

Jm0013

OLLSCOIL NA hÉIREANN  
NATIONAL UNIVERSITY OF IRELAND, GALWAY  
SEMESTER II EXAMINATIONS 1997/98

Masters in Information Technology

**DATABASE SYSTEMS**

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Time allowed: **Three hours**

Answer *both* questions from section A and *any* TWO questions from Section B.

**Section A**

- Q.1.** i) Discuss the procedures involved in database design. Your answer should include a description of conceptual modelling, mapping to relational schema, transactional analysis and considerations associated with choice of keys and index mechanisms.
- ii) With respect to distributed database design, discuss *briefly* the factors that determine fragmentation and replication policies.
- iii) Relations are usually normalised to reduce the possibility of certain data anomalies arising. Describe and illustrate when de-normalisation is appropriate.
- iv) With respect to view creation, explain the advantages gained and the procedure involved. Outline also how certain difficulties may arise.
- Q.2.** i) Explaining the main components of the relational database model. Your answer should include descriptions of data structures, operators and integrity constraints.
- ii) Given the following relational schema and interpretation, develop SQL queries to satisfy the information needs listed before:

**Schema:**

DEPARTMENT:	<u>No</u>	Name	Head	Location
COURSE:	<u>Code</u>	Name		
STUDENT:	<u>ID</u>	day	month	year name CrseCode
SUBJECT:	<u>Code</u>	Name	Hours	
PREREQ:	<u>PreCode</u>	<u>SubjCode</u>		
TAKES:	<u>Idno</u>	<u>s code</u>	year	term grade
OFFERS:	<u>Dno</u>	<u>Crscode</u>		
PART_OF:	<u>Crscode</u>	<u>SubCode</u>		

**Interpretation:**

Keys are underlined>.

Departments offer courses. Courses may be offered by more than one department. Each course comprises a number of subjects (some of which have pre-requisites). Students take a number of subjects in a given year and term and receive a grade (a percentage). Each student is registered for a course.

- a) Find the name of all courses offered by departments with location "Sc. Building".
  - b) Find the name of all subjects offered by a department with name "Maths".
  - c) For all courses which offered by more than one department, list all subjects (name and code) comprising those courses.
  - d) List all students who received a grade in CT202 greater than that received by a student named "John Smith".
  - e) Create a view listing all subjects and the average grade obtained in 1997.
- iii) Explain briefly heuristic optimisation of SQL queries.

**Section B**

- Q.3. i) Outline, briefly, the type of problems that may arise in a database system with no concurrency control.
- ii) With respect to schedules of transactions, explain the term *serializability*. Investigate if the following schedule is serializable.

<i>Transaction 1</i>	<i>Transaction 2</i>	<i>Transaction3</i>
	read_item(Z)	
	read_item(Y)	
	write_item(Y)	
		read_item(Y)
		read_item(Z)
read_item(X)		
write_item(X)		
		write_item(Y)
		write_item(Z)
	read_item(X)	
read_item(Y)		
write_item(Y)		
	write_item(X)	

- iii) Timestamping and the two phase locking protocol (with shared and exclusive locks) are two common techniques used for concurrency control. Choose either technique and apply it to the above schedule.

- Q.4.**
- i) Explain the importance of using indexes in databases systems.
  - ii) Outline briefly a hashing technique that may be used to access a dynamically expanding /contracting file.
  - iii) Describe the advantages gained by using B+-trees. Outline an algorithm that may be used for insertion of values into a tree. Illustrate the algorithm by inserting a set of values into the tree.
- Q.5.**
- i) Explain the need for recovery control in database systems.
  - ii) Explain the use of the main entries in the system log.
  - iii) Outline briefly, recovery techniques for systems using:
    - a) immediate update protocol
    - b) deferred update protocol
  - iv) Given the following fragment from a system log in a system using the immediate update protocol, identify which operations will be undone and those which need to be redone.

(Note: T1, T2, T3, T4 are transaction identifiers; A, B, C are database variables)

```
[start_transaction, T1]
[read_item, T1, A ]
[read_item, T1, D ]
[write_item, T1, D, 20 ]
[commit, T1 ]
[checkpoint ]
[start_transaction, T2]
[read_item, T2, B ]
[write_item, T2, B, 12 ]
[start_transaction, T4]
[read_item, T4, B ]
[write_item, T4, B, 15 ]
[start_transaction, T3]
[write_item, T3, A, 30 ]
[read_item, T4, A ]
[write_item, T4, A, 20 ]
[commit, T4 ]
[read_item, T2, D ]
[write_item, T2, D, 25 ]
< CRASH >
```

- Q.6.**
- i) With respect to deductive databases, outline the differences between backward and forward chaining.
  - ii) With respect to distributed databases, explain the different types of data fragmentation and how they may be specified in the system catalog.
  - iii) Explain the use of the semi-join operator in distributed query evaluation.
  - iv) Outline a procedure that may be used to ensure the atomicity of transactions in a distributed database.