MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE
General Certificate of Education Advanced Level
Higher 2

# COMPUTING

**9597/02**

Paper 2

**October/November 2015**

**3 hours**

Additional Materials: Answer Paper



**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

At the end of the examination, fasten your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **8** printed pages.

Singapore Examinations and Assessment Board

CAMBRIDGE International Examinations

Answer **all** questions

1 The management of a university is keen to implement changes which will result in higher student attainment. The management believes this is possible if it collects more data about its students which is then analysed.

Possible data that might be collected includes: assignment grades, books taken out of the library, attendance at lectures, attendance at tutorials, meetings with personal tutor, email exchanges with university staff, and participation in sporting and cultural activities.

University staff are classified as either academic or management. All data about students will be available to academic staff for viewing and editing. Summary information, which does not identify any individual student, will be viewable by some management staff. Students have no access to the data.

A project working party is to be set up consisting of representatives from across the university. The working party will define the scope of the project. It will consider what data is to be collected. It will also decide what the data is to be used for and consider any potential further use of the data.

If this project has a successful outcome, the university will market its expertise to other universities.

**(a)** Give **three** different representative members of the working party. Justify each choice. [6]

**(b)** The working party has been asked to produce a list of issues that will be considered by the Ethics Committee of the university.

State **two** issues that could be on the list. [2]

After consideration of the reports from the working party and the Ethics Committee the university management decide to proceed with the project. A project team is put together to design and implement a new software system.

The initial work of the project team involves an investigation process.

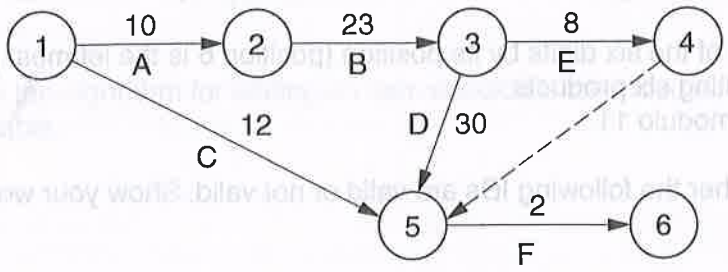
**(c)** Name **two** techniques that can be used by the project team in the investigation process. For each technique, explain how it can be used in this project. [6]

**(d)** A detailed report is produced following the investigation. This report will form the starting point of the design stage. Describe **two** sections of the report. [4]

The project team draw up a list of activities that will be required for the completion of the software project:

| Activity | Activity Description | Expected Duration (in weeks) |
|---|---|---|
| A | Design solution to project | 10 |
| B | Development of solution to project | 25 |
| C | Produce documentation | 12 |
| D | Testing | 30 |
| E | Implement system | 8 |
| F | Acceptance trials | 2 |

A first attempt to produce a Program Evaluation and Review Technique (PERT) chart from the activity table is:




**(e)** **(i)** Describe **two** benefits that can be gained by producing a PERT chart from the activity table. [2]

**(ii)** Explain the significance of the dashed line on the PERT chart. [2]

**(iii)** There are two errors on the PERT chart. Identify these errors. Redraw the PERT chart to show the changes needed to correct these errors. [2]

**(f)** Using your PERT chart from **part (e)(iii)**:

**(i)** State the minimum time in which the project could be completed. [1]

**(ii)** By how many weeks can the start of the production of documentation be delayed without delaying the whole project? [1]

**(iii)** Describe and give an example of concurrent activities. [2]

**(iv)** Describe and give an example of dependent activities. [2]

Output from the system is made available to permitted staff via the university intranet. However, the university intranet can be accessed by all students and staff, both locally and remotely, via the Internet. The system needs security measures to prevent all types of unauthorised access.

**(g)** Describe **two** suitable physical security measures that could be adopted. [4]

**(h)** Describe **two** suitable software security measures that could be adopted. [4]

Following the success of the project, management decides that the software system will be marketed to other universities.

**(i)** Explain how the university's investment in the software can be legally protected. [2]

2 A stock control system requires that each stock item has a unique ID consisting of six digits. The sixth digit is a check digit. This check digit ensures that a value of 0 is the final result of the following series of calculations:

- multiply each of the six digits by its position (position 6 is the leftmost position)
- sum the resulting six products
- find the sum modulo 11.

**(a)** Deduce whether the following IDs are valid or not valid. Show your working.

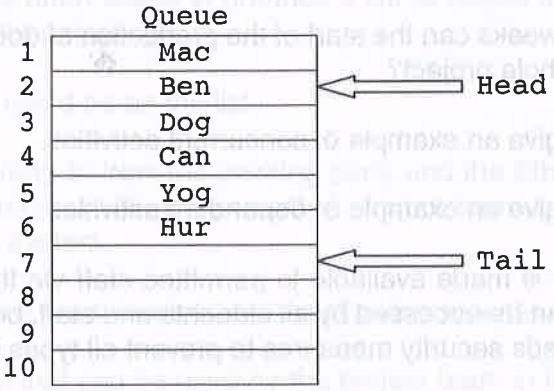
**(i)** 810230 [2]

**(ii)** 371025 [2]

**(b)** The ID 483095 is a valid ID. Describe **one** typical data entry error for this ID. Show how this error would be detected. [3]

**(c)** Describe a method of verification that can be used when an ID is entered from a data entry form. [3]

3 A simple queue data structure is implemented using a one-dimensional array and two pointers, `Head` and `Tail`, as shown:




**(a)** Show the state of the above queue after:

- two items, Dap and Eck, are added (in that order)
- one item is removed. [3]

When ten items have been added, this simple queue cannot accept any further items.

**(b)** A first attempt at an algorithm for adding an item to this queue is:

```
01 IF ..........
02   THEN
03     OUTPUT "No more room to add items"
04   ELSE
05     INPUT "New item to be added", NewItem
06     Queue[..........] ← NewItem
07     ..........
08 ENDIF
```

Write the pseudocode to show the completed lines 01, 06, and 07. [3]

**(c)** Give the initial value for `Tail` when the queue is created and justify your answer. [2]

The programmer can reuse the space released after removing an item. This maximises the available space.

**(d)** Describe how the algorithm for adding an item should be amended so that the released space is made available. [2]

4 An algorithm for converting a number n from denary to octal uses the three built-in functions:

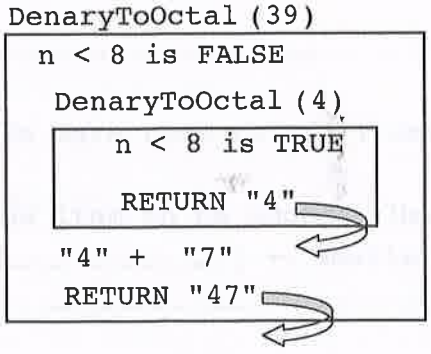
| Function | Description | Example |
|---|---|---|
| `INTMOD(Number,Divisor)` | returns the remainder when the first parameter is divided by the second parameter. | `INTMOD(7,3)` returns 1 |
| `INTDIV(Number,Divisor)` | returns the integer part when the first parameter is divided by the second parameter. | `INTDIV(7,3)` returns 2 |
| `SUBSTR(ThisString,Start,Length)` | forms a substring from `ThisString`, starting at `Start` (with first index in string zero) and taking `Length` characters | `SUBSTR("abcd",1,2)` returns `"bc"` |

Study the following pseudocode:

```
01  FUNCTION DenaryToOctal(n : INTEGER) RETURNS STRING
02      OctalDigits ← "01234567"
03      IF n < 8
04          THEN
05              TempString ← SUBSTR(OctalDigits,n,1)
06          ELSE
07              // '+' is the concatenation operator
08              TempString ← DenaryToOctal(INTDIV(n,8)) +
                                SUBSTR(OctalDigits,INTMOD(n,8),1))
09      ENDIF
10      RETURN TempString
11  ENDFUNCTION
```

**(a)** Identify where and why this is a recursive function. [2]

The diagram shows the execution of the call `DenaryToOctal(39)`.




**(b)** Draw a similar diagram to show the execution of the call `DenaryToOctal(67)`. [3]

**(c)** Changes are to be made to the function `DenaryToOctal()` so that it converts denary numbers to hexadecimal.

Describe the changes:

- that are essential to make the revised function work.
- that are non-essential but would help with the clarity of the pseudocode. [5]

**5** A program is to be written to test an insertion sort algorithm. A top-down approach was used in the design of the program. The program, `InsertionSortTester`, has a number of parts:

- input integer values into the array
- output the initial values in the array
- output the sorted values in the array
- perform the insertion sort
- validate the values

**(a)** Draw a diagram, which exhibits top-down design, for the `InsertionSortTester` program. [3]

A list of data items is stored in the array `Values`. The pseudocode for the insertion sort algorithm is:

```
01  FOR i ← 2 TO ArraySize
02      Temp ← Values[i]
03      j ← i-1
04      WHILE (j > 0) AND (Values[j] > Temp)
05          Values[j+1] ← Values[j]
06          j ← j-1
07      ENDWHILE
08      Values[j+1] ← Temp
09  ENDFOR
```

**(b)** The sort algorithm is to be tested using the sequence of numbers: 6, 8, 2 and 1. Copy and complete the trace table given below.

| Values | | | | | | |
|---|---|---|---|---|---|---|
| [1] | [2] | [3] | [4] | i | j | Temp |
| 6 | 8 | 2 | 1 | | | |
| | | | | | | |
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[6]

**(c)** Explain why this particular algorithm is inefficient for an array where the initial values are already in order. [2]

**(d)** Give **two** different test cases for the program. Justify your selection in each case. [4]



6 Students from several schools are entered for examinations in different subjects.

A relational database is to be used by the examination board to store data about examination entries and results. Four tables present in the database are STUDENT, SCHOOL, SUBJECT and STUDENT-SUBJECT.

Every time a student registers for a subject examination, a new row is created in the STUDENT-SUBJECT table. When the result becomes available, this is added to the appropriate row.

Each student, each school, and each subject has a unique identification code.

**(a)** **(i)** Draw an Entity–Relationship (E-R) diagram to show the relationship between the STUDENT table and the SUBJECT table. [1]

**(ii)** State the type of relationship that exists between the STUDENT and SUBJECT tables. [1]

**(b)** Draw an E-R diagram to show the relationship between the four tables that provides for a fully normalised database design. [3]

A table description can be expressed as:

```
TableName(Attribute1, Attribute2, Attribute3, ...)
```

The primary key is indicated by underlining one or more attributes.

An incomplete STUDENT table is:

```
STUDENT(StudentID, StudentName, DateOfBirth)
```

**(c)** Give a table description for the SUBJECT table. Ensure there are **two** attributes in addition to the primary key. [3]

**(d)** Give a table description for the STUDENT-SUBJECT table. Ensure there is **one** non-key attribute. [3]

**(e)** **(i)** State the type of relationship that exists between the STUDENT and the SCHOOL tables. [1]

**(ii)** Explain how the relationship between the STUDENT table and the SCHOOL table is established. [3]