OLLSCOIL NA hÉIREANN
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SEMESTER II, SUMMER 2003 EXAMINATION

2nd B.Sc. (Information Technology)

Software Engineering I (CT216)

Professor P. Nixon
Professor G. Lyons
Dr. S. Flynn
Dr. J. Duggan

Time Allowed: 3 hours
Answer 5 questions.
Use a separate answer book for each section.
At least one question must be answered from Section B

SECTION A – STRUCTURED TECHNIQUES

1. Analyse this routine specification, and propose a new design based on the principles of coupling, cohesion and factoring.

Routine:	Calculate Net Pay
Uses:	Flag, Hours Worked, Hourly Rate, Salary, Tax Free Allowance
Outputs:	Net Pay
Local Variables:	Gross Pay, Deductions
Comments:	Calculates the net pay for hourly and salaried workers

```
Begin

    If(Flag = 0) Then // its an hourly paid worker

        Gross Pay = Hourly Rate * Hours Worked
        Deductions = (Gross Pay – Tax Free Allowance)  * .42
        Net Pay = Gross Pay – Deductions

    Else If (Flag =1) Then // it's a salaried worked

        Deductions = (Salary – Tax Free Allowance) * .42
        Net Pay = Salary – Deductions

    End If

    Return Net Pay

End
```

2. From the description of the Virtual Music Store (VMS), produce:

   - An Event List
   - A Context Diagram
   - A System-Level DFD
   - A Data Dictionary

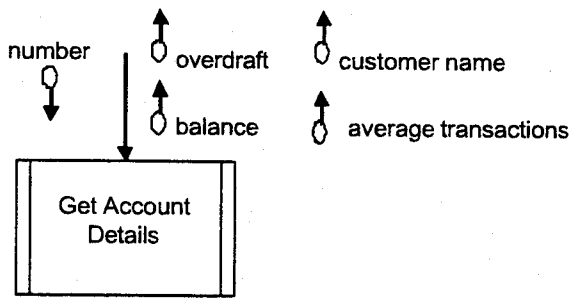
   The Virtual Music Store (VMS) is a 24/7 music store located on the internet. As a software system, it must be able to respond to key events within its environment. First, it must allow users to join up as a member, and provide personal information including: name, date of birth, email address and phone number. As part of this transaction, the user is issues with a membership id, and the information is stored within the VMS.

   Second, the VMS must be able to keep track of new CDs as they arrived within the store. These CDs have important information associated with them: CD Code, Copy Number, Artist, Title, Genre, Price and Year of Release. Finally, the VMS must allow a member to purchase a CD, and record the purchase information such as: membership id, CD Code, Copy Number, date of purchase and purchase price.

3. (a) Map each of the following E-R relationships to the relational model, stating clearly the rules used for each transformation:
   - An employee manages one or more employees.
   - A Student studies many subjects, and a subject is studied by many students.
   - A customer makes many orders, an order is for one customer.

   (b) Write notes on *any two* of the following
   - The Process Specification
   - The Structure Chart
   - Factoring

4. During your first week of Industrial Placement, your employer (a major international banking organisation) has asked you to reflect on the pre-defined routine shown below. They would like you to "wrap" this routine so that ten most recent accounts requested are cached, and would also like all parts of the interface to this wrapper to be functionally cohesive. Based on the idea of an *information cluster,* specify a design that fulfills their requirements.



5. Analyse the following routine, and:

   (a) Draw a flow graph.
   (b) Calculate V(G) using three different methods.
   (c) Design a set of test cases to ensure complete code coverage.

routine sort routine
uses Array, N (array size), sort_flag
updates array
description *selection sort algorithm*

```
Begin
        SET  I  = 0; J = 0; MIN = 0; T = 0;

        DO WHILE  (I < N)
                MIN = I
                J = I + 1
                DO WHILE ( J <= N)
                                IF Array[J] < Array [Min] Then
                                   MIN = J
                                END IF
                                J = J + 1
                END DO
                T = Array[MIN]
                Array[MIN] = Array[I]
                Array[I] = T
                I = I + 1
        END DO
End
```

6. (a) Design an E-R Model, with cardinalities, that maps the information needs of a timetabling system within a University. This basic model information includes: Rooms (RoomID, Capacity); Lecturers (Lecturer ID, Name, Email Address); Classes (Class Code, Size) and Subjects (Subject Code, Description).

   (b) Map this E-R Model to a set of tables. (Sample output from the timetabling system is shown below).

<<Timetable Listing>> Room IT250; Capacity 250; Monday April 8th, 2003.	
9.00-10.00	CT103 Programming [1st IT, 1st Eng, 1st Astrophysics] Dr. M. O'Meara [m.omeara@nuigalway.ie]
10.00-11.00	Vacant
11.00-12.00	Vacant

Section B: Specification in Z

7. A birthday book records people's names with their birthdays. Every person in the book has an associated birthday.

   Using the given sets $[PERSON]$ and $[DATE]$ and the state schema

   $$\begin{array}{|l} \textit{ITLibrary} \\ \hline bbook : PERSON \pfun DATE \\ \hline \end{array}$$

   complete the following tasks:

   (a) Explain the meaning of the state schema and suggest a suitable initial state. (6)

   (b) Write Z specifications for each of the operations: (14)

   (i) Add an entry (person and date) to the birthday book.

   (ii) Remove a person from the birthday book.

   (iii) Given a person, find their birthday.

   (iv) Given a date, find the (set of) people with birthdays on that date.

   Remember to describe all operations using natural language as well as the Z notation.

8. We want to model the booking system for a particular flight. The aeroplane has a limited capacity and the flight should not be overbooked. You are given the axiomatic definition:

   $$\begin{array}{|l} flightCapacity : \mathbb{Z} \\ \hline flightCapacity \geq 0 \\ \hline \end{array}$$

   Using the given set $[PERSON]$ and the state schema

   $$\begin{array}{|l} \textit{Flight} \\ \hline passengers : \mathbb{P}\, PERSON \\ \hline \#passengers \leq flightCapacity \\ \hline \end{array}$$

   complete the following tasks:

   (a) Explain the meaning of the state schema, paying particular attention to the invariant, and suggest a suitable initial state. (6)

   (b) Write Z specifications for each of the operations: (14)

   (i) A passenger books onto the flight.

   (ii) A passenger cancels his booking.

   (iii) Query how many seats are available.

   (iv) Produce a passenger list (set).

   Remember to describe all operations using natural language as well as the Z notation.