UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE AND ENGINEERING

COMPUTER SCIENCE THREE

DATABASE SYSTEMS

Thursday 31 May 2001

14:00 to 15:30

Examiners:

K. Turner (External)

G. Plotkin (Chairman)

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

1. (a) The *reflexivity*, *augmentation*, and *transitivity* rules are sound and complete with respect to the deduction of new functional dependencies from a given set of functional dependencies. Specify these three rules. [*5 marks*]

   (b) Consider the following two sets F and G of functional dependencies:

$$F = \{A \to C,\ AC \to D,\ E \to H\}$$
$$G = \{A \to CD,\ E \to AH\}$$

   Are the sets F and G equivalent? Show clearly how you obtained your answer. [*5 marks*]

   (c) Let $R = \{A,\ B,\ C,\ D,\ E,\ F,\ G,\ H,\ I,\ J\}$ be a relational schema. Consider the following set S of functional dependencies over R:

$$S = \{AB \to C,\ BD \to EF,\ AD \to GH,\ A \to I,\ H \to J\}$$

   For each of the following, draw the appropriate dependency graphs to justify your solution.

   (i) What is the key for R? [*5 marks*]

   (ii) Decompose R into second normal form (2NF) relations. [*7 marks*]

   (iii) Further decompose R into third normal form (3NF) relations. [*3 marks*]

2. (a) Briefly describe the three layers of the ANSI/SPARC database architecture model and explain the two levels of data independence afforded by the model. [*5 marks*]

(b) A relational database contains two tables `EMP` and `DEPT` with information about employees and departments respectively. Consider the following SQL query, noting that it contains a nested subquery:

```
SELECT D.NAME
FROM DEPT D
WHERE D.DEPTNO IN
  (SELECT E.DEPTNO
   FROM EMP E
   WHERE JOB = 'CLERK');
```

(i) State in English the information requested in this query. [*2 marks*]

(ii) Rewrite the query so that it does not use a subquery. [*4 marks*]

(c) Describe the following SQL features, providing a scenario where each would be used.

(i) Views. [*2 marks*]

(ii) Indexes. [*2 marks*]

(iii) Transactions. [*2 marks*]

(d) Give an example of the *phantom* problem, explaining the consequences for transaction isolation. [*4 marks*]

(e) There are two different ways in which *object* and *relational* databases can be combined. Briefly explain the two approaches. [*4 marks*]

3. (a) Explain what is meant by the *atomicity of changes* for a transaction and how it is enforced in a database system. [*5 marks*]

(b) The two-phase locking (2PL) protocol can prevent transactions from interfering with one another.

(i) Briefly describe the *basic* 2PL protocol. [*3 marks*]

(ii) 2PL guarantees serializability. Explain what it means for a set of transactions to be *conflict-serializable.* [*4 marks*]

(iii) Using an example, explain what may go wrong if a transaction does not obey the 2PL protocol. [*8 marks*]

(c) One method for resolving *deadlock* between transactions is to select some 'victim' transactions and abort them.

(i) How can such deadlocks be detected? [*2 marks*]

(ii) Describe a technique for deadlock avoidance, and state any disadvantages of the chosen technique. [*3 marks*]