			
16				✕
17		✕		
18	✕			
19			✕	
20			✕	

Question 21 (a) (i)

The people involved are:
The systems analyst – needs to gather information about the system and prepare the necessary reports from the information gathered.
Management – provides information about the place of the system within the organisation and some operational information. They will also make decisions about the new system based on the information provided by the systems analyst.
Users – the users of the system will provide information as to how the system operates and the data that is to be processed. They will also provide information about how data is presented.

Marking guidelines

Criteria	Marks
• Lists all participants in the stage and gives a comprehensive description of the roles of each.	4
• Lists all participants in the stage and comprehensively describes the role of one of them and mentions some of the roles of the others.	3
• Lists all participants in the stage and briefly describes the role of one of them.	2
• Lists at least one participant in the stage.	1

Question 21 (a) (ii)

The systems analyst has: the right to have access to all the relevant documents held by the organisation and access to facilities needed for the analysis, the right to be paid for the job performed and the right to have management consider the recommendations made in the reports.
The systems analyst has the responsibility to: look at the operations of the organisation in an unbiased way, fully understand the way in which the system works, maintain confidentiality of the information gathered, ensure that all the needs for the system are identified, respect the rights of users and management during the information-gathering process and provide objective recommendations in the reports that are created.

Marking guidelines

Criteria	Marks
• Provides a comprehensive discussion of all the rights and responsibilities of the systems analyst during the information-gathering stage of the systems development process.	4
• Names and briefly describes a number of rights and responsibilities.	3
• Comprehensively describes one right or responsibility OR names a number of rights and responsibilities.	2
• Names one right or responsibility.	1

Question 21 (a) (iii)

A prototype used as an information-gathering tool is created and user feedback is gathered. The prototype may be modified and further user feedback obtained until there is no further information to be gained. The information is collated and used to develop the system and the prototype is discarded.

The prototype used as a development tool is created and feedback is again obtained. The information is used to modify the prototype and this prototype becomes the final product. Both forms of prototype involve creation of a working model and the collection of feedback from users, which is used to modify the solution.

Marking guidelines

Criteria	Marks
• Describes both an evolutionary prototype and an information-gathering prototype and discusses the similarities and differences between them.	3
• Describes both an evolutionary prototype and an information-gathering prototype OR describes one prototype and discusses some similarities and differences between them.	2
• Describes either an evolutionary prototype or an information-gathering prototype.	1

Question 21 (b) (i)

Legal issues could include a malfunctioning of the system that leaves a passenger stranded at a port or the sale of photographs by members of the crew.

Social issues could include privacy concerns, people feeling like they are being watched and the accuracy of the system.

Ethical issues could include the use of the photographs to monitor people's movements, what happens to the photographs after the cruise and the use of the photographs for some other purpose such as advertising.

Marking guidelines

Criteria	Marks
• Names two issues with comprehensive description in context.	4
• Names one issue with comprehensive description in context AND names another issue without description.	3
• Names two issues without description OR names one issue with comprehensive description in context.	2
• Names one issue without description.	1

Question 21 (b) (ii)

A possible dataflow diagram is:
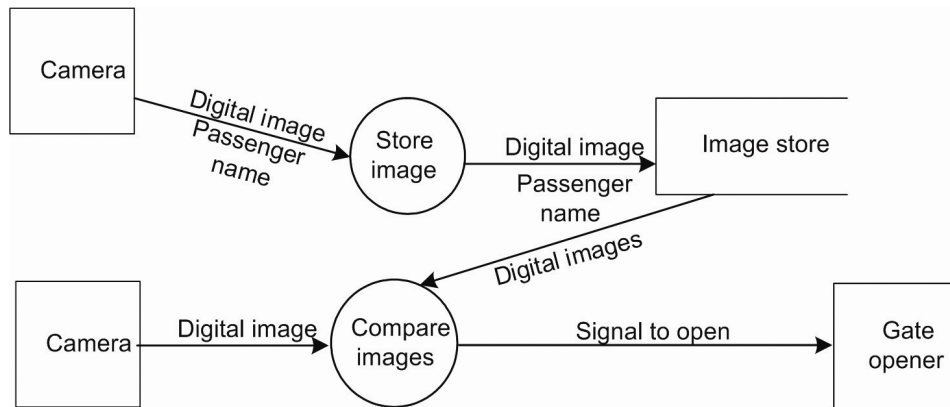
Marking guidelines

Criteria	Marks
• Uses all correct symbols, includes all elements relevant to the scenario and shows all data items in dataflow.	5
• Uses all correct symbols and includes all elements relevant to the scenario.	4
• Uses all correct symbols and includes processes relevant to the scenario.	3
• Uses all correct symbols and includes a process or storage or external entity.	2
• Uses one or more correct symbols.	1

Question 22 (a)

A possible system flowchart is:
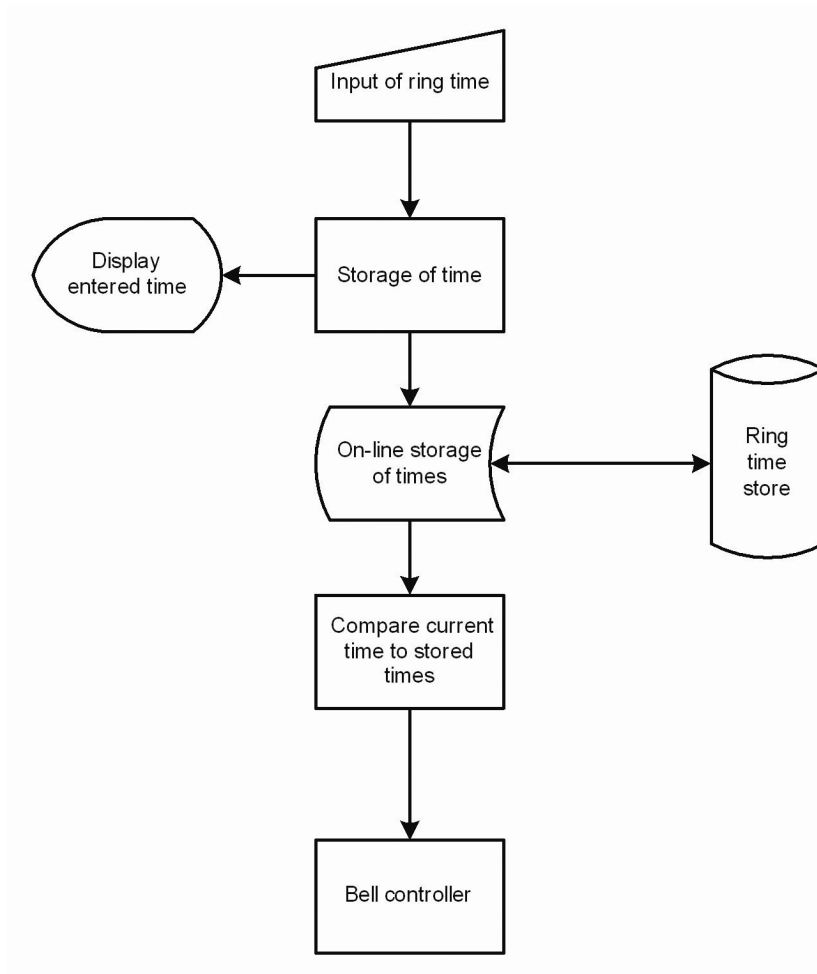
Marking guidelines

Criteria	Marks
• Uses all correct symbols and shows their relationships relevant to the scenario.	3
• Uses all correct symbols and includes some relevance to the scenario.	2
• Uses one or more correct symbols.	1

Question 22 (b) (i)

A possible desk check is:

Index	~~1~~ ~~2~~ ~~3~~ 4
hours[1]	unknown
minutes[1]	unknown
hours[2]	99
minutes[2]	99
hours[3]	99
minutes[3]	99
hours[4]	99
minutes[4]	99

Marking guidelines

Criteria	Marks
• Performs a desk check and picks the error.	2
• Performs a desk check showing some variables.	1

Question 22 (b) (ii)

```
BEGIN
        set hours_index to 1
        set minutes_index to 1
        WHILE hours_index <= array_size
                WHILE minutes_index <= array_size
                        set bell_times[hours_index , minutes_index] to 99
                        set minutes_index to minutes_index + 1
                ENDWHILE
                set hours_index to hours_index + 1
        ENDWHILE
END
```

Marking guidelines

Criteria	Marks
• Creates in pseudocode a structured algorithm that fully addresses the problem and corrects the error.	3
• Creates in pseudocode a structured algorithm that partially solves the problem.	2
• Creates in pseudocode an algorithm that partially solves the problem.	1

Question 22 (c) (i)

The linear search passes through the array one element at a time until a match is found or the array is exhausted. A binary search divides a sorted array into two halves and determines whether the target is in one half or not. The half not containing the element is discarded and the process is continued until either a match is found or the array is exhausted.
The linear search is used to search an unordered array; if the bell times are stored in a random order then a linear search would be appropriate. The binary search is used to search through an ordered array hence the bell times would need to be sorted for a binary search to be used. The most appropriate search in this scenario is the linear search as the array of times is most likely to be unsorted.

Marking guidelines

Criteria	Marks
• Compares and contrasts the features of both searches as applied to the scenario.	3
• States the features of one of the searches as applied to the scenario OR compares and contrasts the features of both searches without using the scenario.	2
• States the features of one of the searches.	1

Question 22 (c) (ii)

A possible solution is:

```
BEGIN
        set bell_to_ring to false
        set index to 1
        get clock_time from clock
        REPEAT
                IF clock_time = stored_time[index]
                THEN
                        set bell_to_ring to true
                ELSE
                        set index to index + 1
                ENDIF
        UNTIL bell_to_ring = true OR stored_time[index] = 99:99
        RETURN bell_to_ring
END
```

Marking guidelines

Criteria	Marks
• The algorithm is well structured and solves the problem.	5
• The algorithm solves the problem OR the algorithm is well structured and solves a majority of the problem. (May contain 1 small error in logic.)	4
• The algorithm solves a majority of the problem. (May contain 1 small error in logic.)	3
• The algorithm shows correct pseudocode keywords and contains a loop to pass through the array.	2
• The algorithm contains correct pseudocode keywords.	1

Question 22 (d)

A possible solution is:

Marking guidelines

Criteria	Marks
• Uses good screen design principles and incorporates all necessary screen elements in an appropriate format.	4
• Incorporates all necessary screen elements in an appropriate format and shows some understanding of good screen design.	3
• Uses some appropriate screen elements in the design.	2
• Shows some knowledge of screen elements.	1

Question 23 (a) (i)

Both translation methods convert source code written in a high-level language into object code that can be understood by the processor. An interpreter converts source code into object code that is then executed and lost. A compiler converts source code into object code that is then stored for later execution. Compilation will only detect and notify errors in the language syntax, whereas interpretation will also detect and notify run-time errors.

Marking guidelines

Criteria	Marks
• Describes both compilation and interpretation and states some similarities and differences.	3
• Describes both compilation and interpretation.	2
• Describes either compilation or interpretation.	1

Question 23 (a) (ii)

Justine should use the interpreter since she will need to detect both run-time and syntax errors. Both types of error need to be detected so that the program functions correctly. A further benefit of using the interpreter is that the object code does not need to be saved at this stage in the development. If she compiles the program, she will still need to execute it, which will usually take longer than interpretation.

Marking guidelines

Criteria	Marks
• States the interpreter should be used, with good reasoning for choosing the interpreter, and why the compiler is not as useful.	3
• States the interpreter should be used with good reasoning for choosing the interpreter.	2
• States the interpreter should be used with minimal reasoning.	1

Question 23 (b) (i)

The program counter register holds the address of the next instruction to be executed, i.e. the instruction to be fetched. The CPU uses the program counter to locate the next instruction. As part of the fetch phase, the program counter is adjusted by the CPU to point to the following instruction to be executed.

Marking guidelines

Criteria	Marks
• Describes the use of the program counter in the context of the fetch phase of the fetch-execute cycle.	2
• Shows knowledge of the program counter as holding the location of an instruction.	1

Question 23 (b) (ii)

Normally the use of the program counter would mean incrementing the counter to point to the next instruction. However, if the program is to branch back to the beginning of a loop, the location of the beginning of the loop is stored in an area of primary storage that has been set aside for this purpose. The instructions in the loop are executed in order. When the program has to go back to the beginning of the loop, the location of that instruction is retrieved from memory and copied back into the program counter so that the CPU can locate the first instruction in the loop again. When it is time to exit the loop, the location of its start is removed from the storage location.

Marking guidelines

Criteria	Marks
• Gives a comprehensive description of the role of the program counter in the execution of a loop.	3
• Describes the role of the program counter in the execution of a loop.	2
• Briefly mentions one of the aspects involved in the use of the program counter to loop.	1

Question 23 (c) (i)

Examples could include: division by zero, non-existent array elements referenced by an out-of-range index, results of calculations involving integers that run outside the range available in integer notation, unexpected outputs due to truncation in calculations and control not following the paths as designed in the algorithm description.

Definition: a run-time error is an error that produces unexpected results when the program is executed.

Marking guidelines

Criteria	Marks
• Defines a run-time error AND describes the effect of a run-time error by using an example.	3
• Describes the effect of a run-time error by using an example.	2
• Defines a run-time error.	1

Question 23 (c) (ii)

Two software debugging tools should be chosen from: breakpoints, resetting variable contents, program tracing and single line stepping through the program

Marking guidelines

Criteria	Marks
• Names and describes two debugging tools.	2
• Names and describes one debugging tool OR names two debugging tools.	1

Question 23 (d)

Test Data Item	Reason for Choice	Expected Output
ab12c	Less than 6 characters	unacceptable
abcde1	Exactly 6 characters, less than 2 digits	unacceptable
a12345	Exactly 6 characters, less than 2 letters	unacceptable
abcd12	Exactly 6 characters, exactly 2 digits	acceptable
ab1234	Exactly 6 characters, exactly 2 letters	acceptable
abc123	Exactly 6 characters, more than 2 of each	acceptable
abcdefg1	Over 6 characters, less than 2 digits	unacceptable
a1234567	Over 6 characters, less than 2 letters	unacceptable
abcdef12	Over 6 characters, exactly 2 digits	acceptable
ab123456	Over 6 characters, exactly 2 letters	acceptable
abcd1234	Over 6 characters, more than 2 of each	acceptable
abcdefghi1	Exactly 10 characters, less than 2 digits	unacceptable
a123456789	Exactly 10 characters, less than 2 letters	unacceptable
abcdefgh12	Exactly 10 characters, exactly 2 digits	acceptable
ab12345678	Exactly 10 characters, exactly 2 letters	acceptable
abcde12345	Exactly 10 characters, more than 2 of each	acceptable
Abcdefghijkl12	Over 10 characters	unacceptable

Marking guidelines

Criteria	Marks
• A complete set of test data, testing all possibilities.	4
• A set of test data that tests most of the combinations (13 items or above).	3
• A set of test data that tests some of the combinations (9 items or above).	2
• A set of test data that tests a few of the combinations (5 items or above).	1

Question 24 (a) (i)

Sample A is in the imperative paradigm; sample B is functional. The imperative paradigm states exactly what has to be done using variables and operations. The functional language works by passing parameters to and from functions. Answers are to be supported by examples from the two programs.

Marking guidelines

Criteria	Marks
• Identifies both of the paradigms and gives at least one property of each paradigm AND states at least one similarity and at least one difference between them using code examples.	4
• Identifies both of the paradigms and gives at least one property of each paradigm AND either states at least one similarity or one difference between them using code examples.	3
• Identifies both of the paradigms and gives at least one property of each paradigm.	2
• Identifies one of the paradigms and gives at least one property.	1

Question 24 (a) (ii)

```
triangular(1,1).

triangular(N,F) :-
   N>1,
   N1 is N-1,
   triangular(N1,F1),
   F is N + F1.
```

Marking guidelines

Criteria	Marks
• Completes the modification with no errors.	4
• Completes the modification with one error.	3
• Attempts the modification and makes substantial progress.	2
• Attempts to change the code and completes one line successfully.	1

Question 24 (b)

The basic building blocks of the imperative languages are variables, assignment and control structures. The basic building blocks of functional languages are parameters and functions. Parameters and variables are similar in that they represent data; the ways in which they are manipulated are different. The processing of variables is governed by the set of instructions provided by the programmer. The processing of parameters by a function is hidden from the programmer.

Marking guidelines

Criteria	Marks
• Describes both types of building block, noting similarities and differences, and provides examples from languages to illustrate the answer.	4
• Describes both types of building block, noting either similarities or differences, and provides examples from languages to illustrate the answer.	3
• Describes the building blocks of one paradigm and provides examples OR describes the building blocks of both paradigms.	2
• Describes the building blocks of one paradigm.	1

Question 24 (c)

Features that could be described are: encapsulation, modularisation, the creation of classes and inheritance, as well as the abstraction of data.
These should be discussed in the context of maintenance of programs rather than the creation of new programs.

Criteria	Marks
• Names two features of object oriented languages AND discusses the ways the features can help programmers maintain a program.	4
• Names two features of object oriented languages AND discusses the ways one of the features can help programmers maintain a program.	3
• Names two features of object oriented languages OR names one feature and discusses the ways it can help programmers maintain a program.	2
• Names one feature of object oriented languages.	1

Question 24 (d)

Answers should discuss how the greater complexity of higher level languages needs a greater degree of processing power to be translated. The needs of users have increased as technology has become cheaper and more powerful. The move to a graphical interface has also influenced the design of some languages.

Criteria	Marks
• Comprehensive discussion of a number of relevant points.	4
• Comprehensive discussion of two points, mention of others.	3
• Comprehensive discussion of one point OR statement of two or more points.	2
• Statement of one point.	1

Question 25 (a) (i)

$0\,0\,1\,1\,1_2$ needs to be turned into its 5-bit two's complement form
One's complement $1\,1\,0\,0\,0_2$
Two's complement $1\,1\,0\,0\,1_2$

Adding: 1 0 1 1 0
           1 1 0 0 1 +
          1 0 1 1 1 1
The leading 1 is omitted so the answer is $0\,1\,1\,1\,1_2$

Marking guidelines

Criteria	Marks
• Correct conversion to two's complement AND correct addition.	2
• Correct conversion to two's complement OR correct addition for binary numbers written down.	1

Question 25 (a) (ii)

$1\ 0\ 1\ 1\ 0_2 = -10_{10}$ and $0\ 0\ 1\ 1\ 1_2 = 7_{10}$ so $-10_{10} - 7_{10} = -17_{10}$.
The result $0\ 1\ 1\ 1\ 1_2$ represents 15_2; however, the use of 5-bit two's complement can only represent the values -16 to 15, thus the correct answer is outside this range.

Marking guidelines

Criteria	Marks
• Correctly converts all binary values to decimal AND gives the correct reason for the answer being wrong.	3
• Correctly converts all binary values to decimal OR correctly converts the answer to the addition and gives the correct reason for it being wrong.	2
• Correctly converts one of the binary values to decimal.	1

Question 25 (b) (i)

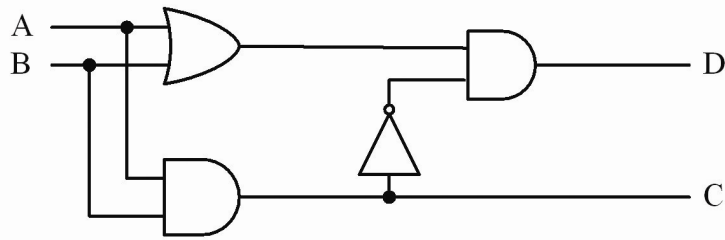The required circuit is a half-adder.

Marking guidelines

Criteria	Marks
• Correctly names the logic circuit for the given truth table.	1

Question 25 (b) (ii)

A	B	C	D
0	0	0	0
0	1	0	0
1	0	0	0
1	1	1	1

Marking guidelines

Criteria	Marks
• Correct truth table.	2
• Makes only 1 error in the truth table.	1

Question 25 (b) (iii)

Marking guidelines

Criteria	Marks
• A correct logic circuit for the half adder.	2
• A logic circuit that contains these elements connected in the wrong way.	1

Question 25 (c) (i)

$B_{16} = 11_{10}$ and $3C_{16} = 3 \times 16 + 12 = 60$ so the sensor is the sensor in room 60 on the 11th floor.

Marking guidelines

Criteria	Marks
• Correct conversion and statement of the location of the sensor.	2
• Correct conversion OR the correct statement of the location of the sensor for the values mentioned.	1

Question 25 (c) (ii)

Room 76 on the 9th floor has the code 94C. The temperature 21.3°C is 113×0.1°C above 10°C. $113_{10} = 71_{16}$
The hexadecimal string would be 94C71.

Marking guidelines

Criteria	Marks
• A correct 5-digit hexadecimal string representing both the code and the temperature.	4
• The hexadecimal code for the sensor AND the hexadecimal code for the temperature are correct.	3
• The hexadecimal code for the sensor AND the value for the temperature (113) are correct.	2
• One of the hexadecimal codes is correct.	1

Question 25 (c) (iii)

The string would contain a header that would have at least a start bit; it could also contain an address for the processor. The data section would then follow, and finally the trailer would probably contain a checksum and a stop bit.

e.g. (values in hexadecimal)
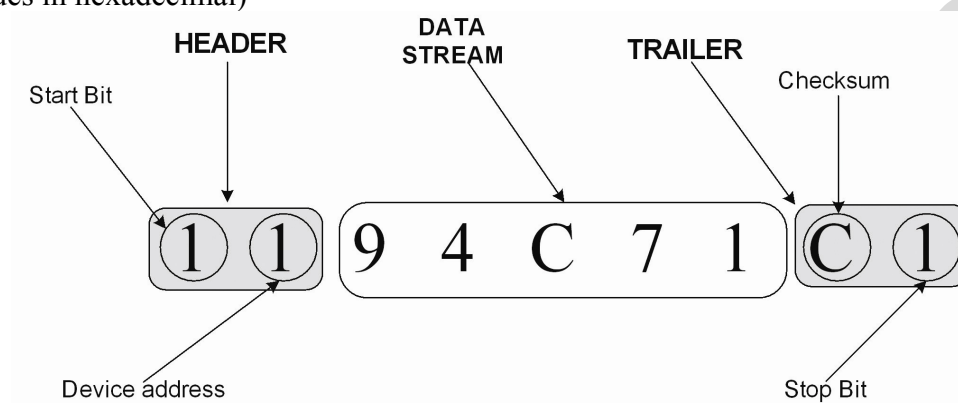
Marking guidelines

Criteria	Marks
• Comprehensive description of a data stream with a well-labelled diagram.	4
• Good description of a data stream with a rough diagram.	3
• Good description of a data stream with no diagram.	2
• An indication of the structure of a data stream mentioning a header, data and trailer.	1