NATIONAL JUNIOR COLLEGE
Science Department

General Certificate of Education Advanced Level
Higher 2

COMPUTING 9597/02

Paper 2 **27 August 2018**

3 hours

Additional Materials: Pre-printed A4 Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your name and class on all work you hand in.

Write in dark blue or black pen on both sides of the paper.
You may use a pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

There are 6 questions totalling 100 marks.

Answer **all** questions.

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

This document consists of **6** printed pages and **0** blank pages.

1 A fast food restaurant chain is considering going cashless by replacing its cash registers with automated point of sale (POS) terminals.

Management does realise that most customers still prefer cash transactions. However, they would like to introduce stored-value smart cards, which customers can either top-up online or at the actual restaurant outlets.

As an alternative, they would also allow customers to pay using the standard electronic payment service provided by banks – i.e., Network for Electronic Transfers (NETS).

The current system typical utilises cash registers, which also allow for NETS transactions.

Under the existing system, sales reports are generated based on products (from the menu) that are sold. On occasion, surveys may also be performed to determine customer satisfaction levels and menu preferences. Management will then study the various pieces of information acquired in order to make decisions about changes to the menu, and about any promotional events and/or schemes.

By utilising the stored value smart cards, the restaurant chain management plans to be able to introduce customer loyalty rewards, special offers, and other discount or promotional schemes. In particular, they would like to utilise individual customer purchase data to make better decisions concerning mutually beneficial schemes for both the customers and the business.

The management of the restaurant chain has secured the services of a software development company to handle this project.

(a) Following an initial feasibility study, the project team is tasked to analyse the current system in detail. Describe two actions that the team may undertake in order to define the current system. You must include all entities and items that would be investigated, and how the investigation would be performed. [4]

(b) The analysts in the project team must include a data flow diagram for the existing system as part of the analysis phase. Draw a data flow diagram for the existing system. [5]

(c) State two other forms of diagrams that are generated during the analysis phase, and state their purpose. [2]

(d) Gantt and PERT charts are two types of project management tools that are typically utilised for the planning of resource allocation. With the use of examples under the current context, explain the benefits and drawbacks of either of these charts. [4]

(e) Following the analysis phase is the design phase, which will include the systems requirements specification. Describe four elements of the systems requirements specification for the system to be implemented. [4]

(f) Another outcome from the design phase is the testing documentation. Describe the objective of this document, and its general contents. [2]

(g) The design team has opted to largely utilise a top-down testing approach for this project. Describe top-down testing, and explain why this choice might have been made for the development of this system. [2]

(h) During the course of the project, several points were raised about both the social and ethical issues associated with the project. Describe two points that could have been raised. [4]

(i) The final phase of the cycle involves the maintenance of the system. Describe one relevant form of maintenance for the system described. Justify your answer. [2]

Suppose that the management of the restaurant also wished to extend the system to also handle online orders.

(j) Explain the difference between a client-server and peer-to-peer network, and explain which is would be relevant for the proposed online system. [2]

(k) Should the design team choose to implement a cloud computing solution, explain how each type of cloud computing, if applicable, would be relevant. [3]

(l) Describe one security vulnerability there may exist in the online ordering system, and then describe how it can be mitigated. [2]

A decision was also made to standardise all user interfaces for orders. Consequently, all devices used to make orders, including the POS terminals within restaurants, and computers or mobile devices (anywhere, including within the restaurant), were all are designed to use the exact same interface.

(m) Describe one pro and one con of such a user interface design choice. [2]

(n) List at least two other user interface design principles that the designers should adopt. [2]

2 **(a)** Describe the difference between the Bubble Sort and Insertion Sort algorithms by tracing their use over the following array:

["7", "6", "15", "11", "1"]

(i) Provide the Bubble Sort trace. [3]

(ii) Provide the Insertion Sort trace. [3]

(iii) Describe the difference between the two sorting algorithms. You should use the traces performed in **(i)** and **(ii)** to do so. You should also comment on the computational complexity of these algorithms. [2]

(b) A hash table is implemented with linear probing. The following function, `search`, returns the object that has the specified `key`:

```
01    FUNCTION search(Table, key)
02        i ← HASH(key)
03        WHILE Table[i, 1] <> key
04            i ← i + 1
05        ENDWHILE
06        RETURN Table[i, 2]
07    ENDFUNCTION
```

Assuming that the specified key (and its associated object) exists in the Hash Table, identify one problem with this implementation, and then modify the function to fix the issue identified. [2]

(c) Describe the enqueue and dequeue methods for a circular queue. [2]

3 The following is a recursive function.

```
01    FUNCTION f(INTEGER a, INTEGER b)
02        IF b = 0 THEN
03            RETURN 1
04        ELSE IF b = 1 THEN
05            RETURN a
06        ENDIF
07        x ← f(a, b DIV 2)
08        IF (b MOD 2) = 0 THEN
09            RETURN x * x
10        ELSE
11            RETURN x * a * x
12        ENDIF
13    ENDFUNCTION
```

(a) Using the above function as an example, define recursion. [2]

(b) Perform a dry-run of the above function using the call `f(3, 4)`. Show the resultant trace tree. [4]

(c) State the purpose of the specified function. [1]

(d) Identify one flaw in the above algorithm, and explain how this flaw may be addressed. [2]

(e) Draw a flowchart depicting an iterative version of the specified function. [3]

4 A student in Malaysia is trying to access the website nationaljc.moe.edu.sg using a computer in her school.

(a) Define a DNS server, and explain why it is important for the given context. [2]

(b) Describe how the web page is fetched, focusing on the various layers/protocols, network devices and addressing that is utilised throughout this network communication. Note that you may to use fictitious addresses, but must use the correct address format for each case. [5]

While accessing the website, the student also downloads certain information that is accompanied by a digital signature.

(c) Explain how a digital signature works. [4]

(d) Provide an example, using the given context, which would require the use of a digital signature. [1]

5 A researcher is compiling a bibliography of the various references that have been reviewed. These references may either correspond to conference/workshop papers, journal papers, or textbooks. In each case, the researcher stores the following information:

- Date of publication
- Title of publication
- Authors

Depending on the type of publication, additional information may also be stored.

For conference/workshop papers, the following is also stored:

- Conference name
- The relevant pages within the proceedings for the paper in question

For journal papers, the following is also stored:

- Journal name
- The volume and issue numbers
- The relevant pages within the issue for the paper in question

For textbooks, the following is also stored:

- The publisher

With each reference, the author also stores:

- Meta tags for the paper, based on relevant topics within the paper
- A summary of the findings within the paper

When a paper is added to the bibliography, the summary and meta tags are first left empty, and only later added. All the other information is available when the paper is added to the bibliography.

(a) Draw suitable UML class diagrams and relationships to model the scheme above. You should also include appropriate attributes (with type information) and methods for each class. [4]

(b) Using the object-oriented programming concepts of encapsulation, inheritance and polymorphism, explain how your implementation will facilitate information hiding and, software reuse and code generalisation. [3]

(c) Describe the relationship between objects, classes and instances. [1]

(d) If the researcher also wishes to link each paper based on citations (i.e., based on the papers referenced within each paper), suggest a relevant data structure design that may be utilised over the classes you have defined. Justify your answer. [2]

6 A bookshop has taken its business online and now only sells books online.

Each time a sale is made, the following information is captured:

- customer reference code – if the customer is already registered
- customer name, address and payment information – if the customer is new; a reference code will also be generated
- books purchased by customer (in the current order)

For each book the company sells, the following information is also stored:

- book ISBN
- book title
- book authors
- book publisher
- book synopsis

Each customer may make as many purchases as he/she desires (even on the same day).

For each book, the company keeps track of the quantity in stock.

Even if a book is no longer sold, the information on the book should still be stored.

The company wants to model its sales and inventory using a relational database.

(a) A database needs a number of tables to store the data for this application.

Draw the Entity-Relationship (E-R) diagram to show the tables in third normal form (3NF) and the relationships between them. [4]

(b) A table description can be expressed as:

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

The primary key is indicated by underlining one or more attributes. Foreign keys are indicated by using a dashed underline.

Using the information given, write table descriptions for the tables you identified in **part (a)**. [6]

(c) Like many other online bookshops, the company also provides a list of recommended books for each customer. Describe the query (or queries) that would facilitate this. [2]

(d) Relational databases are an improvement over the use of flat files. One way to explain these improvements are based on data anomalies. Describe two such anomalies, and exemplify them using the given context. [2]