CS258

THE UNIVERSITY OF WARWICK

Second Year Winter Examinations 2015/16

Database Systems

Time allowed: 2 hours

Answer **FOUR** questions out of six.

Read carefully the instructions on the answer book and make sure that the particulars required are entered on **each** answer book.

Calculators are not required and not permitted.

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1. Consider the COMPANY schema diagram in Figure 1 overleaf.

   (a) Give an example of a database state that violates one of the key constraints expressed by the COMPANY schema. [3]

   (b) Can deletions ever cause a violation of a key uniqueness constraint? Justify your answer. [3]

   (c) Write SQL code to create the following views.

      i. A view named RES that lists the last names of all employees in the 'Research' department. [3]

      ii. A view named PRO1 that provides the following details for every project: project number, project name and the number of employees employed by the department that controls the project. [6]

      iii. A view named PRO2 that reports the following details for each project: project number and the number of employees who do *not* work on the project but who work on a different project controlled by the same department. [10]

   Total mark for this question: 25

Continued

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Figure 1: COMPANY schema diagram

Continued

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2. Write the following queries in SQL for the COMPANY database of Figure 1.

   (a) Retrieve all locations of Department No. 1. [5]

   (b) List without any repetitions the first names of all departmental managers. [5]

   (c) Retrieve the name of the department that controls Project No. 10 along with the address of its manager. [5]

   (d) Retrieve the department numbers of all departments in which every employee is female. [5]

   (e) For all departments with both male and female employees, list the department number followed by the total number of employees. [5]

   Total mark for this question: 25

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3. Specify the following queries for the COMPANY database (Figure 1) in relational algebra.

   (a) Retrieve the birth dates of all male employees. [6]

   (b) Retrieve the names of all dependants of people working on Project No. 8. [6]

   (c) For every project located in Warwick, list the project number, the number of the controlling department along with the manager's last name. [6]

   (d) Retrieve the numbers of all projects such that all employees from Department No. 7 work on them. [7]

   Total mark for this question: 25

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4. (a) What is the difference between a key and a superkey? [3]

   (b) Consider the relation schema PERSON($No, Name, Location, Age$) and the relation state given below. Identify potential superkeys of PERSON.

No	*Name*	*Location*	*Age*
2	John	Bath	28
7	Conrad	York	45
8	John	Bath	28
2	John	Kent	35
7	Helen	York	31

   [10]

   (c) Suppose $X_1 \to Y_1$ and $X_2 \to Y_2$. Which of the following dependencies are true? Justify your answers with proofs or counterexamples.

$$X_1 \cap X_2 \to Y_1 \cap Y_2 \qquad X_1 \cup X_2 \to Y_1 \cap Y_2 \qquad X_1 \cup X_2 \to Y_1 \cup Y_2$$

   [6]

   (d) Consider the relation schema REL($Att1, Att2$). Characterise all valid database states under the assumptions dom($Att1$) = dom($Att2$) = `INTEGER`, $Att1 \to Att2$ and $Att2 \to Att1$. [6]

Total mark for this question: 25

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5. Consider the following relation schema:

   SONG($Singer, Genre, ReleaseDate, Title, ShortTitle, ReleaseYear, ReleasePlace$),

   where $\{Singer, Title\}$ is the primary key. Assume the following additional dependencies:

$$Singer \to Genre,$$
$$ReleaseDate \to ReleaseYear,$$
$$Title \to ShortTitle.$$

   (a) Based on the primary key, determine whether this relation is in 1NF, 2NF, 3NF. [9]

   (b) Perform any normalisation steps required to bring it into 3NF. [16]

Total mark for this question: 25

Continued

6. (a) List the six steps of the heuristic algebraic optimisation algorithm. [12]

   (b) Apply the optimisation algorithm to the following query.

```
SELECT Fname, Lname, Salary
FROM EMPLOYEE, WORKS_ON, PROJECT
WHERE Pno=Pnumber AND Ssn=Essn AND Pname='Product X';
```

   [6]

   (c) A file of 2016 blocks is to be sorted with an available buffer space of 10 blocks. How many passes will be needed in the merge phase of the external sort-merge algorithm? [4]

   (d) What are the benefits of pipelining over materialised evaluation? [3]

Total mark for this question: 25

End