

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

2005

**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 16–19

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** A software development project involves ongoing communication and combined decision making between the software developer and the client.

Which of the following would best describe the approach used during software development?

- (A) Client empowerment approach
- (B) Data flow approach
- (C) Prototyping approach
- (D) Structured approach

- 2** A software development project for a small company is being outsourced. The project has a restricted budget.

Which of the following software development approaches would be the best to use in this situation?

- (A) End user development
- (B) Phased development
- (C) Rapid application development
- (D) Structured development

- 3** During which phase of the software development cycle would program code be generated?

- (A) Defining and understanding the problem
- (B) Planning and design of software solutions
- (C) Implementation of software solutions
- (D) Testing and evaluation of software solutions

- 4** During the development of a new interface for automatic teller machines, surveys will be undertaken to help improve the screen designs for customers.

Which of the following would be the best group to survey for the development of this software?

- (A) Bank staff
- (B) Bank management
- (C) The disabled, aged and infirm
- (D) A representative sample of the public

5 What documentation displays the relationship between processes identified in a system, and data that moves between those processes?

- (A) Critical path diagram
- (B) Data flow diagram
- (C) Gantt chart
- (D) System flowchart

6 The term *quality assurance* is used in relation to the development of software.

Which of the following best describes quality assurance?

- (A) Ensuring the user can access the data
- (B) Ensuring the software is of high quality
- (C) Ensuring the system meets specifications
- (D) Ensuring the user can access the source code

7 When defining and understanding a problem, which of the following best describes *a need* and *an objective*?

	<i>A need is</i>	<i>An objective is</i>
(A)	an essential component of the software	a broad statement of intent
(B)	a broad statement of intent	an essential component of the software
(C)	an option that users may choose	built into the system
(D)	built into the system	an option that users may choose

- 8 An open-source software package has been produced to accelerate and improve data-compression research and development.

As a part of the package the following source code has been made available.

<i>Software group</i>	<i>Components</i>		
General procedures	geometric sequence	asciitodat	datcat
	arithmetic sequence	datcut	datdist
	chnentropy	printfile	
Image processing procedures	imgtoicp	icptoimg	imgtodat
	dattoimg	icptodat	dattoicp
	imgdist	seqdeinterlace	seqdist
	imgdpcmencode	imgdpcmdecode	

Of what is this an example?

- (A) Library routines
 - (B) Paradigm logic
 - (C) Processing strings
 - (D) Thorough documentation
- 9 Which of the following is an example of external documentation?
- (A) Appropriate names for modules
 - (B) Source code comments
 - (C) Templates
 - (D) User manuals
- 10 Which of the following topics should be included in a manual for first-time users of a web browser?
- (A) Data flow diagrams
 - (B) Input-process-output diagrams
 - (C) Screen navigation
 - (D) Variables and data types

11 Consider the fragment of code.

```
on MouseButton  
    play track_10  
end MouseButton
```

Of which type of language is this an example?

- (A) Event-driven
- (B) Procedural
- (C) Prototyping
- (D) Sequential

12 The following information is to be kept on all competitors who have been drug tested at an international athletics event.

```
Name  
Age  
Gender  
Level of substance 1  
Level of substance 2  
Level of substance 3
```

Which of the following would be the most suitable data structure in which to store this information?

- (A) Array of files
- (B) Array of records
- (C) String
- (D) Record

13 Consider the EBNF description of a computer language.

```
<digit> = 1|2  
<letter> = a|b|c  
<expression> = {<letter>} <digit> [{<digit>}]
```

Which of the following would be an allowable expression in this language?

- (A) 2
- (B) b
- (C) bc
- (D) a321

14 During the execution of a program, two numbers are added together.

In which component of the CPU is the answer stored?

- (A) Accumulator
- (B) Arithmetic Logic Unit
- (C) Program Counter
- (D) Stack

15 Consider the algorithm.

```
BEGIN
  i = 1
  WHILE i ≤ 100
    values [i] = i × 2
    i = i + 1
  ENDWHILE
END
```

What is the purpose of the algorithm?

- (A) To assign even integers from 2 . . 100 into an array
- (B) To assign even integers from 2 . . 200 into an array
- (C) To assign even integers from 2 . . 100 into an array of records
- (D) To assign even integers from 2 . . 200 into an array of records

16 The command STOP is used in a software language as a debugging tool to halt a program. The program cannot resume until the debugging command RUN is issued.

Of what is this an example?

- (A) Program traces
- (B) Resetting variable contents
- (C) Stubs
- (D) Use of breakpoints

17 Consider the algorithm.

```
BEGIN MAINPROGRAM          BEGIN SUBPROGRAM process (j,k)
    i = 1                    k = j
    j = 2                    print k
    k = 3                    END SUBPROGRAM process
    process (i,j)
    print k
END MAINPROGRAM
```

What is the output from this algorithm?

- (A) 1 2
 - (B) 1 3
 - (C) 2 2
 - (D) 2 3
- 18 Which of the following would be the most useful tool for scheduling the tasks to be carried out during the implementation stage of the software development cycle?
- (A) Gantt chart
 - (B) IPO diagram
 - (C) Process diagram
 - (D) System flowchart
- 19 A project is running late and over budget.
- Which of the following would be most useful to the project manager in reviewing these problems?
- (A) Context diagram
 - (B) Logbook
 - (C) System flowchart
 - (D) User documentation
- 20 In which part of the CPU do Boolean operations take place?
- (A) Register
 - (B) Accumulator
 - (C) Random Access Memory
 - (D) Arithmetic Logic Unit

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) The installation of a new software solution uses the phased method of implementation.

(i) Define the term *phased method of implementation*. 2

(ii) Discuss reasons for using the phased method of implementation. 4
Illustrate your reasons using realistic examples.

(b) A software solution is required to determine if a word, entered by a user, is a palindrome. (A palindrome is a word that reads the same backwards and forwards. Examples of palindromes are ‘CIVIC’, ‘MUM’ and ‘ESSE’.)

Prior to writing an algorithm, the following draft notes are made.

Part 1. Input text into the string WORD\$

Part 2. Determine the number of characters, n , in WORD\$

Part 3. Initialise integer variable b to 1

Part 4. Example of function left: left(WORD\$, 2) is the 2nd character of WORD\$

Part 5. WHILE ($b \leq n/2$) AND (left(WORD\$, b) = left(WORD\$, $n-b+1$))

$b = b + 1$

ENDWHILE

Part 6. IF ($b = n/2$) THEN

print “Word is a palindrome.”

ELSE

print “Word is not a palindrome.”

ENDIF

(i) Describe the purpose of each of the conditions used in the WHILE statement in Part 5. 3

(ii) There are errors in the logic described in the notes that would result in an incorrect output statement. 3

Using the word ‘BLOB’, identify ONE error in the logic, and suggest how it could be fixed.

Question 21 continues on page 10

Question 21 (continued)

- (c) Eight randomly selected words are entered into an array. Students in a Software Design and Development class were asked to write an algorithm to sort the words into ascending alphabetical order.

One student submitted documentation indicating an original, non-standard approach to sorting.

Stage 1 Enter data into array

zebra	dog	cow	bat	cat	lizard	koala	lion
-------	-----	-----	-----	-----	--------	-------	------

Stage 2 Divide array into sub-array pairs

zebra	dog	cow	bat	cat	lizard	koala	lion
-------	-----	-----	-----	-----	--------	-------	------

Stage 3 Order each sub-array pair

dog	zebra	bat	cow	cat	lizard	koala	lion
-----	-------	-----	-----	-----	--------	-------	------

Stage 4 Merge pairs of adjacent arrays in order

bat	cow	dog	zebra	cat	koala	lion	lizard
-----	-----	-----	-------	-----	-------	------	--------

Stage 5 Merge in order the arrays created in Stage 4

bat	cat	cow	dog	koala	lion	lizard	zebra
-----	-----	-----	-----	-------	------	--------	-------

- (i) Compare and contrast the student’s algorithm with ONE of the standard sort algorithms that you have studied. **3**
- (ii) Write an algorithm fragment, using pseudocode, that merges in order the arrays in Stage 4 to produce the final array in Stage 5. **5**

End of Question 21

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

- (a) A project team is developing a computer-based adventure game. The game involves animated characters moving through chambers in a maze.

To progress through each chamber, characters must collect items. These items are used to overcome obstacles and allow characters to progress to the next chamber.

- (i) Describe ONE scheduling issue that would need to be considered in determining the feasibility of this game. **2**

- (ii) The team decides to use an event-driven language rather than a sequential approach in developing the software. **3**

Justify this decision.

- (iii) During the development of the game a new hand-held game machine is released. It is decided that a version of the game will be developed to run on this machine. **3**

Analyse ONE hardware issue that would need to be addressed.

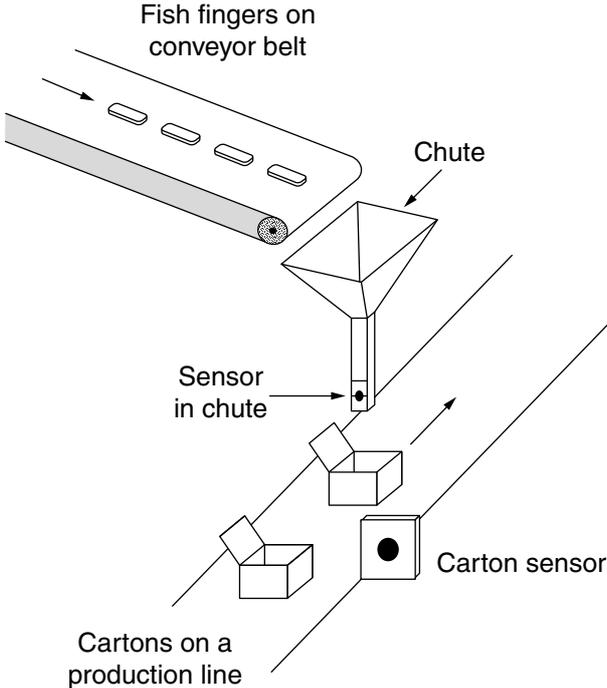
Question 22 continues on page 12

Question 22 (continued)

- (b) A local fish-canning factory packs fish fingers into cartons of 100, using the machinery shown below.

As fish fingers move to the end of the conveyor belt they fall into a chute. A sensor in the chute counts each fish finger as it falls.

The fish finger falls into a carton which has been moved into the correct position under the chute by the carton sensor.



Question 22 continues on page 13

Question 22 (continued)

The following algorithm describes the process.

```

10  BEGIN MAINPROGRAM PackFishFingers
20      WHILE system_on = true
30          ScanCarton(scan)
40          IF scan = true THEN
50              fingers = 0
60              CountFishFingers(fingers)
70              CloseCarton
80          ENDIF
90      ENDWHILE
100  END MAINPROGRAM

110  BEGIN SUBPROGRAM CountFishFingers(fingers)
120      WHILE fingers < 100
130          ScanChute(scan)
140          IF scan = true THEN
150              fingers = fingers + 1
160          ENDIF
170      ENDWHILE
180  END SUBPROGRAM

```

- (i) Prepare a data dictionary for this system using a table with headings 'Variable', 'Type' and 'Description'. **3**
- (ii) Analyse the necessity for passing a parameter to CountFishFingers. **3**
- (iii) The system is required to print the number of cartons produced each day. **2**
Write the lines of code to alter the algorithm to meet this specification.
- (iv) At the end of each day a production supervisor switches the system off. This results in loss of production data. This is unsatisfactory. **4**

The system needs to be redesigned to produce automatically:

- monthly production data, such as total number of cartons
- the maximum number of cartons packed on a day
- the minimum number of cartons packed on a day.

Propose how this could be achieved. It is NOT necessary to create an algorithm in your answer.

End of Question 22

		Marks
Question 23 (20 marks) Use a SEPARATE writing booklet.		
(a)	(i) Define the term <i>reverse engineering</i> .	2
	(ii) Describe ONE situation where reverse engineering would be legal.	2
(b)	Software should be targeted at its intended audience, including the culture of that audience.	
	(i) Describe TWO areas that would need to be considered in order to maximise cultural acceptance of software in the international market.	3
	(ii) Explain how a modular approach to software design could be used to change a software product for another culture.	3

Question 23 continues on page 15

Question 23 (continued)

- (c) The Big Lolly Company employs 200 factory workers. Factory workers are paid on an hourly basis.

Workers clock in and out of work daily. At the end of each week a timekeeper collects all workers' time cards. Time cards are compared to a database of authorised employees, initialised by the timekeeper and forwarded to the payroll department.

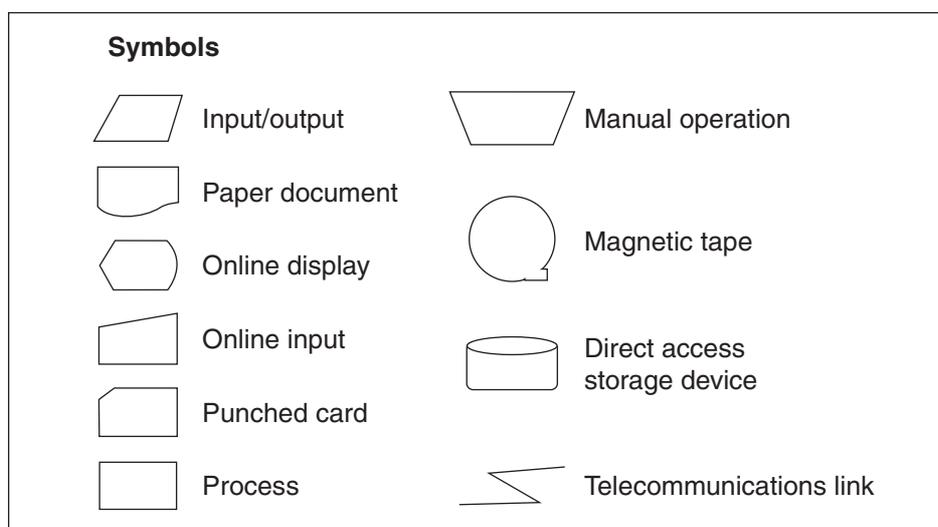
A clerk in the payroll department batches the time cards in groups of 40 or less and prepares a pre-numbered batch control form for each batch. The batch control form contains a batch identification number, date and number of cards in the batch. The entire batch is then submitted to the computer processing department where it is entered into the computer payroll system, verified and processed.

If any item in the batch is rejected because of either inaccurate data or data mismatch, a report is generated. All items in that batch are rejected to maintain batch integrity. The clerk then corrects the error and re-submits the batch using a new batch control form. This procedure is repeated until the batch is processed.

After this:

- the payroll master file is updated,
- pay slips are printed, and
- an electronic transfer of pay is made to each employee's bank account.

- (i) Identify ONE input and ONE output for the payroll system. 2
- (ii) Describe ONE computer process involved in the payroll system. 3
- (iii) Draw a system flowchart that accurately documents both the manual and computer components of the payroll system. Use any of the symbols below as needed. 5



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) Consider the program segment.

```
female (cathy).  
female (mary).  
parent (bob, cathy). //parent (X, Y) is defined as X is the parent of Y.  
parent (mary, bob).  
parent (tom, mary).  
grandparent (X, Z):- parent (X, Y), parent (Y, Z).  
ancestor (X, Y):- parent (X, Y).  
ancestor (X, Z):- parent (X, Y), ancestor (Y, Z).
```

- | | |
|--|----------|
| (i) Identify ONE fact from this segment. | 1 |
| (ii) Evaluate the output from ancestor (mary, Y). | 2 |
| (iii) Explain why there are two ancestor definitions. | 2 |
| (iv) Extend the program segment to include the following logic: | 3 |
| <ul style="list-style-type: none">• bob and tom are males• son (X, Y) defines that X is the son of Y. | |

Question 24 continues on page 17

Question 24 (continued)

- (b) (i) Outline a real-world example in which use of the functional paradigm would be most appropriate. Describe a specific function that would be used in this situation. **3**
- (ii) Discuss the impact of functions on a programmer's productivity. **3**
- (c) A library system is being developed using the object-oriented programming paradigm. The class BOOK has been developed and includes an attribute, availability, which is set to true if the book is on the shelves, and false if it is either borrowed or on reserve. BOOK also has a public method, can-borrow().

```

10    Class BOOK {
20        private —
30            title:string
40            author:string
50            cost:real
60            availability:boolean
70        public —
80            can-borrow( ):boolean{
90                return availability
100           }
           :
           :
990    } //end class

```

- (i) Explain how the declaration would be amended to include a variable, num-borrowed, that stores the number of times the book has been borrowed. **2**
- (ii) Discuss how the method, can-borrow(), demonstrates encapsulation, and explain how encapsulation assists in program maintenance. **4**

End of Question 24

OR

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

- (a) A computer communicates with a printer using the following communication protocol.

<i>Control characters</i>	<i>Description</i>
OUTP	Sets the device to receive mode and alerts to accept a message.
MSGSTART	Start of packet of data
MSGEND	End of packet of data
MSGREQ	Send next packet
MEOL	Signal to commence a new line
MSOP	Signal to start a new page
MEOP	Signal to end a page
EOD	Clears device, sets device to wait, end of data

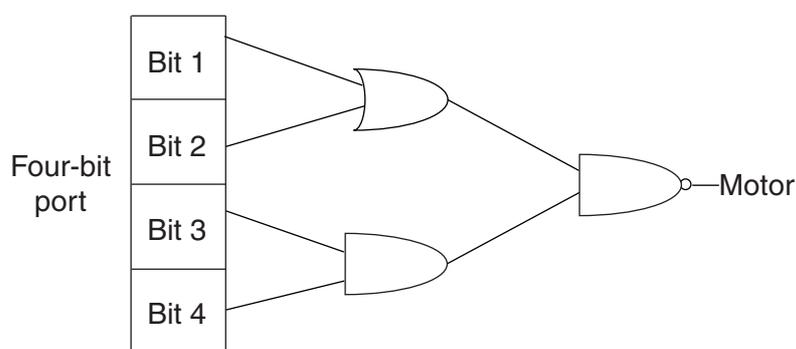
- (i) Identify which component of a print message would include the control character EOD. **1**
- (ii) Evaluate the importance of the control character OUTP in the structure of the communication protocol. **2**
- (iii) Explain why the control character MEOP is redundant. **2**
- (iv) Extend the communication protocol to include control characters that will manage the event of a printer running out of paper before completing a print job. **3**
- (b) (i) In binary arithmetic **3**
- $$101_2 \times 11_2 = 1111_2$$
- A computer performs this calculation using four-bit sign and modulus integer representation. Discuss how this representation impacts on the calculation.
- (ii) Discuss the use of floating point in the representation of fractions. **3**

Question 25 continues on page 19

Question 25 (continued)

- (c) A computer has a four-bit output port that allows it to be connected to peripheral devices.

The circuit, drawn below, was built to allow the computer to connect to an electric motor.



- (i) The motor is switched ON when the final output from the circuit is 1. 2

Explain how the signal 1000, sent from the output port, will cause the motor to be switched ON.

- (ii) Once the motor is switched ON it is important that it is not accidentally switched OFF. The motor is switched OFF when the final output from the circuit is 0. 4

Design a new circuit that will convert the signal 0111 to a final output of 0, converting all other four-bit signals to 1.

End of paper

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