

B6.

- a) Explain what is meant by referential integrity. **(3 marks)**
- b) What is the consequence of the SQL clause 'ON DELETE CASCADE'? **(3 marks)**
- c) Consider the following unnormalised table. Using the example table shown below, illustrate the process of normalisation by showing the resultant tables when placed in 1st, 2nd and 3rd Normal Form.

Software Engineering Projects - Unnormalised								
Project Number	Project Name	Project Start	Employee Number	Employee Name	Job Class	Cost/hour	Hours on Project	Total Charge
155	Big Data	Jun-19	103	Smith	Dev	£105.00	23	£2415.00
			101	Cook	Dev	£105.00	12	£1260.00
			106	Bloggs	Analyst	£300.00	23	£6900.00
165	Web App	Jan-19	114	Blue	Prog	£250.00	45	£11275.00
			103	Smith	Dev	£105.00	45	£4725.00
			101	Cook	Dev	£105.00	3	£315.00
178	Admin	Oct-15	103	Smith	Dev	£105.00	12	£1260.00
			106	Bloggs	Analyst	£300.00	12	£3600.00
			109	Red	Leader	£200.00	1	£200.00

(19 marks)

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DATABASE SYSTEMS

Wednesday 12th May 2021 - Morning

Answer **any** FOUR questions out of SIX. All questions carry equal marks.

Time: TWO hours.

Answer any Section A questions you attempt in Answer Book A
Answer any Section B questions you attempt in Answer Book B

The marks given in brackets are **indicative** of the weight given to each part of the question.

Calculators are **NOT** allowed in this examination.

End of Examination

Section A
Answer Section A questions in Answer Book A

A1.

- a) E. F. Codd proposed a Relational data model that presents the database as a set of Relations.

Define the following relational terms and comment on the differences between these terms and the way that data is represented in a flat file.

- i) Tuple;
- ii) Attribute;
- iii) Domain;
- iv) Relation;
- v) Primary Key.

(10 marks)

- b) Logical/Physical data independence is an important characteristic supported by a Relational database system.

Explain why Logical and Physical data independence is important.

(7 marks)

- c) Concurrency control of transactions is another important characteristic supported by a Relational database system.

Describe the so-called ACID properties of transactions and explain why they are important in concurrency control.

(8 marks)

B5.

Consider the following two tables and answer the questions below.

Employee

ID	Name	LastName	DepName
1	Archie	Allan	Accounts
2	Berta	Blue	Sales
3	Charlie	Church	Customer Service
4	Archie	Elephant	Sales
5	Archie	Miller	

Department

DepName	Manager
Accounts	1
Sales	4
Customer Service	3

- a) Write SQL Data Definition Statements to create the two tables above. Choose suitable data types. Ensure that suitable keys are defined.

(10 marks)

- b) Write an SQL query that finds the Name of all Employees who are not Managers.

(3 marks)

- c) Consider the following relational algebra queries and create matching SQL queries for the Employee and Department tables.

i) $\pi (\sigma (\text{name=Archie}) \text{Employee})$

ii) $\text{Employee} \times \text{Departments}$.

(6 marks)

- d) Consider the following SQL queries and create matching relational algebra queries.

i)

```
SELECT Name, LastName
FROM Employee E LEFT JOIN Departments D
ON E.DepName = D.DepName;
```

ii)

```
SELECT DepName FROM Employee;
```

(6 marks)

Section B
Answer Section B questions in Answer Book B

B4.

Consider the following scenario for a garage selling and servicing cars and answer the questions in parts (a) and (b) below. The following rules describe the garage in more detail. A customer engages with the garage either as a buyer or by having their car(s) serviced (or both).

- i) A salesperson may sell many cars, but each car is sold by only one salesperson.
- ii) Each salesperson or mechanic has a name and last name. Cars have a number plate, make and model as well as registration year. Customers have a first and last name as well as an address.
- iii) A customer may buy many cars, but each car is bought by only one customer. A sale takes place on a specific date.
- iv) A salesperson writes a single invoice for each car he or she sells.
- v) A customer receives an invoice for each car he or she buys.
- vi) When a customer takes one or more cars in for repair or service, one service ticket is written for each car. A service takes place on a specific date and customers receive comments on what has been done.
- vii) A car brought in for service can be worked on by many mechanics, and each mechanic may work on many cars. Each mechanic spends a certain amount of time on a job, called an assignment, and has an associated rate.

- a) Draw an entity relationship diagram for the Car Dealership scenario using a suitable notation. Your answer must show the entities and their relationships. Cardinalities and optionality between entities **MUST** be shown. State any additional assumptions you are making.
(14 marks)
- b) Design a set of tables derived from the Entity-Relationship Diagram in part (a). Highlight **ALL** primary and foreign keys and show a few rows of sample data (no more than four rows per table).
(11 marks)

A2.

- a) Describe the main recovery techniques that many DBMS (Database Management Systems) provide to safeguard and protect data as a result of **EACH** of the following events:
- i) Human Error: an employee may unintentionally delete some data or may have used a routine that has modified the data unknowingly in a way that would cease the DBMS from interacting with the database effectively.
 - ii) Network failure where a connection of a database to a shared network has been interrupted.
 - iii) Database software failure: this might be the result of the DBMS crashing unexpectedly.
 - iv) Media Failure with possible loss of all or some data.
 - v) National catastrophe such as an earthquake or flood meaning the entire operation of the host DBMS is lost.
- (15 marks)**
- b) Describe the security measures and precautions that a DBA (Database Administrator) must have in place to prevent the database from being subject to hacking, for example, someone trying to steal data.
(5 Marks)
- c) A data dictionary holds information that is crucial for the correct operation of a database. If the data dictionary is lost, the database cannot operate.

Describe the contents of a typical data dictionary.

(5 marks)

[Turn Over]

A3.

Refer to the EMP (Employee) and DEPT (Department) Tables supplied below (Fig A3.1 FigA3.2).

Fig A3.1 EMP (Employee) table:

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7934	MILLER	CLERK	7782	23-JAN-12	1300		10
7782	CLARK	MANAGER	7839	09-JUN-19	2450		10
7839	KING	PRESIDENT		17-NOV-11	5000		10
7369	SMITH	CLERK	7902	17-DEC-18	800		20
7876	ADAMS	CLERK	7788	12-JAN-13	1100		20
7566	JONES	MANAGER	7839	02-APR-14	2975		20
7788	SCOTT	ANALYST	7566	09-DEC-18	3000		20
7902	FORD	ANALYST	7566	03-DEC-18	3000		20
7900	JAMES	CLERK	7698	03-DEC-18	950		30
7654	MARTIN	SALESMAN	7698	28-SEP-16	1250	1400	30
7521	WARD	SALESMAN	7698	22-FEB-17	1250	500	30
7844	TURNER	SALESMAN	7698	08-SEP-12	1500	0	30
7499	ALLEN	SALESMAN	7698	20-FEB-16	1600	300	30
7698	BLAKE	MANAGER	7839	01-MAY-19	2850		30

Fig A3.2 DEPT (Department) table:

DEPTNO	DNAME	LOC
10	ACCOUNTING	NEW YORK
20	RESEARCH	DALLAS
30	SALES	CHICAGO
40	OPERATIONS	BOSTON

a) Show the data that would be returned when executing the following SQL statement (code sample 1) and then briefly explain how SQL supports and processes the extraction of data from more than one table.

Code Sample 1

```
SELECT ename AS EMPLOYEE
       ,sal AS SALARY
       ,loc AS LOCATED_IN
FROM emp e JOIN dept d
ON e.deptno = d.deptno
AND loc IN ('NEW YORK', 'DALLAS')
```

(7 marks)

b) Explain the effect of the following changes to code sample 1:

i) Append a new line to the statement as follows

```
ORDER BY loc, sal
```

ii) Replace JOIN with RIGHT JOIN

(6 marks)

c) Show the data that would be returned when executing the following SQL statement (code sample 2). The statement is designed to return the departments that have more than two employees with a salary greater than 1400. Briefly explain how the SQL statement is processed in order to return aggregated and summarised data when using aggregate functions and the GROUP BY clause:

Code Sample 2

```
SELECT d.deptno
       ,COUNT(*)
FROM dept d JOIN emp e
ON d.deptno = e.deptno
AND e.sal > 1400
GROUP BY d.deptno
HAVING COUNT(*) > 2
```

(8 marks)

d) Study the two following SQL statements shown in code sample 3, with their respective outputs and explain why the two statements give differing results:

Code Sample 3

```
(i) SELECT d.deptno
      ,d.dname
      ,e.sal
      ,e.ename
FROM dept d LEFT JOIN emp e
ON e.deptno = d.deptno
AND e.sal > 3000
```

DEPTNO	DNAME	SAL	ENAME
10	ACCOUNTING	5000	KING
20	RESEARCH		
30	SALES		
40	OPERATIONS		

```
(ii) SELECT d.deptno
       ,d.dname
       ,e.sal
       ,e.ename
FROM dept d LEFT JOIN emp e
ON e.deptno = d.deptno
WHERE e.sal > 3000
```

DEPTNO	DNAME	SAL	ENAME
10	ACCOUNTING	5000	KING

(4 marks)

[Turn Over]