

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

2004

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 9–16

60 marks

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

Section III Pages 17–20

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.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A B C D
correct ↙

- 1 Why does a project manager use a Gantt chart?
- (A) To assist in writing the computer code
 - (B) To help with maintenance of the system
 - (C) To assist with organising the project team
 - (D) To help in maintaining the software when it is written
- 2 What type of documentation would an inexperienced user be most likely to access?
- (A) On-line
 - (B) Project
 - (C) System
 - (D) User specification

- 3 Consider the following fragment of pseudocode.

```
BEGIN
  n = 0
  FOR n = 1 TO 3
    print n
  NEXT n
  print n
END
```

What would be the output from this pseudocode?

- (A) 1, 2, 3
 - (B) 0, 1, 2, 3
 - (C) 1, 2, 3, 3
 - (D) 0, 1, 2, 3, 3
- 4 A team of software developers created a new library system that consists of a number of modules. Each module was fully tested using real data, and operated as expected. The new system was installed in the library. At the end of the day it failed to operate correctly when attempting to produce a summary report.

Which of the following was not fully tested?

- (A) Response times
- (B) Large file sizes
- (C) The mix of driver types
- (D) The interface between the modules

- 5** You are a member of a team of programmers working on a large program. The module you are developing will depend on data passed to it by a module yet to be developed.

Which of the following should you use to test your module?

- (A) Compilation
- (B) Flag
- (C) Instruction
- (D) Stub

- 6** You have been asked to make modifications to a software program you did not write.

In addition to the source code, which would be the most useful documentation?

- (A) Data dictionary
- (B) Gantt chart
- (C) On-line tutorial
- (D) User manual

- 7** Which of the following does the process of quality assurance of software ensure?

- (A) Benchmarking
- (B) Interface structure
- (C) Modular structure
- (D) Reliability

- 8** Newer CASE tools have been developed that will automatically generate code for a project from design specifications.

What will change as a result of this emerging technology?

- (A) The compilation process
- (B) The way code is interpreted
- (C) The packaging of software
- (D) The role of the software developer

9 A given CPU is able to carry out the following instructions:

load r_x ab	Load register r_x with the hexadecimal value ab
store r_x m_y	Store the contents of register r_x in memory location m_y
add r_x r_y	Add the contents of register r_x and r_y and place results in register r_y
stop	Stop execution

The following lines of code are executed:

```
load    r1 2D
load    r2 11
add     r1 r2
store   r1 m1
stop
```

What is the hexadecimal value of the contents of m_1 after execution?

- (A) 2D
 - (B) 3E
 - (C) 45
 - (D) 62
- 10 Which name is given to the process of obtaining source code from object code?
- (A) Backward engineering
 - (B) Compilation
 - (C) Decompilation
 - (D) Reverse engineering
- 11 At which level of testing would users of a new computer system most likely be involved?
- (A) Module testing
 - (B) Program testing
 - (C) System testing
 - (D) Unit testing
- 12 If a small team of developers was employed to solve a computer problem in a restricted amount of time, which software development approach would NOT be suitable?
- (A) Structured
 - (B) Prototyping
 - (C) Rapid application development
 - (D) A combination of rapid application development and prototyping

Refer to the array below to answer Questions 13–14.

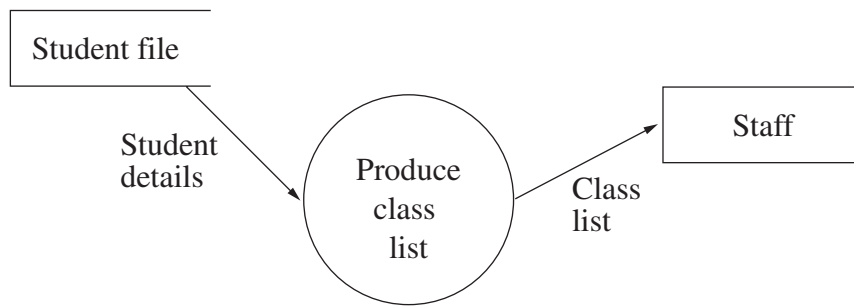
The diagram shows a two-dimensional array called `class_age`. The starting index is 0 for both dimensions.

1	1	2	2	3	3
10	11	10	11	11	12
12	9	9	12	9	12

It consists of three rows. The top row is the class number, the middle row indicates the age of the students and the bottom row indicates the number of students of the age in the class.

- 13** What would be the most suitable data type for the elements in the array?
- (A) Array
 - (B) File
 - (C) Integer
 - (D) Record
- 14** Which of the following calculations would produce the number of students who are aged 10?
- (A) `class_age[0,1] + class_age[2,1]`
 - (B) `class_age[0,2] + class_age[2,2]`
 - (C) `class_age[0,1,2] + class_age[2,1,2]`
 - (D) `class_age[0,2,2] + class_age[2,2,2]`
- 15** It is difficult to determine who is responsible for an error in a computerised system. While front-line service personnel or incompetent users are the first to be blamed, the problem is more likely to be poor user interface, lack of training or errors in the software.
- Of what is this an example?
- (A) Legal implications of computing
 - (B) Ethical implications of computing
 - (C) Copyright implications of computing
 - (D) Environmental implications of computing

- 16 The data flow diagram shows part of the administration system at a school.



Whenever a student from a particular suburb is correctly enrolled, an incorrect class list is generated.

Where would the error most likely be located?

- (A) Class list data
 - (B) Produce class list process
 - (C) Staff external entity
 - (D) Student details data
- 17 There is a one-dimensional array of four elements called A. Consider the following fragment of pseudocode.

```
1 REPEAT
2   A[4] = A[3] + 1
3   A[2] = A[3]
4   A[1] = A[2]
5   .....
6 UNTIL A[1] > A[3]
7 PRINT A[1]
```

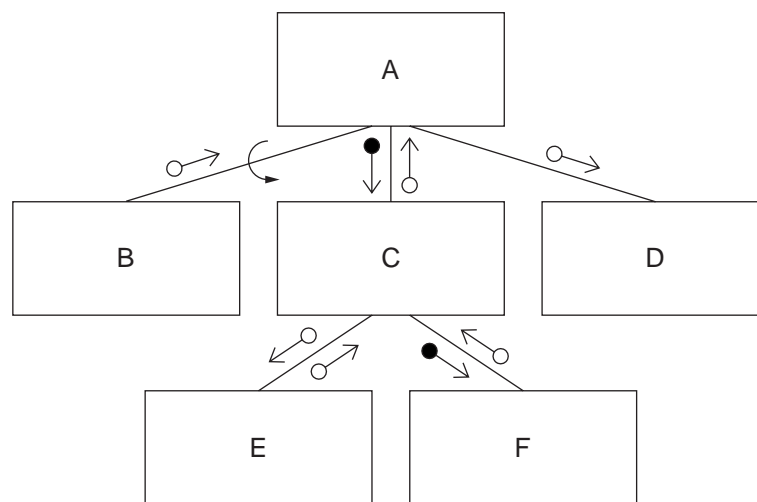
Without line 5, the algorithm will not perform line 7. Which line should be inserted at 5 in order to ensure that line 7 is performed?

- (A) $A[1] = A[3]$
- (B) $A[1] = A[4]$
- (C) $A[2] = A[4] + 1$
- (D) $A[3] = A[1] + 1$

- 18 Which of the following is a method of including standard or common routines after compilation?
- (A) # included code
 - (B) Interpreted code
 - (C) Compilation library
 - (D) Dynamic link library

Refer to the diagram below to answer Questions 19–20.

The diagram indicates the structure of a software system.



- 19 In order to alter the software module C, which software module(s) will need to be specifically considered?
- (A) C
 - (B) A, C, F
 - (C) A, C, E, F
 - (D) A, B, C, D, E, F
- 20 In the diagram, what does the symbol \curvearrowright mean?
- (A) Repeat execution of module A.
 - (B) Repeat execution of module B.
 - (C) Perform module B once only.
 - (D) Perform module A only if module B calls it.

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.

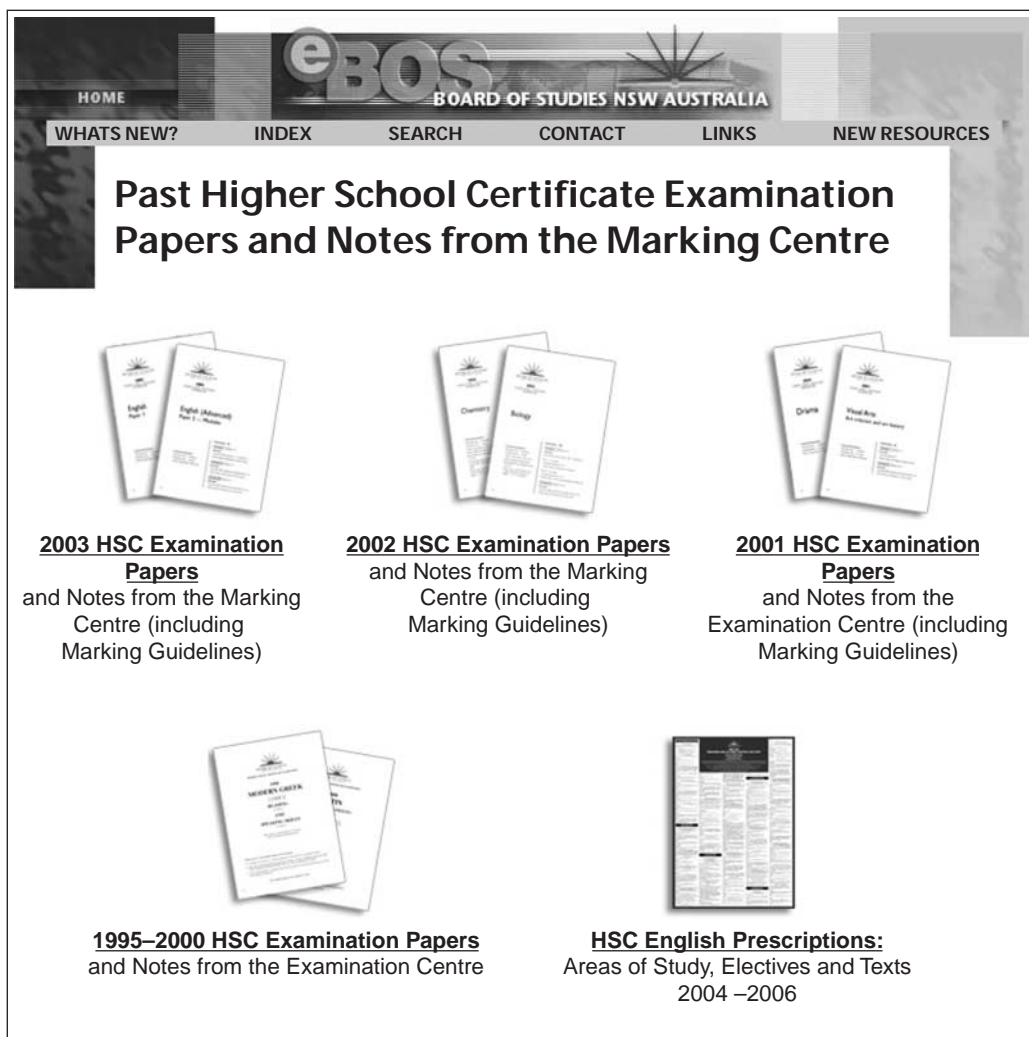
If you include diagrams in your answer, ensure that they are clearly labelled.

	Marks
Question 21 (20 marks) Use a SEPARATE writing booklet.	
(a) A commercial organisation is considering the <i>structured approach</i> to the development of a system.	
(i) Define the <i>structured approach</i> to software development.	2
(ii) List the advantages and disadvantages of the <i>structured approach</i> and analyse ONE advantage and ONE disadvantage from your list.	4
(iii) Describe the rights and responsibilities of a commercial software developer that would need to be considered when making the choice to use the <i>structured approach</i> .	3
(b) A veterinary practice that employs two veterinary surgeons, an assistant nurse and an office manager has contracted a programmer to develop a software solution for the management of its accounts and client files. Currently the practice has no software system. The programmer has decided to use a <i>prototyping approach</i> in the development of the solution.	
(i) Define the <i>prototyping approach</i> to software development.	2
(ii) When the software solution is complete, the programmer wishes to sell the program to other veterinary practices. Outline the issues involved.	2
(iii) Describe the involvement of the staff at the veterinary practice in the software development process.	3

Question 21 continues on page 10

Question 21 (continued)

- (c) Consider the webpage shown below, from The Board of Studies NSW website. 4



With reference to the webpage, discuss elements of screen design and their impact on the user interface.

End of Question 21

Question 22 (20 marks) Use a SEPARATE writing booklet.

- (a) A local council wishes to minimise its water wastage by installing a computer-controlled watering system for one of its parks. The watering system is required to determine the operation, starting time, and duration of watering.

The following rules will apply to the watering system:

- Watering can commence at any time between 9:00 pm and 4:00 am;
- A normal watering session will last for 30 minutes;
- Watering will not occur more than once per night;
- No watering will occur during rainfall;
- If the maximum temperature exceeds 30°C, an extra ten minutes of watering will occur;
- No watering will occur if rain has fallen in the preceding 12 hours.

- (i) An incomplete IPO chart for the above watering system is given below. Construct an IPO chart in your writing booklet and complete the blank rows. **3**

<i>IPO chart for watering system</i>		
<i>Input</i>	<i>Processes</i>	<i>Outputs</i>
Rainfall	Reading rainfall sensor Calculate rainfall in 12 hour period 9:00 am to 9:00 pm	Watering or not watering Duration of watering

Question 22 continues on page 12

Question 22 (continued)

- (ii) Copy the following partial data dictionary into your writing booklet and complete the two rows. 2

<i>Watering system data dictionary</i>			
<i>Variable</i>	<i>Data type</i>	<i>Size</i>	<i>Description</i>
Day of week			
Rainfall			

- (iii) Construct a data-flow diagram for the watering system. 5
- (iv) The council management team introduces an additional requirement. A printed report is required on a weekly basis to show daily maximum temperature, start time, and duration of watering. 3

Construct an appropriate layout for this weekly report.

Question 22 continues on page 13

Question 22 (continued)

(b) Consider the following algorithm.

```

BEGIN
  last = 5
  WHILE last > 1
    current = 1
    WHILE current < last
      IF list(current) > list(current + 1)
        THEN temp = list (current)
        list(current) = list(current + 1)
        list(current + 1) = temp
      ENDIF
      current = current + 1
    ENDWHILE
    last = last - 1
  ENDWHILE
END

```

The following list was sorted using the above algorithm.

Shark	Eel	Whale	Bream	Goldfish
-------	-----	-------	-------	----------

The result of the sort is shown below.

Bream	Eel	Goldfish	Shark	Whale
-------	-----	----------	-------	-------

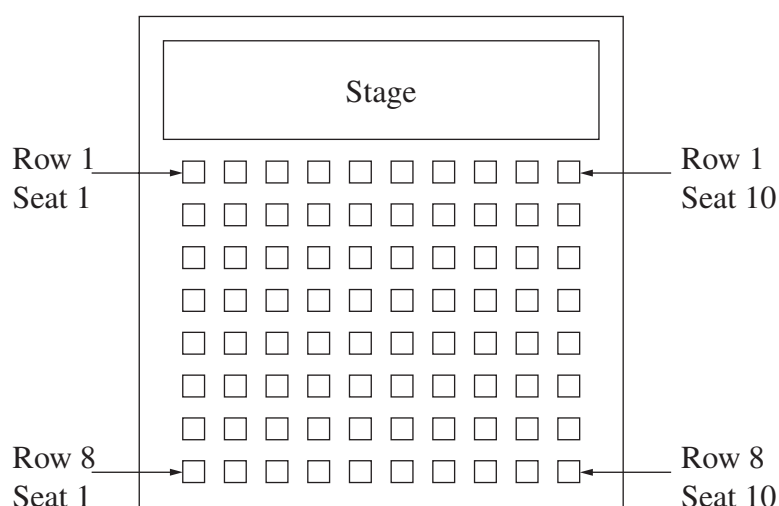
- (i) Show the elements of the list after each pass of the sort. **2**
- (ii) Compare the method used in this sort with the method used in another standard sort algorithm. **2**
- (iii) Propose a suitable sorting method if the number of elements in this list were increased to 10 000. Justify your answer. **3**

End of Question 22

Question 23 (20 marks) Use a SEPARATE writing booklet.

- (a) (i) Describe the method used to perform a linear search on a one-dimensional array of elements. 2
- (ii) Compare the method used to perform a linear search with the method used to perform a binary search on a one-dimensional array of elements. 2
- (b) An amateur theatre company wants to computerise the allocation and sale of seats at its performances. The theatre company would like to have a system that identifies and prints out a list of all unsold seats when a customer makes a purchase enquiry.

The theatre used by the company can seat 80 people. The theatre has eight rows, each with 10 seats, as shown in the diagram below.



The following algorithm has been designed to print a list of all unsold seats.

```

1   BEGIN print_all_unsold_seats
2   seat = 1
3   row = 1
4   available = false
5   WHILE row <= 8
6     WHILE seat <= 10
7       IF array(row, seat) = "unsold" THEN
8         available = true
9       ENDIF
10      increment seat
11    ENDWHILE
12    increment row
13  ENDWHILE
14  IF available = true THEN
15    print array(row, seat)
16  ENDIF
17  END print_all_unsold_seats

```

Question 23 continues on page 15

Question 23 (continued)

- (i) A deskcheck is conducted on the algorithm. It is found that it does not operate as expected. Identify where two logic errors occur and, for each error, write the corrected line(s) of code. **4**

- (ii) After meeting with members of the theatre company it is decided that the algorithm needs to be able to print out a list of adjoining seats for any customer who enquires about purchasing two or more seats in the same row. **6**

Develop an algorithm, using either pseudocode or a flowchart, which would meet this specification.

- (iii) After further discussion with members of the theatre company it is determined that the software solution needs to be amended so that it is able to record the sale of seats to different performances of each production. **2**

During a season, the theatre company performs nine times per week.

Describe ONE way that the algorithm may be altered to meet this new specification.

Question 23 continues on page 16

Question 23 (continued)

- (c) The following report was broadcast on ABC News Radio on 4 September 2003.

Getting a doctor in the bush can be hard work – especially if you need to see a specialist. But thanks to Queensland Health and today's technology, you can see a doctor with the flick of a camera, or the click of a mouse.

Professor Peter Yellowless, the director for the Centre for Online Health, believes that *e-Health* is the way of the future, and it is simply a matter of time before more and more doctors consult via the Internet and video-conferencing.

Already this technology is being used to hook-up the Royal Children's Hospital in Brisbane and two regional hospitals.

www.abc.net.au/newsradio. Reproduced with permission

It is expected that the *e-Health* system will be expanded to remote and isolated farmhouses in rural areas in the near future.

- (i) Discuss the technical feasibility of this expansion. 2
- (ii) Describe ONE ethical issue raised by the expansion of the *e-Health* system. 2

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.

	Marks
Question 24 — Evolution of Programming Languages (20 marks)	
(a) Explain the difference between a programming language and a programming paradigm.	3
(b) Suppose a functional language supports a data structure called List. Examples of List are: [] [1, 2] [Nick, Masa, Denise] [1, [Nick, Masa, Denise], [32, 16]] Two built-in (primitive) functions for List manipulations are: $\text{CONS} (a, [b, c, d]) = [a, b, c, d]$ and $\text{CDR} (2, [a, b, c, d]) = b$ Evaluate, showing all working:	
(i) $\text{CDR} (2, \text{CONS} (\text{Nick}, \text{CONS} (\text{Sally}, [])))$	2
(ii) $\text{CONS} (\text{CDR} (3, [\text{Bob}, \text{Billy}, \text{Tom}, \text{Cathy}]), [\text{John}, \text{Masa}, \text{Denise}])$	2

Question 24 continues on page 18

Question 24 (continued)

(c) Consider the following two functions.

4

<pre>define (a(n)) (if n = 1) 1 else n * a(n - 1)</pre>	<pre>function b(n) { k = 1 result = 1 while k ≤ n {result = result * k k = k + 1} return result}</pre>
---	---

Compare and contrast these functions. In your answer, include:

- an evaluation of each function using the value $n = 3$, and
- a discussion of the possible paradigms from which each algorithm is drawn.

(d) Describe a real-world example in which the use of the logic paradigm would be most appropriate, identifying specific paradigm concepts that match the situation.

3

(e) A school is developing a new administration program using Object Oriented Programming (OOP). It will need to store data about teachers, office staff and students. The data to be stored include date-of-birth, address and home phone number. In addition, extension phone number and pay details will be stored for teachers and office staff, and year level will be stored for students.

(i) A class called Person is to be developed. Describe an attribute and a method for this class, using examples.

2

(ii) Propose a possible subclass of Person, and explain how inheritance improves programmer productivity.

4

End of Question 24

OR

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

- (a) Explain the difference between the one’s and two’s complement methods for representing a negative number in binary using 4-bit representation. **3**
- (b) The keyboard character ‘h’ has the ASCII code number which is represented in binary as 1101000.
- (i) Convert this to its decimal equivalent. Show all working. **2**
- (ii) The decimal representation of keyboard character ‘H’ has a value that is 32 less than ‘h’. Calculate the binary value of its ASCII code number. Show all working. **2**
- (c) The following algorithms describe the process of logic circuits. **4**

<pre> BEGIN Program_Fish READ A,B IF A = 1 THEN IF B = 1 THEN C = 1 ELSE C = 0 END IF ELSE C = 0 END IF END Program_Fish </pre>	<pre> BEGIN Program_Chips READ A,B IF A = 1 AND B = 1 THEN C = 0 ELSE C = 1 END IF END Program_Chips </pre>
---	---

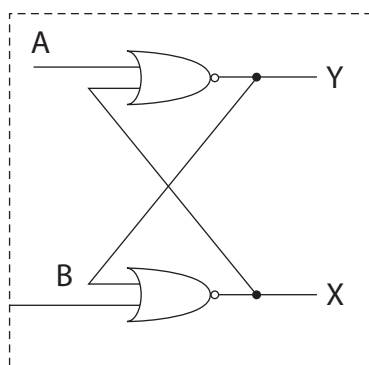
Compare and contrast these algorithms. In your answer, include:

- a truth table for each algorithm, and
- a discussion of the purpose of each logic circuit.

Question 25 continues on page 20

Question 25 (continued)

- (d) Describe the purpose and operation of the logic circuit shown in the diagram. 3



- (e) (i) Describe the function of a control character in the operation of a printer, using examples in your description. 2
- (ii) The following section of text has been produced using a word-processing package. 4



Propose a system of control characters that would enable this section of text to be printed. Include for each character a complete description of its operation.

End of paper