THE BRITISH COMPUTER SOCIETY

THE BCS PROFESSIONAL EXAMINATIONS
Professional Graduate Diploma

ADVANCED DATABASE MANAGEMENT SYSTEMS

26th April 2006, 10.00 a.m.-1.00 p.m.
Answer THREE questions out of FIVE. All questions carry equal marks.
Time: THREE hours.

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

Attached Appendix A: SWIFT.

1. *a)* "Domains are to relations as nouns are to sentences". (Date and Darwen 1998).

Discuss the above statement in order to establish the role played by the concept of domain in the relational model of data. **(9 marks)**

b) Discuss whether the concept of domain in the relational model is equivalent to the concept of class as defined in object-oriented terminology. **(16 marks)**

2. *a)* Give an example of a query which has two differing relational algebra implementations and explain why the choice of implementation may affect the time taken to execute the query. **(6 marks)**

b) When a query is optimised, it is essential that the revised query returns the same result as the original. List a number of relational algebra transformations that achieve this. **(12 marks)**

c) Compare and contrast heuristic query optimisation with cost-based query optimisation. **(7 marks)**

3. *a)* Explain, aided by example code, the differences between the following programming constructs that could be used to implement database integrity constraints:

- Triggers
- Check Constraints
- Stored Procedures

(9 marks)

b) **Refer to Appendix A for this part of the question**
Examine the Business Rules in section A4 of Appendix A. Which of these Business Rules could be relatively easy to implement by programming a Trigger and which (if any) would not? Justify your answer. **(9 marks)**

c) One of your customers complains about the delivery of products which she did not order. Having investigated the matter the complaint is found to be genuine. Indeed someone reported a similar problem occurred before. It is suspected there are faults in the database software as other possible causes such as human error and a breach of security have been discounted. You are the leader of the database technical team charged with identifying possible causes of this breakdown of database integrity.

Write an account of the procedure you would follow to identify the cause of this breakdown of database integrity. Suggest possible solutions to avoid breakdown of database integrity arising in the first place. **(7 marks)**

4. *a)* Explain the characteristics that differentiate a Data Warehouse from a Database System.

(7 marks)

b) Explain why a Data Warehouse is *unlikely* to contain data that is in 3rd Normal Form.

(4 marks)

c) **Refer to Appendix A for this part of the question**

i) Describe an application area relevant to SWIFT that would benefit SWIFT from the support of a Data Warehouse and the associated analysis tools. Include in your answer the type and nature of the business data and the analysis tools that would be used in a Data Warehouse. **(10 marks)**

ii) Explain how transaction data added to the SWIFT database could be made available for use in a Data Warehouse. **(4 marks)**

5. Refer to Appendix A for this question

a) Describe the distributed information system technology known as *'Web Services'*. Explain what Web Services facilities would be required and explain how they could be configured to support the following functionality:-

SWIFT on behalf of its customers is investigating the use of web technologies to allow remote access to all of the airline operator databases. One functional requirement will allow SWIFT to have read access to airline operators databases so that they can check the availability and price of seats on any flight.

(12 marks)

b) Describe the characteristics of a distributed database technology that uses data replication. Explain how a data replication approach used by SWIFT would differ from the Web Services approach you described in your answer to part *a)* above.

(13 marks]

Appendix A: SWIFT (Saving With Internet Flight Travel)

SWIFT is an agency that sells discounted seats on flights on behalf of some low cost airlines. These discounted seats are called 'Offers' and are only available for purchase by registered customers over the internet. There are a number of low cost airlines that SWIFT is an agency for and sometimes more than one airline can offer seats with the same start and destination. Each seat offered for sale contains some information that is supplied by the airline operator:-

- The Ticket Number that identifies the seat on a particular flight.
- The start and destination of the city/airport for the journey undertaken.
- The date and time of the flight/journey and the check-in time.

Some information is derivable and depends on the number of confirmed customer bookings/sales of seats, this information is held on the SWIFT database:-

- The baggage allowance. The baggage allowance for passengers is reduced if the aircraft is carrying cargo as well as passengers. .
- The price of the seat. The price starts at a low discounted price and increases as the bookings fill up. The earlier the seat is purchased then the cheaper the price that a customer pays. The current price is the price quoted for customers wishing to purchase seats. This may also be the final price, particularly if customers book a seat near the departure date of a flight.

It is the responsibility of SWIFT to determine the price of a seat, they have to be competitive, however they must cover the operating costs of the flights. SWIFT have negotiated a contract whereby they get 12% of the profit that an airline makes each year from the passenger flights it is commissioned to sell seats.

Figure A1 (below) shows a sample ticket purchases and contains data that was captured today (assume the date is 3rd December 2005). **Figure A2** shows the customer details.

Figure A1: TBL_Tickets

TicketNo	CustID	FlightCode	Quantity	PurchDate	Current/Final Price	Price Paid	FlightDate/Time
1962	343371	BG_8971	1	12/Nov/05	231.99	219.56	01/Dec/05 12:23
1963	343371	GTX_281	2	12/Nov/05	211.67	211.59	14/Nov/05 16:34
1964	343371	TL121_281	1	12/Nov/05	2040.72	833.59	04/Dec 05 00:56
1965	034933	GTX_281	15	12/Nov/05	299.69	209.59	16/Nov/05 04:22
1966	984311	PD0045	5	12/Nov/05	102.67	99.59	16/Nov/05 06:09
1967	984311	JDYE_6	10	10/Nov/05	251.99	222.37	30/Nov/05 05:55
1968	343371	TL121_281	1	02/Dec/05	2040.72	2040.72	04/Dec/05 00:56
1969	953534	GTX_281	1	03/Dec/05	21.59	NULL	NULL

Figure A2: TBL_Customers

CustomerID	Member	CustomerName	Address1	Address2
343371	Y	Andrews	123 Abel Ave	London
034933	Y	Ling Wing	6 Princes Street	Hong Kong
984311	N	Hutton	564 Holly Road	Manchester
953534	N	Rivers	80 Grange Way	Glasgow

Figure A3 shows flights that SWIFT has advertised on its web site.

Figure A3 TBL_Flights

OfferNo	AirlineID	FlightCode	Operating Cost	Seating Capacity	Flight Time	FlightDate
1004	B&G	BG_8971	20119.56	102	12:23	01/Dec/05
1005	B&G	GTX_281	19012.59	261	16:34	14/Nov/05
1006	JH Price	TL121_2	2033.59	100	00:56	17/Nov/05
1007	B&G	GTX_281	19012.59	260	04:22	16/Nov/05
1006	B&G	PD0045	21201.59	261	06:09	17/Nov/05
1008	JH Price	JDYE_6	22008.37	90	05:55	30/Nov/05
1009	B&G	JDYE_6	22008.37	100	11:23	30/Nov/05

Turn over]

BUSINESS RULES

BR1: When seats for the flights that depart on the same day to the same destination are sold out then the offer period terminates immediately.
BR2: Seats for all flights that are subject to the offer can only be purchased from 6 months prior to departure of the flight and up to 5 hours prior to departure.
BR3: Only customers who have completed an on-line registration form can purchase seats offered for sale from the SWIFT web site.
BR4: Most flights also carry cargo such as goods for export and the carrying of this cargo may reduce the seats that are offered for sale and the baggage allowance of passengers.