

B. Sc. Examination 2008

for External Students

**COMPUTING AND INFORMATION SYSTEMS AND
CREATIVE COMPUTING**

2910209 Database Systems

Western

Duration: 3 hours

Date and Time : Tuesday 6 May 2008 : 2.30 – 5.30 pm

This paper consists of **5** questions. Each question carries **25** marks. Answer only **4** of them. You may choose **any 4** questions. Full marks will be awarded for **complete** answers to **4** questions.

The mark carried by each part is printed within square brackets. **Gauge the time to be spent on each part by the number of marks awarded.**

No calculators may be used.

THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM

1. An airline's database needs to record information about its PASSENGERs, AIRCRAFT, FLIGHTs and TRIPs.

FLIGHTs are identified by Flight Numbers. Each flight has a Departure City and a Destination City, a Take-off Time and an Arrival Time, and a First-Class-Ticket-Price and an Economy-Class-Ticket-Price.

A PASSENGER is given a unique Customer-Number, has a Family-Name and First-Name, and an (optional) Credit-Card Number.

A PASSENGER can book one or more FLIGHTs, each for a specific Date. A given FLIGHT on a particular Date is called a TRIP. Each TRIP will have many PASSENGERs, and one Pilot. A PASSENGER's booking of a trip will be for a given class of ticket. A given FLIGHT is in one direction between two cities. (Return journeys have different Flight Numbers.)

For example, FLIGHT 034 takes place between London and Edinburgh, takes off at 6.30 am on Monday through Friday, and is always made by an Airbus 320. (The airline owns several Airbus 320 AIRCRAFT, and any one of them may be used on this FLIGHT on a particular date.)

An AIRCRAFT will be a certain Model (such as an Airbus 320), be identified by a unique Plane-Number, have a certain number of First-Class Seats and a certain number of Economy-Class Seats. (These may differ slightly from AIRCRAFT to AIRCRAFT, even among AIRCRAFT of the same model.)

PASSENGER P2094 booked an Economy-Class seat on FLIGHT 056 for the 28th of December 2003. On this TRIP he was allocated Seat B in Row 24. The AIRCRAFT used for that TRIP was Plane-Number 23, an Airbus 330, flown by Captain Marie Suddin, whose Employee Number is P345.

A. Draw an Entity/Relationship Diagram that expresses the relationships among the entity types described above. Show the attributes of each entity type.

[9 marks]

B. Design a fully normalized relational schema that can capture the data relationships expressed in your Entity-Relationship diagram. Be sure to indicate the primary and foreign keys of each relation

[16 marks]

[Total: 25 marks]

2. An aircraft maintenance company holds all information about the servicing of its clients' airplanes in a single table. The table records which mechanic has worked on which aircraft, and the date that the mechanic worked on it. Mechanics are identified by their employee numbers (such as M0001), and aircraft are identified by unique registration numbers, such as B832. A given mechanic only works on one aircraft on a given day, but that aircraft may have more than one mechanic working on it that day. This table also records, for each aircraft, what model it is, and how many passengers (in addition to the pilot) that model holds (its 'capacity'). (For instance, Apaches have a capacity of four passengers, while Cubs hold two.) From the table shown below we are able to see which mechanic worked on which aircraft and on what date; what model a particular aircraft is; and what the capacity of that model is.

A partial "snapshot" of this relation might look like the following:

MECHANIC	AIRCRAFT	DATE	MODEL	CAPACITY
M0001	B832	21-12-98	Apache	4
M0001	C720	22-12-98	Aerostar	6
M0001	B502	23-12-98	Cub	2
M5672	B832	21-12-98	Apache	4
M8341	B832	21-12-98	Apache	4
M8341	B437	22-12-99	Hawk	8

A. Identify the Functional Dependencies in this table.

[3 marks]

B. This table is susceptible to update, deletion, and modification anomalies. Give an example, based on the table, of each kind.

[6 marks]

C. Bring the data in this table to BCNF, specifying the Primary Keys of each new table, and showing the extension of the resulting relations.

[9 marks]

D. Write brief definitions of **seven** of the following terms, as they apply to relational databases, illustrating your answer with reference to an example where possible.

- (1) Determinant
- (2) Entity integrity
- (3) Degree
- (4) Functional dependency
- (5) Tuple
- (6) Candidate key
- (7) Composite (or concatenated) Key
- (8) Cardinality
- (9) Attribute
- (10) Foreign Key

[7 marks]

[Total: 25 marks]

3. The following tables are a medical database, recording treatments of patients with drugs, in a hospital.

DOSE

PATIENTNUM	DRUGCODE	DOSEDATE	QUANTITY
P4	D5	01.02.2007	8
P2	D6	12.07.2007	4
P4	D5	10.09.2007	5
P1	D1	02.10.2007	3
P7	D1	20.10.2007	6
P8	D6	05.11.2007	2
P4	D6	30.11.2007	2
P4	D6	02.01.2008	8
P1	D6	03.03.2008	5
P4	D2	01.04.2008	3
P1	D6	05.05.2008	2
P8	D2	31.05.2008	1
P4	D1	05.06.2008	7

DRUG

DRUGCODE	DNAME	UNIT	DOI	COST
D1	Tarazan	Tab	20.04.1997	9.15
D2	Dorodene	Mg	12.03.2001	12.00
D5	Phenobarbitol	Mg	10.07.1998	3.89
D6	Enthomycin	Tab	04.09.2005	4.90
D7	Dactyl	Mg	05.08.1999	4.75

PATIENT

PATIENTNUM	PNAME	TITLE	DOB	GP
P3	Brown	Mrs	13.05.1971	Dr Chang
P7	Rafferty	Mr	25.06.1964	Dr Ives
P2	Currie	Mrs	03.01.1965	Dr McVay
P8	Adad	Mr	12.04.1983	Dr Hammadi
P4	Adad	Mrs	13.06.1979	Dr Hammadi
P1	Popper	Miss	03.08.1979	Dr Chang

Construct queries in SQL to carry out the following tasks:

1. List the details of all the drugs in the database.
2. Get the drug names of all drugs in the database together with their code numbers.
3. Retrieve the names of all drugs whose unit is a tablet (Tab).
4. Get drug numbers (DRUGCODE) of drugs in tablet form that cost more than £5.50 each.

(question continues on next page)

5. List the patient numbers of patients who have Dr Hammadi, Dr Ives or Dr McVay as their GP.
6. Get the patient names of Dr Hammadi's patients who have been given drug D6.
7. Find the patient names of patients who have been given drugs costing more than £8.50 per unit.
8. Find the total quantity of drug D6 prescribed by the hospital.
9. Get the total quantities of each of the drugs that have been prescribed.
10. Get the total quantities of each of the drugs that have been prescribed in 2008.

[20 marks]

- B.**
- (1) Allow user M01 to read the table PATIENT, but to do nothing more to it.
 - (2) Allow read, insert and update privileges on the table PATIENT to users M02 and M03.

[5 marks]

[Total: 25 marks]

4. A. In the context of database processing, what do we mean by a "transaction"? Why do we need the concept of a "transaction"? How is "transactional integrity" enforced in SQL?

[8 marks]

- B. In some database systems we must permit more than one transaction to access the same data at the same time. However, if one, or both, of these transactions can change the data being accessed, problems can arise. Describe the problem known as the "Lost Update" problem. Describe how it can be prevented. (Your answer should distinguish between shared and exclusive locks.)

[10 marks]

- C. Record-locking by transactions can result in new problems. If, for example, two transactions each want access to the same two records, a situation called "deadlock" can occur. Describe how this might happen, and briefly describe at least one method for dealing with it.

[7 marks]

[Total: 25 marks]

5. A. Briefly describe horizontal fragmentation. When might it be implemented? Assume that the relation below (Staff), of which four example tuples have been shown here, has about 100,000 tuples, of which about 500 have the Role of Manager, and the rest have the role of Employee. Assume that almost all queries on this relation include either the clause "Where Role = Manager" or the clause "Where Role = Employee". Use this relation as an example, and show how it might be horizontally fragmented to speed up answers to these queries. What possible disadvantages are there to horizontal fragmentation?

Staff

Primary Key: Employee-Num

Employee-Num	Surname	FirstName	Role	Birthdate
13641098	Ahn	Charles	Manager	23-10-60
64193649	Pilger	Susan	Employee	12-09-81
47901636	Fahy	Paul	Employee	09-12-85
55134177	Siddiqi	Mohammed	Manager	15-02-73

[8 marks]

- B. In the context of a database, what is a "view"? When might we want to define a "view"? Are there any problems involved in updating views?

[6 marks]

- C. Demonstrate how a query optimiser can increase the efficiency of query execution in a distributed database where a query involving a selection and a join must unite tuples from two different relations located at different geographical locations. Illustrate your answer with an example of your own devising.

[7 marks]

- D. What do we mean by the terms "data replication," and "replication independence" in the context of a distributed database? Why do we sometimes replicate data in a distributed database?

[4 marks]

[Total: 25 marks]

END OF EXAMINATION