

**B O A R D O F S T U D I E S**  
NEW SOUTH WALES

**2009**

**HIGHER SCHOOL CERTIFICATE  
EXAMINATION**

# Software Design and Development

## **General Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil

**Total marks – 100**

**Section I** Pages 2–9

**20 marks**

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

**Section II** Pages 10–17

**60 marks**

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

**Section III** Pages 18–21

**20 marks**

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

## Section I

20 marks

Attempt Questions 1–20

Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

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- 1 “The more society depends on computer software for its day-to-day functioning, the greater the risk if that software fails.”

To what aspect of software development is this quotation referring?

- (A) Reliability
  - (B) Authorship
  - (C) Copyright laws
  - (D) Code of conduct
- 2 What is the output from the following segment of code?

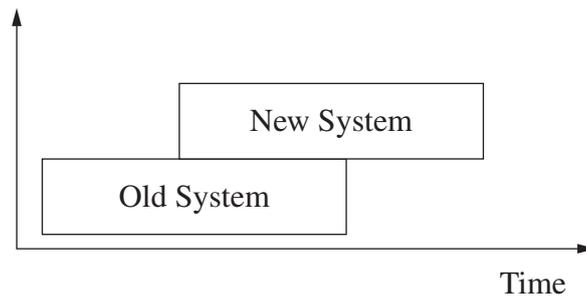
```
X = 4  
Y = X  
Z = X*Y  
PRINT Z
```

- (A) 4
  - (B) 8
  - (C) 16
  - (D) 32
- 3 Which control structure is used in the following algorithm?

```
WHILE health > 0  
    playGame  
ENDWHILE
```

- (A) Binary selection
- (B) Multiway selection
- (C) Post-test loop
- (D) Pre-test loop

4 Which method of implementation is shown in the diagram below?



- (A) Direct Cut Over
- (B) Parallel
- (C) Phased
- (D) Pilot

5 A student downloads a file from the internet. She discovers that her version of the application software will not open the file.

Which of the following solutions to the problem is NOT legal?

- (A) Downloading a trial copy of the new version of the application
- (B) Installing a borrowed copy of the new version of the application
- (C) Installing open-source software that is capable of opening the file
- (D) Emailing the file to a friend who has bought the new version of the application and can convert it to a compatible file type

6 Consider the following job advertisement.

Our client is seeking an experienced person to work within a team on the implementation of a large web-based administration system. The right person will have communication, facilitation and report writing skills, and the ability to understand the project, its environment and related issues.

The work will involve:

- Developing data models and schemas
- Convening workshops of user representatives to identify operational and statistical reporting requirements
- Developing business requirements and specification documentation

What job is being advertised?

- (A) Document writer
- (B) Hardware engineer
- (C) Systems analyst
- (D) Web programmer

7 Which of the following occurs in a CPU when a subroutine is called?

- (A) The accumulator is incremented by 1.
- (B) The program counter is incremented by 1.
- (C) The accumulator is set to the start address of the subroutine.
- (D) The program counter is set to the start address of the subroutine.

8 Which of the following is true of Dynamically Linked Libraries (DLLs)?

- (A) They can only be used by one program.
- (B) They are secure programs, free of viruses.
- (C) They are included when a program is compiled.
- (D) They can be loaded into memory while a program is executing.

- 9 Where is a stub most often used?
- (A) In subprograms to flag errors
  - (B) In programs to replace incomplete code
  - (C) In flowcharts to represent a sub-procedure
  - (D) In storyboards to design a screen interface

- 10 insert is a function which acts on strings.  
insert(string1,string2,n) inserts string2 after the nth character in string1  
For example: insert(football,goal,4) returns footgoalball

What would be the output from the following algorithm?

```
BEGIN
  a = cat
  b = fish
  FOR k = 1 TO 2
    a = insert(a,b,k)
  NEXT k
  PRINT a
END
```

- (A) catfish
- (B) cffishishat
- (C) cfishfishat
- (D) catcatfishfish

- 11 A company keeps its secure customer details in a file. Each record has the following structure.

name	id	password
------	----	----------

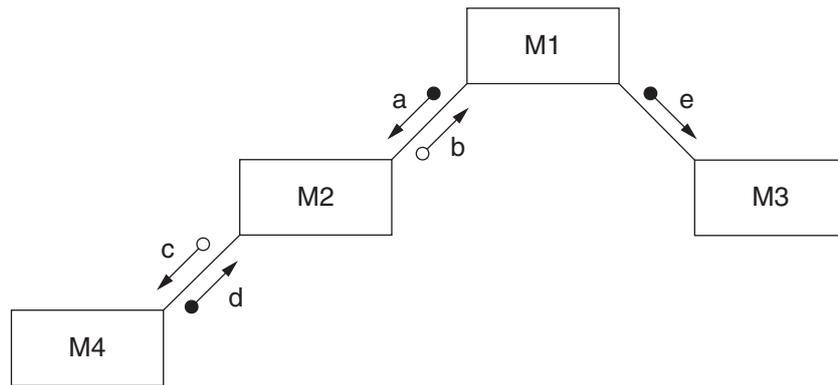
What is the most appropriate fragment of algorithm to access a record from the file?

- (A) READ
- (B) WRITE name(k); id(k); password(k)
- (C) READ (customer.name, customer.id, customer.password)
- (D) FOR k = 1 to 3  
    WRITE customer (k)  
NEXT k
- 12 Which of the following is an advantage of programs written in assembler over programs written in higher level languages?
- (A) Assembler programs can execute faster.
- (B) Assembler programs are easier to read.
- (C) Assembler programs are more transportable.
- (D) Assembler programs can allow for the faster development of large software solutions.
- 13 A student enters a number into a calculator and keeps multiplying the number by 10 until the calculator displays an error message.

What type of error is this?

- (A) Syntax
- (B) Logical
- (C) Division by zero
- (D) Arithmetic overflow

Use the following structure diagram to answer Questions 14 and 15.



14 What does item 'e' represent?

- (A) A breakpoint
- (B) A decision
- (C) A flag
- (D) A stub

15 What is the first line in the pseudocode of module 'M2'?

- (A) BEGIN SUBPROGRAM M2 (a,b)
- (B) BEGIN SUBPROGRAM M2 (a,d)
- (C) BEGIN SUBPROGRAM M2 (c,d)
- (D) BEGIN SUBPROGRAM M2 (a,b,c,d)

16 EBNF syntax definitions for a language are given below.

```

char = A|B|C
digit = 1|2|3
op = +|-
operand = <char>{<char>}<digit>
statement = <op><operand><operand>{<op><operand>}
  
```

Which of these is a legal statement in this language?

- (A) +ABC
- (B) -A2BC3
- (C) +A1BC23-AB
- (D) +BC32A1-A2

Use the following algorithm to answer Questions 17 and 18.

```

BEGIN MAINPROGRAM
  num1 = 10
  num2 = 3
  calc (num1,num2)
END MAINPROGRAM

BEGIN SUBPROGRAM calc (first,second)
  IF first > second THEN
    greater = "TRUE"
  ELSE
    greater = "FALSE"
  ENDIF
  PRINT greater
END SUBPROGRAM

```

17 What is the scope of the variable 'first'?

- (A) External
- (B) Global
- (C) Local
- (D) Numeric

18 Which of the following IPO diagrams best describes SUBPROGRAM calc?

- (A)
- | INPUT         | PROCESS  | OUTPUT  |
|---------------|--|---------|
| first, second | Tests if first is larger; Prints whether larger or not | message |
- (B)
- | INPUT                  | PROCESS  | OUTPUT  |
|------------------------|--|---------|
| first, second, greater | Tests if first is larger; Prints whether larger or not | message |
- (C)
- | INPUT         | PROCESS                  | OUTPUT        |
|---------------|--------------------------|---------------|
| first, second | Tests if first is larger | first, second |
- (D)
- | INPUT                  | PROCESS                  | OUTPUT        |
|------------------------|--------------------------|---------------|
| first, second, greater | Tests if first is larger | first, second |

Use the following algorithm to answer Questions 19 and 20.

```
10      BEGIN
11      GET target
12      index = 1
13      WHILE index <= lengthOfArray (dataArray)
14          IF dataArray [index] = target THEN
15              PRINT "Target value found"
16          ENDIF
17          index = index + 1
18      ENDWHILE
19      END
```

**19** What type of search algorithm is this?

- (A) Binary
- (B) Bubble
- (C) Linear
- (D) Random

**20** A new line is to be inserted between lines 60 and 70 to improve the algorithm when searching for a target in an array of unique values.

Which of the following best does this?

- (A) found = TRUE
- (B) target = index
- (C) PRINT "Target NOT found"
- (D) index = lengthOfArray (dataArray)

## Section II

60 marks

Attempt Questions 21–23

Allow about 1 hour and 50 minutes for this section

Answer each question in the appropriate writing booklet. Extra writing booklets are available.

If you include diagrams in your answer, ensure that they are clearly labelled.

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**Question 21** (20 marks) Use the Question 21 Writing Booklet.

- (a) A software company is developing a large scale, multi-million dollar system for a client. The project timeline is two years. The client is unsure of some of the requirements for the new system and they would like to see working models to further refine their ideas and add other requirements.
- (i) Recommend a software development approach that would be suitable for this situation and justify your recommendation. **3**
- (ii) In undertaking this project the software company makes use of a software tool that represents the relationships between the different modules of the system. As the project progresses, the software tool automatically updates this representation. **3**
- Describe benefits of using this tool in this situation.
- (b) A computerised security system is being developed for use at sporting and entertainment venues.
- Security guards will use handheld devices to scan the fingerprints of people entering the venue. The fingerprint images will be transmitted to a remote location where they will be compared against a police database.
- (i) Outline technical constraints that would need to be considered during the feasibility study. **2**
- (ii) Discuss social and/or ethical issues that could arise from the operation of this system. **3**

**Question 21 continues on page 11**

Question 21 (continued)

- (c) The purpose of using live test data is to assess the performance of complete software solutions. **3**

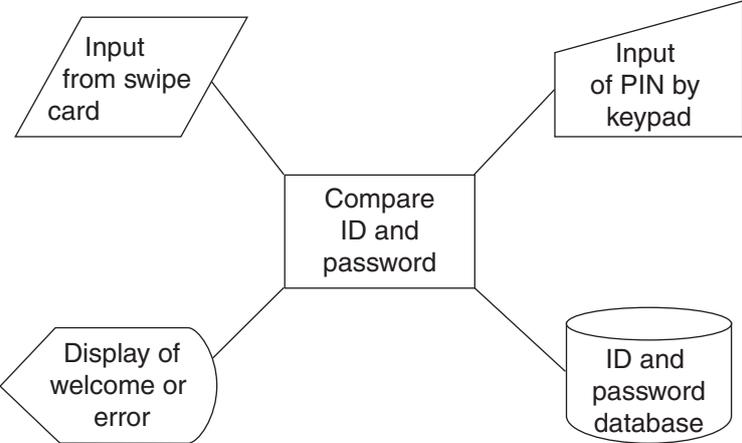
Describe the performance issues that could be identified by using live test data.

- (d) Despite improvements in software technology, the development of successful software projects remains a significant issue.
- (i) Identify a common cause for the failure of software projects. **1**
- (ii) Identify consequences for end-users of inappropriately developed software. **2**
- (iii) Outline the responsibilities of software developers. How does meeting these responsibilities contribute to successful software projects? **3**

**End of Question 21**

**Question 22** (20 marks) Use the Question 22 Writing Booklet.

(a) Consider the following diagram.



- (i) What is the representational tool shown in the diagram? **1**
- (ii) Why would a systems analyst use this tool? **2**

**Question 22 continues on page 13**

Question 22 (continued)

- (b) In the sorting algorithm shown, the subprogram swap exchanges two elements of the array 'names'.

```
BEGIN ORDER
  position = 1
  end = lengthOfArray (names)
  WHILE position < end
    current = position+1
    maximum = position
    WHILE current <= end
      IF names [current] > names [maximum] THEN
        maximum = current
      ENDIF
      current = current+1
    ENDWHILE
    swap (names,maximum,position)
    position = position+1
  ENDWHILE
END ORDER
```

- (i) Desk check the ORDER algorithm using the test data below. **4**

names:

index	1	2	3	4
element	Smith	Farelli	Wu	Andrews

- (ii) Identify the standard algorithm for sorting used in the ORDER algorithm. Justify your answer. **2**
- (iii) Write an algorithm for the swap subprogram. **3**

**Question 22 continues on page 14**

Question 22 (continued)

- (c) A school is implementing an electronic assignment submission system which will allow students to submit their assignments via the school's website.

When submitting an assignment, a student will enter their:

- unique student identification number and
- teacher's name.

The student will receive:

- a receipt number.

The teacher will receive:

- an alert message informing them that an assignment is waiting to be marked and
- the receipt number of the assignment which has been submitted.

The student identification number, teacher name, receipt number and the assignment are then stored in a central database.

The teacher uses the receipt number to access the assignment.

- (i) Draw a data flow diagram of the electronic assignment submission system. **4**
- (ii) Construct a data dictionary for the electronic assignment submission system. **4**

**End of Question 22**

**Question 23** (20 marks) Use the Question 23 Writing Booklet.

(a) Modifications to the code of an existing software solution are often required. Frequently those modifications are not made by the original software developer.

(i) Identify reasons for changing the code of an existing software solution. **2**

(ii) Explain how different types of documentation could be used to identify sections of code that need to be modified. **3**

**Question 23 continues on page 16**

Question 23 (continued)

- (b) A system is being developed to accurately time swimming events.

The following algorithm describes a part of the system:

```
100 BEGIN MAINPROGRAM
110     swimmer_start_time = -1.000
120     swimmer_time = -1.000
130     starters gun fired
140     timeRace(swimmer_start_time, swimmer_time)
150 END MAINPROGRAM

200 BEGIN SUBPROGRAM timeRace(swimmer_start_time, swimmer_time)
210     WHILE startBlockOccupied = TRUE
220         swimmer_start_time = getTimerValue
230     ENDWHILE
240     WHILE touchPad = TRUE
250         swimmer_time = getTimerValue
260     ENDWHILE
270 END SUBPROGRAM
```

*Note:*

- The system has a timer which starts at zero when the starter's gun is fired
- getTimerValue returns the current value of the timer
- startBlockOccupied returns a boolean value of TRUE when the swimmer is on the starting block
- touchPad returns a boolean value of FALSE until the swimmer touches the touch pad at the end of the lane

- (i) There is an error in the subprogram timeRace. Describe this error. 2
- (ii) swimmer\_start\_time is used in the detection of a false start (that is, when the swimmer leaves the starting block before the starter's gun is fired.) 2

How is swimmer\_start\_time used to detect a false start?

- (iii) The system needs to display the swimmer's time only when the swimmer has finished the race. (Currently the system does not display the swimmer's time.) 2

What modification needs to be made to the algorithm to achieve this?

**Question 23 continues on page 17**

Question 23 (continued)

- (c) A biology student writes a program to store information for 100 different organisms. The program stores Kingdom, Class, Latin Name and Common Name for each organism.

The following segment of code is used to store the data for the first organism.

```
organismDB[1].kingdom = "Animalia"  
organismDB[1].class = "Mammal"  
organismDB[1].latin_name = "Panthera leo"  
organismDB[1].common_name = "Lion"
```

- (i) Identify the data structure used for organismDB. **1**
- (ii) The following segment of code is designed to print out the common names of all mammals that are stored in organismDB. **3**

```
10      BEGIN  
20          i = 1  
30      WHILE i < 100  
40          IF organismDB[i].class = "Mammal" THEN  
50              PRINT organismDB[i].common_name  
60          ENDIF  
70      ENDWHILE  
80      END
```

Identify and describe the impact of TWO errors in this code.

- (iii) The organismDB structure has been filled with 100 different organisms belonging to three of the kingdoms: Animalia, Plantae and Fungi. **5**

Assuming that no two kingdoms have the same number of organisms, write a subprogram called maxKingdom that will print:

- the name of the kingdom with the most organisms, and
- the number of organisms in that kingdom.

**End of Question 23**

## Section III

20 marks

Attempt either Question 24 or Question 25

Allow about 35 minutes for this section

Answer the question in a SEPARATE writing booklet. Extra writing booklets are available.

If you include diagrams in your answer, ensure that they are clearly labelled.

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### Question 24 — Evolution of Programming Languages (20 marks)

- (a) Consider the following segment of code which has been written using the Object Oriented Programming (OOP) paradigm.

```
class PERSON {
    private –
        id_no: integer
        firstname: string
        surname: string
        dob: date
        gender: character
    public –
        getFullName(id_no):
            return firstname & surname
}
sub-class STUDENT {
    is a PERSON
    private –
        year_group: integer
    public –
        getYearGroup (id_no):
            return year_group
}
```

- (i) Identify a method in the code. **1**
- (ii) Based on the code, define a subclass TEACHER of PERSON which has the attributes of staffroom (string), phonenumber (integer) and permanent (boolean). **2**
- (iii) Explain why inheritance is an important concept of the OOP paradigm. Support your answer using the above segment of code. **3**

**Question 24 continues on page 19**

Question 24 (continued)

(b) Consider the following segment of code.

$$T1(X) = X * X$$

$$T2(X) = 3 * X$$

$$T3(X) = T1(T2(X))$$

- (i) Identify the paradigm illustrated by this code. Justify your choice. **2**
- (ii) Evaluate  $T2(T3(X))$  when  $X = 2$ , showing all working. **3**
- (c) All programming paradigms have characteristics that impact on programmer productivity.
- (i) Outline what is meant by the term *programmer productivity*. **2**
- (ii) Other than a need for greater productivity, describe historical reasons for the development of different paradigms. **3**
- (d) A car manufacturer develops a software program to assist its sales team to match customer preferences to different car models. Customer preferences are collected for features such as price range, safety features, colour choices and engine size. **4**

These preferences are entered into the software program which then compares customer preferences to the features of different cars sold by the manufacturer. The software then prints out a recommended list of cars that best match customer preferences.

Select an appropriate paradigm to use in developing this software program. Justify your selection.

**End of Question 24**

**OR**

**Question 25 — The Software Developer’s View of the Hardware (20 marks)**

(a) (i) Show that the decimal number 9 is equivalent to the 8-bit binary number 00001001. **1**

(ii) Use two’s complement to perform the arithmetic operation: **2**

$$9 + (-2)$$

(iii) Explain why floating point representation is used to store real world numerical data. Use examples to support your answer. **3**

(b) A joystick controls a robotic arm that moves along two axes (left-right and forward-backward). The direction of movement of the robotic arm corresponds to the direction of movement of the joystick.

A processor inside the joystick sends a data stream to the processor controlling the robotic arm. The data stream consists of 2-byte packets in the following format.

Header				Data						Trailer			
Start bits		Unused bits		L/R bits		F/B bits		Unused bits		Unused bits		Stop bits	

The L/R bits represent movement along the left-right axis, 01 to move left, 10 to move right and 00 for no movement. The F/B bits represent movement along the forward-backward axis, 01 to move forward, 10 to move backward and 00 for no movement.

(i) Describe the movement of the joystick which generates the following data packet. **2**

1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

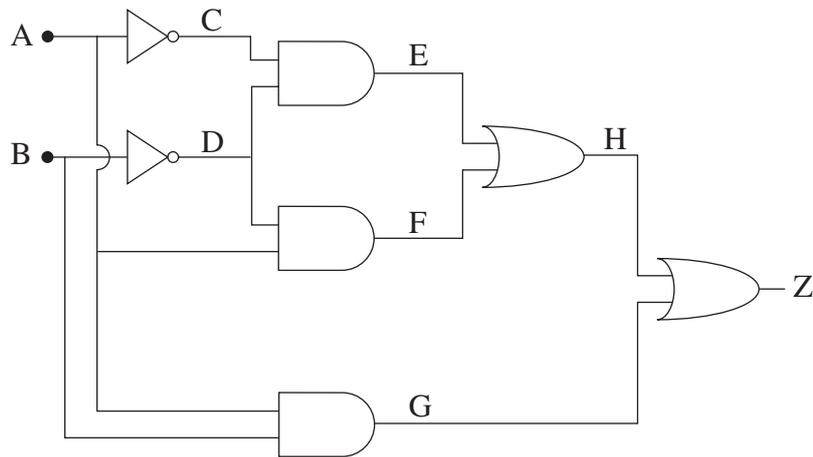
(ii) The system is to be improved so that the amount that the joystick is moved from its centre position, along either axis, determines the corresponding speed of movement of the robotic arm. **3**

Explain how the packet could be modified to make this improvement.

**Question 25 continues on page 21**

Question 25 (continued)

- (c) (i) Outline the purpose of a flip-flop. 2
- (ii) Describe the operation of a flip-flop with two inputs and two outputs. 3
- (d) Consider the following circuit. 4



Design a simplified version of this circuit which performs the same function. Justify your design using truth tables.

**End of paper**

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