BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

DATABASE SYSTEMS

Thursday 7th October 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.

Section A
Answer Section A questions in Answer Book A

A1

a) Define 'data validation' and explain why it is important**.**

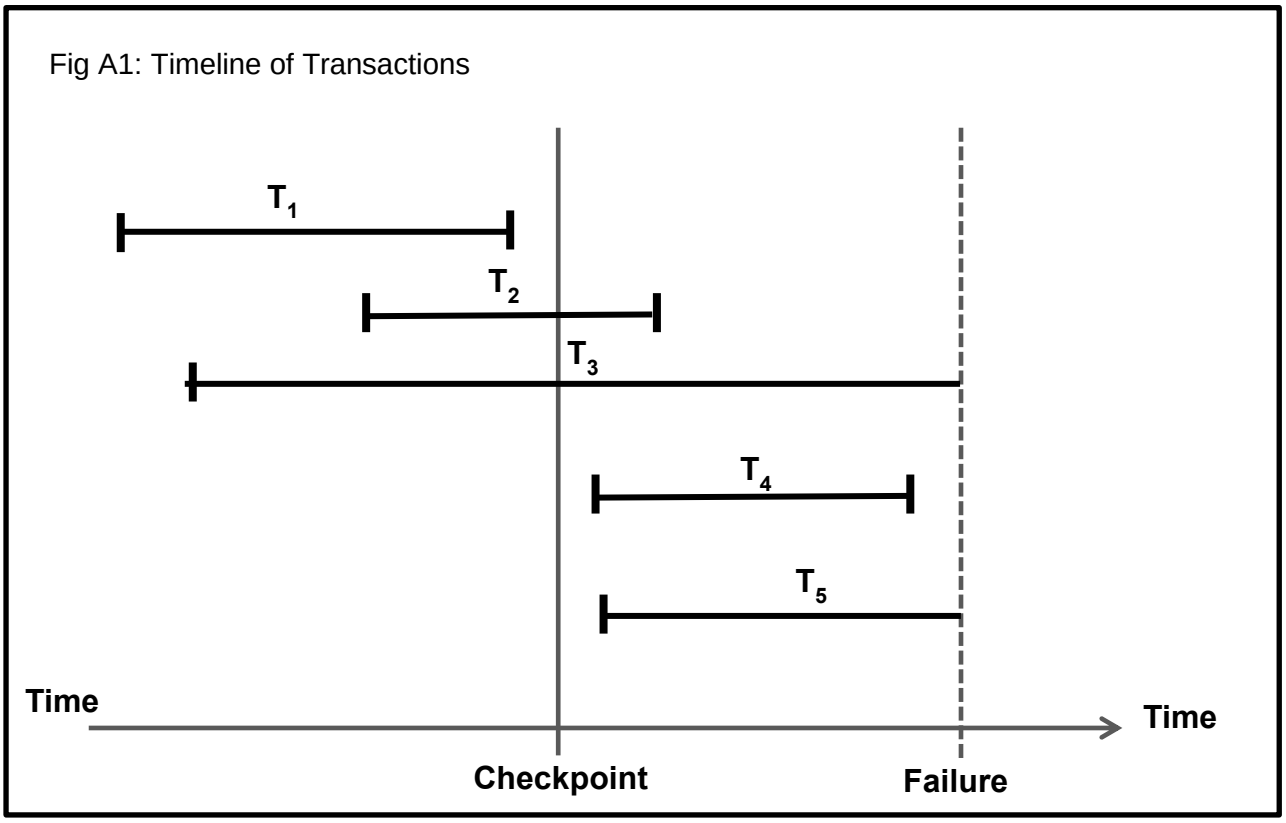
(4 marks)

b) Describe **SIX** types of validation checks that can be carried out when data is entered into a database table.

(6 marks)

c) Consider the following graph (Fig A1) showing the timelines of five transactions T1, T2, T3, T4 and T5. Note that transactions T3 and T5 are not yet finished and have no end stop.

Fig A1: Timeline of Transactions



With reference to FigA1, explain the processing steps required to recover the database from the point of failure back to a consistent state.

(9 marks)

d) Using the following example (a sequence of SQL statements), explain how the commands, `COMMIT`, `ROLLBACK`, and `SAVEPOINT` would recover a database when a transaction fails.

```
INSERT INTO TEACHERS VALUES (1, 'Database Theory','Thomas');
INSERT INTO TEACHERS VALUES (2, 'SQL', 'Sammi');
INSERT INTO TEACHERS VALUES (3, 'Data Modelling','Thomas');
INSERT INTO TEACHERS VALUES (4, 'SQL', 'Michel');
INSERT INTO TEACHERS VALUES (5, 'Python', 'Stella');
INSERT INTO TEACHERS VALUES (6, 'Python', 'Gordon');
INSERT INTO TEACHERS VALUES (7, 'Java', 'Conn')
```

(6 marks)

A2

DCL statements such as `GRANT` and `REVOKE` are part of the SQL language that enforces database security.

Refer to the following SQL statements for this question:

```
CREATE USER 'paul' IDENTIFIED BY 'abc123';
CREATE USER 'rob'  IDENTIFIED BY 'sawyer';
GRANT SELECT,INSERT ON employee TO 'paul';
GRANT ALL PRIVILEGES ON employee TO 'rob';
GRANT CREATE ROLE TO 'paul';
CREATE ROLE secretary IDENTIFIED BY password;
```

a) In terms of access to the database and its data, what is a `PRIVILEGE`? Explain the function of the `GRANT` statements shown above.

(5 marks)

b) What is a database `ROLE`? Explain how roles help to manage database security.

(5 marks)

c) What is a database `VIEW`? Explain using an example how views can be an alternative to a `GRANT` in restricting access to data.

(4 marks)

d) Explain how you would revoke one of the privileges granted to user `'rob'`.

(2 marks)

e) Discuss techniques and precautions needed to ensure that only authorised users can access a database.

(4 marks)

f) To protect data, backups of the database are used. What measures should be taken to ensure a backup is secure and protected?

(5 marks)

[Turn Over]

A3

Refer to the following Department and Employee tables (Fig A3.1, A3.2) and the supplied SQL script (Fig A3.3):

Fig A3.1 Department Table

DEPTID	DEPTNAME	LOCATION
44	HQ	LONDON
45	IT	LEEDS
46	HR	MANCHESTER

Fig A3.2 Employee Table

EMPID	EMPNAME	JOB	SALARY	SUPERVISOR	DEPTID
1	TAN	MGR	3500		45
3	JONES	MGR	4000		45
4	SMITH	PA	2000	3	45
5	ALI	CLERK	500	6	45
6	ALI	SECRETARY	1000	3	45
7	SAR	MGR	4500		46
8	PATEL	CLERK	1000	4	45
9	BRIEN	RECEPTIONIST	1000	7	46
10	WU	PA	4500		46

Fig A3.3 SQL script

```
CREATE TABLE employee(
     empid INT,
     empname VARCHAR(20),
     job VARCHAR(12),
     salary DECIMAL(9,2),
     supervisor INT,
     deptid INT);

CREATE TABLE department(
     deptid INT,
     deptname VARCHAR(9),
     location VARCHAR(12));

INSERT INTO employee VALUES(1, 'TAN', 'MGR', 4000.00, NULL, 45);
INSERT INTO employee VALUES(3, 'JONES', 'MGR', 6000.00, NULL, 45);
INSERT INTO employee VALUES(4, 'SMITH', 'PA', 2000.00, 3, 45);
INSERT INTO employee VALUES(5, 'ALI', 'CLERK', 500.00,6, 45);
INSERT INTO employee VALUES(6, 'ALI', 'SECRETARY', 1000.00, 3, 45);
INSERT INTO employee VALUES(7, 'SAR', 'MGR', 6500.00, NULL, 46);
INSERT INTO employee VALUES(8, 'PATEL', 'CLERK', 1000.00, 4, 45);
INSERT INTO employee VALUES(9, 'BRIEN','RECEPTIONIST', 1000.00,7,46);
INSERT INTO employee VALUES(10, 'WU', 'DIR', 3500, NULL,46);

INSERT INTO department VALUES(44, 'HQ' , 'LONDON');
INSERT INTO department VALUES(45, 'IT' , 'LEEDS');
INSERT INTO department VALUES(46, 'HR' , 'MANCHESTER');
```

a) Explain the concepts of Entity Integrity and Referential Integrity.

(6 marks)

b) Explain why a referential integrity constraint should be imposed between the `employee` and `department` tables.

(3 marks)

c) Write `ALTER TABLE` SQL statements that could be added to the end of the supplied script (Fig A3.3) to name and apply entity and referential integrity constraints to the **existing populated** `department` and `employees` tables.

(8 marks)

d) Determine and show the output that the following SQL query (Fig A3.4) produces when run against the tables Fig A3.1 and Fig A3.2 above. Give full details of how you have arrived at your answer.

(8 marks)

Fig A3.4 SQL query

```
SELECT empname
      ,salary
FROM employee
WHERE job <> 'MGR'
AND deptid IN (SELECT deptid
               FROM department
               WHERE deptname = 'HR')
               AND salary > (SELECT AVG(salary)
                             FROM employee
                             WHERE job = 'MGR');
```

[Turn Over]

Section B
Answer Section B questions in Answer Book B

B4

Consider the layered schema approach for database management systems with physical schema, logical schema and external schema.

a)

i) Illustrate a three schema architecture showing in which layer **views**, **relations**, and **files/indexes** are introduced/designed.

(3 marks)

ii) With reference to your figure, explain the concept of physical independence.

(4 marks)

iii) Provide **THREE** reasons why data independence is desirable.

(3 marks)

b) Explain how data is physically stored and accessed in the following approaches.

i) Operating system flat files;

(5 marks)

ii) Relational databases;

(5 marks)

iii) Object-oriented database.

(5 marks)

B5

a) Outline the key steps in the database design process, which will lead from a problem/requirements description given by a client to a suitable database design.

(8 marks)

b) Define the following concepts and provide an example for each:

i) Entity;

(2 marks)

ii) Redundant relationship;

(2 marks)

iii) One to one relationship;

(2 marks)

iv) Recursive relationship;

(2 marks)

v) Primary key.

(2 marks)

c) Explain the concepts of **database partitioning** and **table partitioning** and provide detailed reasons for the importance of partitioning of data?

(7 marks)

B6

Consider the following scenario and answer the questions in part a) and b) below. The following rules describe the scenario:

- A cottage has an address and a number of available rooms
- A client has a name and address
- A client can make none, one or many bookings
- A cottage can be booked by one or many clients or have no bookings yet
- A booking has a start and end date and a discount might apply to a booking
- A cottage has a cost to rent (its price), which can vary over time
- A price applies from a specific date to a specific date
- A facility (such as a fire place or a balcony) has a descriptor
- Each cottage has a number of facilities

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

(15 marks)

b) Using your design from part a) design a set of tables. Clearly identify all primary and secondary (candidate) keys and show **up to THREE** rows of data in each of your proposed tables.

(10 marks)

End of Examination