

Two hours

SECTION A AND SECTION B ARE COMPULSORY

**UNIVERSITY OF MANCHESTER  
SCHOOL OF COMPUTER SCIENCE**

Fundamentals of Databases

Date: Wednesday 23rd January 2013

Time: 14:00 - 16:00

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**The Paper is in THREE Sections**

**You must answer Section A, worth 10 marks**

**You must answer Section B, worth 10 marks**

**You must answer ONE of the two questions in Section C, worth 20 marks.**

**Use a SEPARATE answerbook for each SECTION.**

**The total examination mark is out of a possible 40**

**For full marks your answers should be concise as well as accurate, and must explicitly state any assumption you make.**

**Marks will be awarded for reasoning and method as well as being correct.**

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This is a CLOSED book examination

The use of electronic calculators is NOT permitted

## Section A

This section contains one question.  
You **MUST** answer it using a **SEPARATE** answerbook.

1. Consider a company that manufactures products and stores them as part of their stock of finished goods. When an order for an item in stock comes from a customer, the company retrieves the item and ships it to the customer along with an invoice.
  - a) Briefly explain why a transaction manager such as offered by classical DBMSs is essential in this scenario if the workings of the company are to be correctly reflected in the data they hold. (2 marks)
  - b) Although the company is not expecting a significant increase in its sales, they are keen to cut down on the time it takes to do all their backend processing resulting from sales volume. As such, they are keen to invest in more processing power for that purpose. One of your colleagues has said that “it is wise indeed to scale up”. Briefly explain whether you agree with your colleague and why. (2 marks)
  - c) Assume that when an item is shipped, it can happen that it is posted to the customer in parts (because each part is sent to a different address). In the database, the company wants to record the address to which each part is sent, but there is no natural way of uniquely identifying each part. In terms of conceptual modelling, what kind of entity type is *Part* and what kind of attribute is the *deliveryAddress* of a part? (2 marks)
  - d) Assume two relation schemas

Dept(deptId, deptName, budget)

and

Emp(empId, name, dept)

where dept is a foreign key referencing deptId in Dept. Draw an expression tree that corresponds to the following SQL query:

```
SELECT  e.name, d.deptName
FROM    Emp e, Dept d
WHERE   d.deptId = e.dept AND d.budget > 3 ;
```

(4 marks)

**Section B**

This section contains one question.  
You MUST answer it using a SEPARATE answerbook.

2. a) Briefly explain the concept of transaction and the properties that characterise it. (3 marks)
- b) Briefly state the difference between PL/SQL and SQL and cite one expressive advantage of PL/SQL over SQL. (2 marks)
- c) Briefly explain what is an index and what it is for. (1 mark)
- d) Briefly describe the three different types of single-level index. (2 marks)
- e) Briefly explain what is a log file, in what type of device it is stored, and why this is needed. (2 marks)

**Section C**

Answer one of the two questions in this section.  
Use a SEPARATE answerbook for the question you choose.

3. Consider the following (partial) requirements for a company database:

- R1** An employee has a unique national insurance (NI) number, a name and a salary.
- R2** A department has a unique department id, a name and a budget.
- R3** There are several buildings, uniquely identified by their address, with the capacity of each building also being stored.
- R4** An employee must work in a single department, a department may have many employees (and must have at least one) that work in it.
- R5** A department may be located in more than one building (and must be located in at least one).
- R6** A building must have an occupant department, and may have more than one department occupying (parts of) it.
- R7** It is crucial to know in which location an employee works.

- a) Draw an entity-relationship diagram that captures the requirements above.  
(10 marks)
- b) Assume that each entity type and each relationship type in your answer above is mapped to a relation. Now, write a SQL query that computes the average salary per building (i.e., taking into account only the employees that work in each building).  
(4 marks)
- c) Under the same assumptions about the logical schema that were used in the question immediately above, show with a sequence of assignments how to retrieve the names of departments that occupy either the 25 Oxford Road or the 10 Market Street buildings.  
(4 marks)
- d) Once more, under the same assumptions about the logical schema that were used in the questions immediately above, consider the retrieval request to return the names of departments that occupy one or the other of two buildings. Assume that there are  $B$  tuples in the relation that stores information about buildings and  $D$  tuples in the relation that stores information about departments.. A colleague of yours stated that the number of tuples in the result is at most equal to  $B$ . State whether you agree with your colleague and briefly explain why you believe your colleague is right or wrong.  
(2 marks)

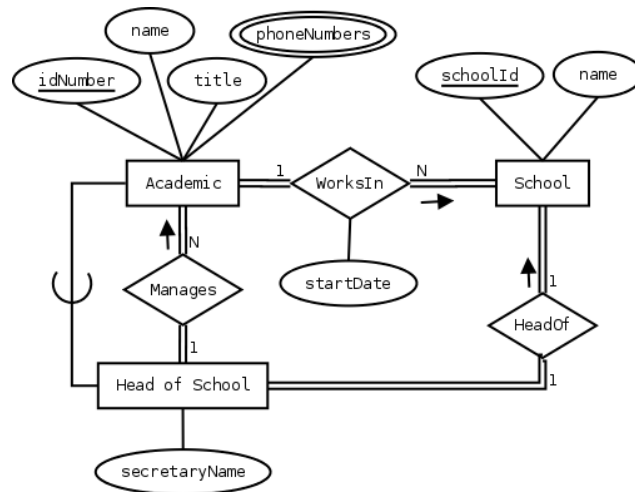
4. a) Consider the following relation (whose key is the set of underlined attributes) from a database containing information about employees and projects:

$\text{EmpProj}(\text{Emp}\#, \text{Proj}\#, \text{EmpName}, \text{ProjName}, \text{Hours\_Worked})$

State whether the above relation schema facilitates the process of updating the information held in the database about employees and projects and justify your answer (either with an argument that no update anomalies arise or else with an example of an update anomaly that does arise).

(3 marks)

- b) Map the ER diagram shown below into a relational schema and indicate the primary key and the foreign key (or keys) for each relation stating, for each foreign key, what relation the foreign key depends on.



(8 marks)

- c) Given the relation  $R(A, B, C, D, E, F)$  and the following set  $\Phi$  of functional dependencies:

$$\Phi = \{A \rightarrow \{B, C\}, \{C, D\} \rightarrow \{E, F\}, B \rightarrow E\}$$

State three other non-trivial functional dependencies that can be derived from  $\Phi$  explicitly indicating which inference rule you used to derive each functional dependency.

(3 marks)

- d) From your experience of the real world, briefly explain when you would use hashing and when you would use indexing.

(6 marks)