

**DATABASE SYSTEMS**

Thursday 6<sup>th</sup> October 2022 – Morning

**B6.**

The brass band association has asked for a database. They need to manage bands and their members, as well as the pieces played by members. Consider the scenario below and answer the questions in part a) and b) below.

The following rules describe the scenario:

- A band has a name and a location (e.g. the town they are based in).
- A band has one or more members.
- Band association rules prescribe that each member can only play in one band.
- A member has a name and a date when they joined the band.
- Each member plays one or more instruments.
- Each instrument is played by one or more members (e.g. there could be a number of tubas in the band).
- Each instrument has a name and a key (in the musical sense: e.g. Bb).
- Music is organised in pieces, where each piece has a name and composer.
- Each piece needs a number of instruments, and obviously each instrument can be used in a number of pieces.
- A piece might have a single solo instrument.
- An instrument can occur in many pieces as a solo.

a) Create an entity relationship diagram for the scenario provided using a suitable notation. Your answer must show entities with their attributes and their relations (including cardinality and optionality).

**(17 marks)**

b) Using your diagram from part a), design a set of tables. Clearly identify all primary and foreign keys.

**(8 marks)**

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.** Read the following scenario and then answer the question parts that follow:

**Scenario**

An Exam Processing System (EPS), uses Spreadsheets to process the marking of examinations taken by around 1000 students. Each student can take up to 5 examinations on topics such as Software Engineering; Web Development; Databases.

A spreadsheet file is initially populated with names and ids of students who sat a particular exam.

An examiner then inputs the marks awarded for each question a student attempts and the total mark for all questions attempted by a student is calculated

The following sample data contains a set of marks for around 50 students who took an exam in Software Engineering:

<i>StudentID</i>	<i>StudentName</i>	<i>Mark1</i>	<i>Mark2</i>	<i>Mark3</i>	<i>Mark4</i>	<i>Total</i>
<i>C1243</i>	<i>Masali</i>	<i>14</i>	<i>22</i>	<i>25</i>	<i>20</i>	<i>81</i>
<i>C1245</i>	<i>Jotu</i>	<i>10</i>	<i>10</i>	<i>12</i>	<i>5</i>	<i>37</i>
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<i>C1299</i>	<i>Keswani</i>	<i>22</i>	<i>18</i>	<i>18</i>	<i>11</i>	<i>69</i>

a) **Data Independence** is regarded as one of the most important characteristics of a Relational Database approach to data management.

Explain why data independence is important and explain how EPS could benefit from data independence if a centralised database approach were to be adopted.

**(8 marks)**

b) Apart from Data Independence, describe **THREE** further characteristics of a centralised database approach to data and explain how the EPS would benefit from such an approach.

**(12 marks)**

c) Discuss the drawbacks of EPS adopting a centralised database approach.

**(5 marks)**

d) Consider the following relational algebra statement and tables. Show the table of results after execution of the query on the given tables.

$\Pi_{\text{customers.customername, orders.orderid}}(\text{customers} \bowtie_{\text{customers.customerid=orders.customerid}} \text{Orders})$

Customers:

<b>CustID</b>	<b>CustName</b>	<b>City</b>
1	Joe Bloggs	London
2	Jane Smith	Berlin
3	Peggy Blue	New York

Orders:

<b>OrderID</b>	<b>CustID</b>	<b>OrderDate</b>
999	2	12/12/2021
998	50	12/12/2021
997	51	13/12/2021

**(5 marks)**

[Turn Over]

**B5.**

- a) Define the following concepts and provide an example for each:
- i) Table **(2 marks)**
  - ii) Entity **(2 marks)**
  - iii) One-to-one relationship **(2 marks)**
  - iv) Trivial Functional Dependency. **(2 marks)**
- b) Explain the concept of the two aspects of data independence and discuss their importance. **(7 marks)**
- c) Relational algebra provides a mathematical foundation to relation databases.

Consider the following SQL statements and provide the Relational Algebra equivalent:

- i) 

```
SELECT student.name
       ,course.name
       ,stcrs.grade
FROM student
   ,course
   ,stcrs
WHERE course.name='databases'
```

**(2 marks)**
- ii) 

```
SELECT Orders.OrderID
       ,Customers.CustomerName
FROM Orders INNER JOIN Customers
ON Orders.CustomerID = Customers.CustomerID
```

**(3 marks)**

**A2.**

Refer to Fig A2 showing data in an Employee table

**Fig A2 Employee Table**

<u>EmployeeID</u>	EmployeeName	HourlyRate	HoursWorked PerWeek	Department
231	Jones	34.00	35	BIOTECH
232	Mathews	22.00	37.5	HR
233	Kohli	55.00	30	HR
234	Kane	8.50	37.5	MECH
235	White	27.50	43	ENG
236	Black	28.00	40	BIOTECH

- a) Write a SQL statement that will output the name of the employee, their employee ID and their weekly salary for each employee in the Biotech department. **(3 marks)**
- b) Write a SQL statement that demonstrates the effect of the `GROUP BY` clause. Use the `Employee` table to source an example. **(4 marks)**
- c) The SQL statement specified in part a) can be used to form a View.
- i) Write a SQL statement that creates the View and show how the View is invoked. **(3 marks)**
  - ii) Explain why retrieving data from a view might be more convenient than retrieving the data from a view's underlying base table(s). **(4 marks)**
- d) Describe **THREE** further benefits of using views in database applications. Use examples to illustrate your answer. **(6 marks)**
- e) Explain how the nature and use of a Stored Procedure differs from a view. **(5 marks)**

[Turn Over]

**A3.**

a) Describe each of the following activities that are performed in database technology:

- Database backup
- Database recovery
- Database restore.

**(6 marks)**

b) A Database Management System (DBMS) is now an integral part of many web-based applications that are supported and deployed on 3-tier computer architectures consisting of database server, web/application server and client/web browser.

i) Describe **ONE** of the main benefits of a 3-tier architecture compared with a 1- and 2-tier architecture.

**(3 marks)**

ii) Describe the role and function of each tier and explain how a DBMS interacts to support the data processing tasks of a typical web based application.

**(7 marks)**

iii) Explain how the following concepts contribute to maintaining safe and secure access to data in a web database application:

- Confidentiality
- Authentication
- Data integrity.

**(9 marks)**

**Section B**  
**Answer Section B questions in Answer Book B**

**B4.**

Consider the following table from a student record system and answer the questions below:

StudNo	CourseID	StudName	CourseName	Grade	Staff	StaffPhone
1234	CO98	Ali Baba	Programming 1	A	Bloggs	111
2345	CO98	Rapunzel	Programming 1	B	Bloggs	111
3456	CO87	Snowwhite	Databases	B	Doe	222
3456	CO98	Snowwhite	Programming 1	F	Bloggs	111

a) State the Normal form of the table (e.g. it is in unnormalised form, 1<sup>st</sup> Normal form, 2<sup>nd</sup> Normal form or 3<sup>rd</sup> Normal form) and justify your answer by highlighting the relevant properties the table fulfils.

**(4 marks)**

b) Convert the table into 3<sup>rd</sup> Normal Form.

**(8 marks)**

c) Write the SQL create table statements required to create the set of 3<sup>rd</sup> NF tables identified in part b). Ensure that suitable data types are given and that referential integrity constraints are included.

**(8 marks)**

d) When deleting data from a table, a problem called the delete anomaly might occur. Describe the problem using examples and explain how good database design and SQL allows you to avoid this.

**(5 marks)**

[Turn Over]