THE BRITISH COMPUTER SOCIETY

THE BCS PROFESSIONAL EXAMINATION
Diploma

DATABASE SYSTEMS

24th April 2002, 2.30 p.m.-4.30 p.m.
Answer FOUR questions out of SIX. All questions carry equal marks.
Time: TWO hours.

*The marks given in brackets are **indicative** of the weight given to each part of the question.*

1.   Use the Tables given in Appendix A in your answers to both parts of this question.

   a)   Give example SQL statements that show how SQL processes the following relational algebra set operations:
   i)   SELECTION
   ii) CARTESIAN PRODUCT
   iii) RESTRICTION   **(9 marks)**

   b)   Assuming dates are stored in 'short date format' (i.e. no time component) implement the following using SQL.
   i)   Use a SQL date function that calculates the current date to display the names of guests arriving tomorrow.
   ii) Use a SQL date function that extracts part of a given date to display the number of days, starting from today, before a guest who is identified as GuestId=9 is due to arrive.
   iii) Use SQL date functions to display those rooms with a booking that started prior to today and is an unconfirmed booking.   **(16 marks)**

2.   *a)*   Show that the Tables given in Figure 1 (Appendix A) conform to Boyce Codd Normal Form (BCNF). Include your working and any assumptions that you have made.   **(8 marks)**

   b)   Give an example of a situation where a Table can be in 3NF but NOT in BCNF.   **(7 marks)**

   c)   Explain what is meant by 'de-normalisation'.   **(4 marks)**

   d)   Using the Tables given in Figure 1 (Appendix A) or using an example of your own, describe a situation where de-normalisation could be advantageous.   **(6 marks)**

3.   "MNG" is a company that owns a chain of hotels that provide budget accommodation on a 'room-only' basis. MNG has its own web-site hosted on a server provided by an Internet company. The web site merely advertises its accommodation and provides a map to show the location of its hotels. Currently, potential guests have to phone the hotel at which they want to stay in order to make a booking for accommodation. MNG have commissioned you to investigate the technical feasibility and the cost-benefits of a new system that will allow guests to book accommodation over the WWW.

Each hotel stores a record of the bookings in a relational database whose structure is given in Figure1 (Appendix A). Each hotel currently has its own independent database running on stand-alone PCs.

   a)   Explain the benefits and the drawbacks of providing an on-line room booking facility over the WWW for use by guests.   **(8 marks)**

   b)   Explain why a 3-tier client server model is the most appropriate platform to meet the requirements of the new system.   **(8 marks)**

   c)   Outline the technical differences between TWO of the following 3-tier client-server software technologies which could be used to implement this system: Active Server Pages; Java Server Pages; Common Gateway Interface.   **(9 marks)**

[Turn over

4. *a)* Define the following terms:
  - *i)* Database
  - *ii)* Database management system
  - *iii)* Data model **(3 marks)**

b) With reference to the three-schema architecture for database systems, describe the role of the following:
  - *i)* The internal schema
  - *ii)* The conceptual schema
  - *iii)* The external schema **(6 marks)**

c) What is the relationship between the concept of a data model and the conceptual schema of a database system? **(6 marks)**

d) Describe briefly the relational data model. **(10 marks)**

5. *a)* With respect to database design, define the following terms:
  - *i)* Conceptual database design
  - *ii)* Logical database design
  - *iii)* Physical database design **(5 marks)**

b) When transforming entity-relationship diagrams into relational database schemas, describe with the aid of examples, how you would handle each of the following:
  - *i)* Composite attributes
  - *ii)* Multi-valued attributes
  - *iii)* Binary one-to-many relationships
  - *iv)* Binary many-to-many relationships
  - *v)* Binary relationships which have attributes **(15 marks)**

c) Describe, with the aid of examples, the following concepts:
  - *i)* Entity integrity
  - *ii)* Referential integrity **(5 marks)**

6. *a)* With respect to the entity-relationship model, define the following terms:
  - *i)* Entity
  - *ii)* Entity type
  - *iii)* Attribute
  - *iv)* Relationship **(4 marks)**

b) Explain, with the aid of an example, the difference between a strong entity type and a weak entity type. **(4 marks)**

c) Explain, with the aid of examples, the difference between each of the following:
  - *i)* Simple versus composite attributes
  - *ii)* Single-valued versus multi-valued attributes
  - *iii)* Stored versus derived attributes **(6 marks)**

d) Give an example of each of the following:
  - *i)* Unary relationship
  - *ii)* Binary relationship
  - *iii)* Ternary relationship **(6 marks)**

e) Explain the concept of cardinality constraints on a relationship. Give examples of:
  - *i)* One-to-many relationships
  - *ii)* Many-to-many relationships
  - *iii)* Optional relationships
  - *iv)* Mandatory relationships **(5 marks)**

APPENDIX A (for use in Questions 1, 2 and 3). Hotel Booking System

The following database design and corresponding data sets are used in a Hotel Booking system. The Guest table identifies any Guest who has reserved a room for 1 or more nights. Each room is either Smoking or Non-Smoking and can sleep up to 2 people in a double bed or in twin beds. A room booking is either Reserved (state = Unconfirmed and not yet paid for) or Confirmed (the payment for the room has been received usually on the day they wish to be accommodated). The arrival date is the start date when a guest commences their stay.

Figure 1 below gives the structure of an MS-Access database used in a hotel to process room bookings. Figures 2a, 2b and 2c show sample data for 3 tables – Bookings, Rooms and Rooms Booked.
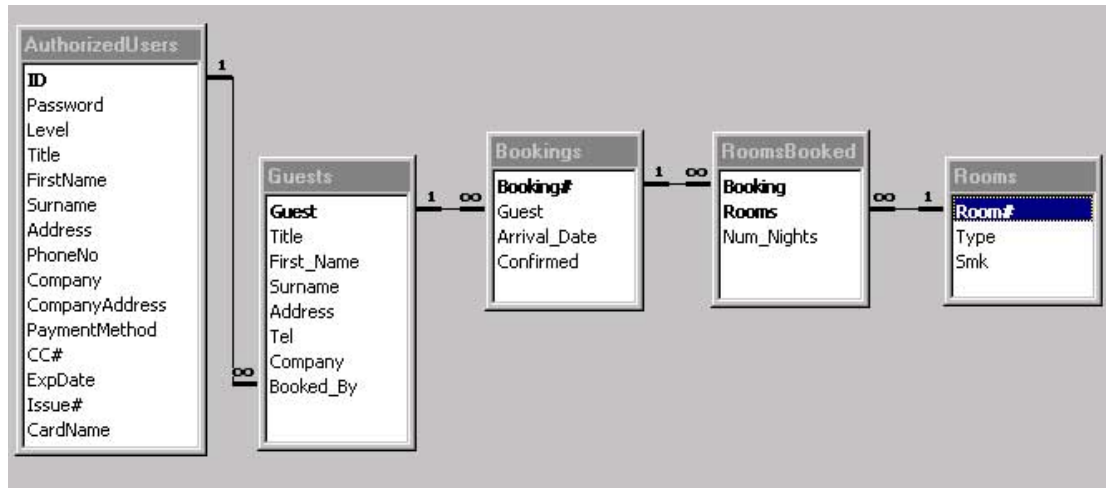

Figure 1: Database Design – Diagram

Booking#	Guest	Arrival_Date	Confirmed
1	2	1/26/02	Yes
2	5	1/26/02	Yes
3	4	1/26/02	Yes
4	1	1/27/02	Yes
5	6	1/30/02	Yes
6	7	1/30/02	Yes
7	8	1/30/02	No
8	3	1/29/02	Yes
9	1	2/3/02	Yes
10	9	1/25/02	No
11	9	12/31/01	No
12	2	2/2/02	No
14	11	1/9/02	Yes
16	15	1/15/02	No
18	17	1/29/02	Yes

Figure 2a: Sample Data Table – Bookings

RoomsBooked : Table

Booking	Rooms	Num_Nights
1	4	4
2	1	1
3	2	2
4	1	5
5	4	1
6	5	1
7	6	1
8	2	4
9	5	3
10	1	1
10	2	1
10	3	1
10	4	1
10	5	1
10	6	1
10	7	1
10	8	1
10	9	1
10	10	1
10	11	1
10	12	1
10	14	1
10	15	1
10	16	1
10	17	1
10	18	1
10	19	1
10	20	1
10	21	1
11	1	1
11	2	1

Rooms : Table

	Room#	Type	Smk
▶ ⊞	1	Twin	No
⊞	2	Twin	No
⊞	3	Double	No
⊞	4	Double	No
⊞	5	Twin	No
⊞	6	Twin	No
⊞	7	Double	No
⊞	8	Double	No
⊞	9	Twin	No
⊞	10	Double	No
⊞	11	Twin	Yes
⊞	12	Twin	Yes
⊞	14	Double	Yes
⊞	15	Double	Yes
⊞	16	Twin	Yes
⊞	17	Twin	Yes
⊞	18	Double	Yes
⊞	19	Double	Yes
⊞	20	Twin	Yes
⊞	21	Double	Yes

Figure 2b: Sample Data – Rooms   **Figure 2c: Rooms Booked**