

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

**2007**

**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 2–8

**20 marks**

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

**Section II** Pages 9–15

**60 marks**

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

**Section III** Pages 16–18

**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 Consider the following algorithm.

```
BEGIN
  A = 1
  B = 1
  WHILE A = B
    C = A + B
    B = 2
  ENDWHILE
  PRINT C
END
```

What will be printed by the algorithm?

- (A) 1
  - (B) 2
  - (C) 3
  - (D) 4
- 2 A team is developing software for space exploration. To ensure the appropriate quality assurance in software required for manned space vehicles, the software is documented in detail.
- Which method of documentation could lead to greater quality assurance in the development of space software?
- (A) Tutorials
  - (B) User documentation
  - (C) System specification
  - (D) Regulatory documentation

- 3** James is a programmer on the design team developing a financial system for a major bank. He needs to decide on an appropriate data structure to track and compare interest rates and dates for a number of financial institutions.

Which would be the most appropriate data structure for James to use?

- (A) Array of records
  - (B) Array of characters
  - (C) One dimensional array of interest rates
  - (D) Two dimensional array of interest rates and dates
- 4** Which of the following is increasingly used in software development?
- (A) Assembly languages
  - (B) Internet-based applications
  - (C) Non-processor applications
  - (D) Processor-dependent scripting languages
- 5** What is the role of the accumulator in the CPU?
- (A) It controls the system clock.
  - (B) It stores the next instruction.
  - (C) It controls the fetch–execute cycle.
  - (D) It stores the results of calculations.
- 6** Which data type is most commonly used for a flag?
- (A) Array
  - (B) Boolean
  - (C) Integer
  - (D) String

Use the following to answer Questions 7 and 8.

Character is an empty array used to store letters in the range A to Z.

```
MyCharacter = 'A'  
FOR index = 1 to 20  
  Input character[index]  
  IF MyCharacter < character[index] THEN  
    MyCharacter = character[index]  
  END IF  
NEXT index  
Output MyCharacter
```

- 7 What does this pseudocode segment do?
- (A) It performs a binary search on the array.
  - (B) It sorts data as it is entered into the array.
  - (C) It enters characters into the array and identifies the largest letter.
  - (D) It performs a standard linear search of the filled array to find the largest letter.
- 8 What are the control structures in this pseudocode segment?
- (A) Post-test loop and binary selection
  - (B) Counted loop and binary selection
  - (C) Post-test loop and multi-way selection
  - (D) Counted loop and multi-way selection
- 9 A software developer uses specific software to assist in the management of versions during the development process.
- What is the common name of such software?
- (A) Security management tools
  - (B) Structured development packages
  - (C) Debugging development packages
  - (D) Computer aided software engineering tools

**10** A developer tests a program using very large values. During testing, she observes unexpected results in the output from a multiplication calculation.

What would be the most likely cause?

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

**11** Which of the following includes a diagrammatic representation of the movement of data in a software system?

- (A) Structure chart
- (B) Data flow diagram
- (C) Data movement chart
- (D) Data tracking diagram

**12** What is the conversion method by which a small part of the existing system is replaced while the remaining parts are kept operating?

- (A) Cut-over conversion
- (B) Direct conversion
- (C) Parallel conversion
- (D) Phased conversion

**13** What translates source code to object code, and executes one line at a time?

- (A) A compiler
- (B) An editor
- (C) An inheritor
- (D) An interpreter

- 14 User-help and balloon text are examples of which type of documentation?
- (A) Internal documentation
  - (B) Intrinsic documentation
  - (C) Online documentation
  - (D) Technical documentation
- 15 The diagram is a screen capture from a school database.

The screenshot shows a window titled "Data Entry - Year Nine Subjects". It features a grid of small dots on the left and right sides. The form includes the following elements:

- Surname:
- First Name:
- Gender:  Male  Female
- Subjects (checkboxes):
  - English
  - Mathematics
  - Science
  - Geography
  - History
  - French
  - Italian
  - PDHPE
  - Food Technology
- Other:
- Buttons: "Previous student", "Next student", "Return to menu"

Which of the following lists elements that are found on the screen?

- (A) Menus, radio buttons and boxes
- (B) Prompts, text boxes and scroll bars
- (C) Navigational elements, menu bars and radio buttons
- (D) Radio buttons, text boxes and navigational elements

**16** Refer to the following algorithm.

```
BEGIN RandProg
  A = 3
  B = 4
  C = 5
  counter = 0
  number = 20
  WHILE number > counter
    A = A + 1
    B = B + A
    C = C + B
    PRINT C
    counter = counter + B
  ENDWHILE
END RandProg
```

Which values are outputs of the algorithm?

- (A) 9, 13, 19
- (B) 12, 24, 36, 48
- (C) 13, 26
- (D) 13, 26, 45, 71

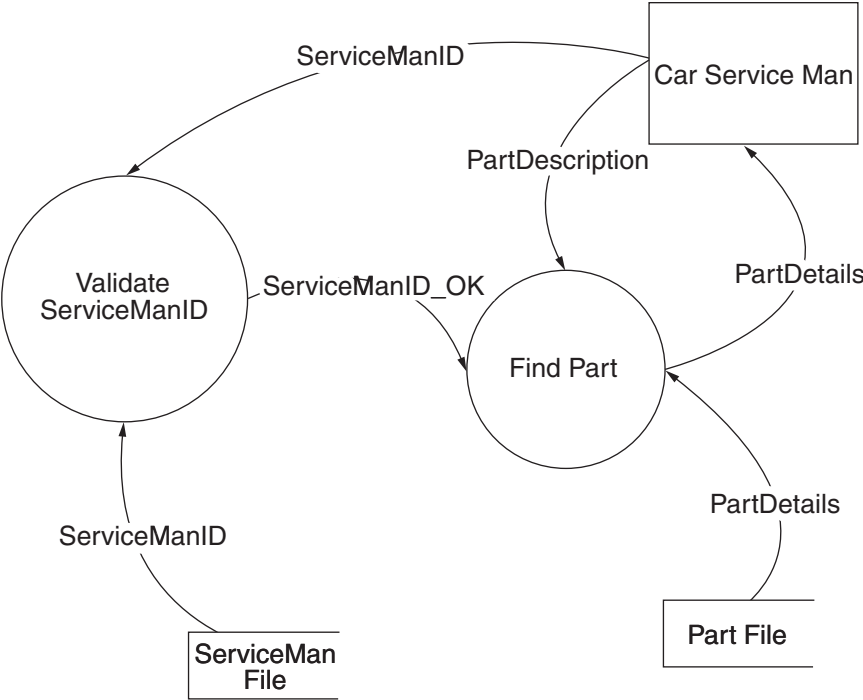
**17** What is a *stub*?

- (A) A temporary piece of code that represents a subprogram
- (B) A temporary piece of code that translates source-code
- (C) A subroutine that links executables
- (D) A subroutine that links DLLs

**18** What name is given to software that may be legally copied and used without restrictions?

- (A) Copyrighted software
- (B) Pirated software
- (C) Public domain software
- (D) Shareware

Use the diagram below to answer Questions 19 and 20.



- 19** Which of the following statements is true?
- (A) ServiceManID\_OK is a flag.
  - (B) PartDetails are written to the Part File.
  - (C) The Car Service Man has to enter PartDetails.
  - (D) Find Part is a process that happens before Validate ServiceManID.
- 20** Which of the following contains all the data elements required for the Find Part process?
- (A) ServiceManID, PartDescription
  - (B) ServiceManID\_OK, PartDetails, ServiceManID
  - (C) PartDescription, ServiceManID\_OK, PartDetails
  - (D) PartDescription, PartDetails, ServiceManID, ServiceManID\_OK



## Section II

**60 marks**

**Attempt Questions 21–23**

**Allow about 1 hour and 50 minutes for this section**

Answer each 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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|   | <b>Marks</b> |
|---|--------------|
| <b>Question 21</b> (20 marks) Use a SEPARATE writing booklet.   |              |
| (a) (i) Define <i>quality assurance</i> .   | <b>1</b>     |
| (ii) Describe how a software developer ensures the quality assurance of the user documentation when developing a piece of software.   | <b>2</b>     |
| (b) The manufacturer of a new printer wants to bundle some application software with the printer driver. A software developer has been given the task of writing an application that will allow a user to design CD and DVD labels and print them directly onto the face of CDs and DVDs. |              |
| (i) The developer has chosen to use a RAD approach to develop the application. Justify this choice.   | <b>3</b>     |
| (ii) Explain what you would do if you used a prototyping approach to develop this application.  | <b>3</b>     |

**Question 21 continues on page 10**

## Question 21 (continued)

- (c) The following algorithm is intended to print out the 6 times table from  $1 \times 6 = 6$  to  $12 \times 6 = 72$ . It contains a logic error.

```

10  BEGIN PrintTimesTable
20      Table = 6
30      FOR Counter = 0 to 12
40          PRINT (Counter + 1), " × 6 = ", (Counter + 1) *Table
50      NEXT
60  END PrintTimesTable

```

- (i) Describe the error, identifying where it occurs and how it can be fixed. **2**
- (ii) The above algorithm uses a fixed variable 'Table' to define the times table to print. **3**

Describe how the algorithm can be altered to print tables of any value, or a range of values.

- (d) To manage the water resources of a river system, a government department needs an application to store information on water users and types of use. For example, water users could include farmers (irrigators), commercial fish farmers and others.

For each user the application needs to store:

- the user's name
- the user's address
- the type of use
- the quantity of water required annually
- the actual monthly water usage.

- (i) Design a suitable data structure for a record called UserDetails that includes all details except actual monthly water usage. Use appropriate variable names. **2**
- (ii) A separate file called WaterUsage is used to store actual monthly water usage for users. **4**

Evaluate the effectiveness of using sequential access to read and write to this file rather than direct access (random access) techniques.

**End of Question 21**

|   | <b>Marks</b> |
|---|--------------|
| <b>Question 22</b> (20 marks) Use a SEPARATE writing booklet.   |              |
| (a) Define <i>peer checking</i> .   | <b>2</b>     |
| (b) Explain how software developers use breakpoints and single line stepping in order to locate a logic error.                  | <b>3</b>     |
| (c) Explain why screen design should be considered during the <i>defining and understanding the problem</i> phase of a project. | <b>2</b>     |
| (d) (i) Define <i>program counter</i> and outline the role of a program counter in the execution of a program.                  | <b>2</b>     |

A browser program calls a subroutine stored in memory address *X*, which displays an aerial photograph of a school.

During the execution of the browser program, an error changes the content of the program counter to memory address *Y* before the subroutine is called.

- |   |          |
|---|----------|
| (ii) Explain what could happen to the browser program execution in the above situation.                     | <b>2</b> |
| (iii) Construct a scenario whereby such a situation could be used in the development of malicious programs. | <b>4</b> |

**Question 22 continues on page 12**

## Question 22 (continued)

- (e) The following algorithm allocates eight runners in a 100 metre race to lanes randomly. RunnerName is an array of 8 elements, initialised to null (empty).

```
100 BEGIN
110     FOR Runner = 1 to 8
120         RandomLane = random Integer between 1 and 8 inclusive
130         WHILE RunnerName (RandomLane) is not null
140             RandomLane = random Integer between 1 and 8 inclusive
150         ENDWHILE
160         Input Name
170         RunnerName (RandomLane) = Name
180     NEXT
190     FOR Runner = 1 to 8
200         LaneNo = Runner
210         Output RunnerName (Runner), "is in Lane", LaneNo
220     NEXT
230 END
```

- (i) If the WHILE loop was left out of the algorithm, what type of error would be produced? Describe the effect this error would have. **2**
- (ii) Construct modifications to the original algorithm so that lane 6 is always free. **3**

**End of Question 22**

|                    |   | <b>Marks</b> |
|--------------------|---|--------------|
| <b>Question 23</b> | (20 marks) Use a SEPARATE writing booklet.                          |              |
| (a)                | (i) Define <i>test data</i> .                                       | <b>2</b>     |
|                    | (ii) Explain the use of live test data to test a complete solution. | <b>3</b>     |

**Question 23 continues on page 14**

## Question 23 (continued)

- (b) The following algorithm is designed to check the numbers from 2 to 100, and either print that the number is prime, or print out the number's factors.

A prime number is a number that has no factors except itself and 1.

7 is prime because its only factors are 1 and 7.

6 is not prime and its factors are 1, 2, 3 and 6.

```
BEGIN MAIN
  i = 2
  WHILE i <= 100
    CheckPrime(i, isprime)
    IF isprime = TRUE
      THEN print i, "is a prime number"
    ELSE PrintFactors(i)
    ENDIF
    i = i + 1
  ENDWHILE
END MAIN
```

```
BEGIN SUB CheckPrime(i, isprime)
//Note: mod(i, j) = 0 if j is a factor of i
  isprime = TRUE
  j = 2
  WHILE isprime = TRUE AND j < i
    IF mod(i, j) <> 0
      THEN j = j + 1
    ELSE isprime = FALSE
    ENDIF
  ENDWHILE
END SUB
```

- (i) Describe a purpose of the variable `isprime` in the sub-procedure CheckPrime. 2
- (ii) Describe the problem that would occur in the sub-procedure CheckPrime if `j` were initialised to 1 instead of 2. 2
- (iii) Construct a sub-procedure PrintFactors(n) which prints out all the factors of a number `n`. For example, PrintFactors(6) would print 1 2 3 6, and PrintFactors(9) would print 1 3 9. 4

**Question 23 continues on page 15**

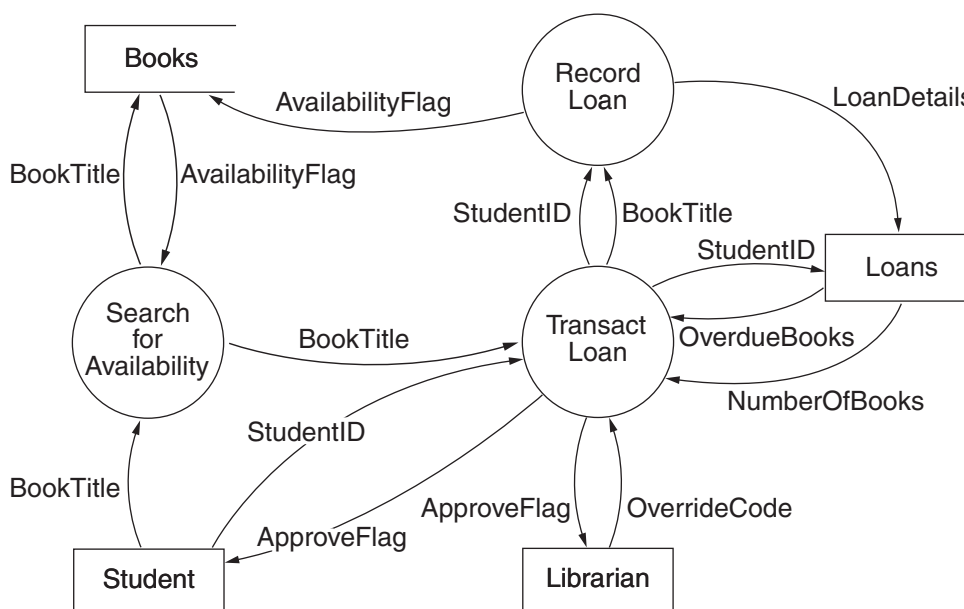
Question 23 (continued)

(c) Cheverton Girls' High School is implementing a new computerised system for its library. Once installed, students will need to use a computer terminal to check the availability of a book. The student's library card is then scanned into the system. The system searches through the student database to check the student's borrowing history. The student will be allowed to borrow a book if:

- she has no overdue books; and
- she currently has no more than four books on loan.

If the loan is disallowed, the librarian can still enter a code into the system to allow the loan.

A systems analyst has drawn the following diagram to represent the system.



- (i) Identify the processes in the diagram. 2
- (ii) Explain why a designer, as part of the system development, may draw additional data flow diagrams to further refine certain processes. 2
- (iii) The system performs the OverdueBooks check and NumberOfBooks check within Transact Loan. 3

Construct an additional data flow diagram that further refines the Transact Loan process.

**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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|  |   | Marks |
|--|---|-------|
| <b>Question 24 — Evolution of Programming Languages (20 marks)</b> |   |       |
| (a)  | (i) Define a <i>function</i> .  | 1     |
|  | (ii) Consider the following functions.<br><br>UPPER(text string) = TEXT STRING<br>STRIP_PUNCT( text; with punctuation!) = text with punctuation<br>CONCAT(text1,text2,text3) = text1text2text3<br><br>Evaluate, showing working:<br><br>CONCAT(UPPER(sdd), STRIP_PUNCT( ipt, it and ist are great! ),subjects.) | 2     |
| (iii)  | Discuss an historical reason for the development of the functional paradigm.  | 3     |

Question 24 continues on page 17



Question 24 (continued)

- (b) (i) Define a *fact*, in the context of the logic paradigm. 1
- (ii) Distinguish between *forward* and *backward chaining*. 2

Consider the following fragment of code.

```
non_animal (rock).  
animal (lizard).  
animal (kangaroo).  
animal (cat).  
suckles_young (cat).  
mammal (X): – animal(X), suckles_young(X).
```

- (iii) Describe how the rule mammal (X) would be evaluated if X = cat. 2
- (iv) The fragment of code is to be expanded to define a new rule for a marsupial. 3

A marsupial is a mammal that has a pouch.

Construct the rule and facts so that marsupial (kangaroo) will be evaluated as True.

- (c) (i) Describe a concept of the object oriented programming paradigm. 3
- (ii) Explain how *abstraction* is used in the development of a program. 3

**End of Question 24**

**OR**

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

(a) (i) Define *ASCII*. 1

(ii) Evaluate the following 8 bit two’s complement expression. 2

$$11111101 \times 00001111$$

Show all working in binary.

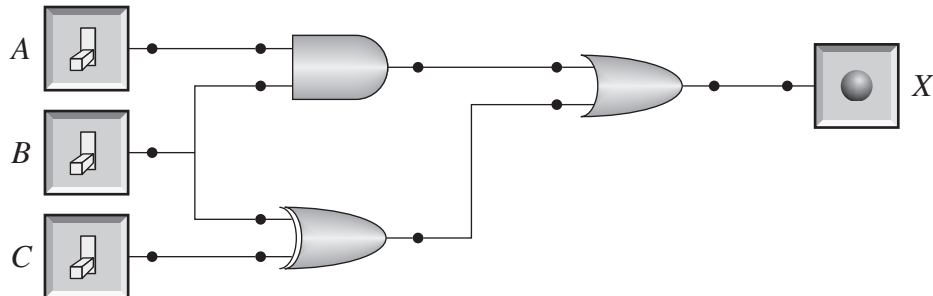
(iii) Discuss why binary systems have had difficulties representing real numbers. Describe how these difficulties have been overcome. 3

(b) (i) Define the term *logic gate*. 1

(ii) Distinguish between a *half adder* and a *full adder*, in terms of the operation of each device. 2

(iii) Describe the operation of an XOR logic gate. 2

(iv) Modify the following circuit diagram by adding another logic gate so that the output at X is 1 if all inputs are 0 (zero). 3



(c) (i) Describe the main components of a data stream. 3

(ii) Explain how a data stream could be used to control a printer. 3

In your explanation, identify what elements of the printer need to be controlled.

**End of paper**

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