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**TECHNOLOGICAL UNIVERSITY DUBLIN**  
CITY CAMPUS

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TU856/DT228 BSc in Computer Science  
TU857/DT211C BSc in Computer Science (Infrastructure)  
TU858/DT282 BSc in Computer Science (International)  
Year 4

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SUPPLEMENTAL EXAMINATIONS 2021/2022

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**Advanced Databases**

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***Instructions***

**Answer any FOUR questions.**

**All questions carry equal marks.**

1. (a) (i) Explain *FOUR* (4) key characteristics of a data warehouse.

(4 marks)

- (ii) Briefly compare a data warehouse and operational DBMS considering data design, data structure and access pattern.

(5 marks)

- (b) A painting and decorating company (DPC) undertakes a range of tasks for corporate clients and supplies the products used during tasks e.g., paint, sealant etc.). Consider the following ER Schema (primary keys are underlined, foreign keys are indicated by the suffix (FK)):

**Client**(clientId, clientName, clientAddress, phone, email, contact\_person)

**PaintingStaff**(staffId, first\_name, last\_name)

**Painting\_task**(taskId, clientId (FK), startTime, endTime, staffId (FK), success\_or\_fail)

**Product**(productId, productName, unit, pricePerUnit)

**Product\_supplied**(psId, productId (FK), taskId (FK), units)

**Product\_offered**(poId, productId (FK), taskId (FK), units)

**Product\_writtenoff**(woId, woDate, productId (FK), units, wo\_reason)

**Product\_on\_order**(orderId, productId (FK), suppId (FK), units)

**Supplier**(suppId, suppName, suppAddress, phone, email, contact\_person)

DPC can undertake many tasks for a client. Each client nominates a contact person, but this may change over time. For each task, DPC recommends a number of products to the client (product\_offered) and records the products the client actually selects (product\_supplied). When a task is completed, the client indicates whether they were satisfied with the service or not. DPC maintains a store of products they use and regularly needs to dispose of products that are no longer usable. This represents a loss to DPC and details are recorded (product\_writtenoff). Products need to be replaced regularly. Details of any orders placed with suppliers are recorded (product\_on\_order). DPC would like to be able to generate reports on their annual performance.

Provide an example of how denormalization could be applied to this schema to achieve *FOUR* (4) possible benefits of denormalization.

(16 marks)

2. Consider the following trigger and data:

```
create or replace TRIGGER grade_update_control
BEFORE update ON studentgrade
FOR EACH ROW
DECLARE
    v_username varchar2(10);
    authorised VARCHAR2(1);
BEGIN
    SELECT user INTO v_username FROM dual;
    SELECT authorised_to_update INTO authorised
    FROM application_users WHERE app_user = v_username;

    IF :NEW.update_reason <> 'Correction' THEN
        RAISE_APPLICATION_ERROR(-20001, 'warning: grades cannot be increased without a valid reason');
    END IF;
    IF :NEW.update_reason = 'Correction' and authorised='N' THEN
        RAISE_APPLICATION_ERROR(-20002, 'warning: User not authorised to update grades');
    END IF;
END;
```

studentgrade			
student_id	student_marks	student_module_name	update_reason
1	40	OOP Programming	Created
2	65	OOP Programming	Created
3	80	OOP Programming	Created

application_users	
app_user	authorised_to_update
aTutor	N
aTeacher	Y

(a) Explain what a trigger is and how triggers can be used in a relational DBMS.

(7 marks)

(b) Is the trigger provided above a row level or statement level trigger? Justify your answer.

(2 marks)

Question 2 continues on the next page

2. (c) Given the trigger and data provided, explain what would happen in each of the scenarios provided in the following table. Justify your answers.

SQL Statement	Executed By
update studentgrade set student_marks=60, update_reason='Correction' where student_id=1;	aTutor
update studentgrade set student_marks=60, update_reason='Error' where student_id=2;	aTeacher
update studentgrade set student_marks=60, update_reason='Correction' where student_id=1;	aTeacher

(3 x 2 marks)

- (d) Write a trigger to ensure that whenever a student grade record is updated, a record is created in a grade\_audit table (student\_id, student\_module\_name, updatedby, updatetime). The identifier of the student and module of the record amended, the username that executed the SQL to update record, and the date and time at which the audit record was created should be recorded.

Note: You can retrieve the username from dual e.g. SELECT user FROM dual; SYSTIMESTAMP holds current date and time.

(10 marks)

3. (a) (i) Explain how each of the following works in Oracle's DBMS and when they would be used:

- a. Full Table scan
- b. Fast full index scan
- c. Index range scan

**(3 x 2 marks)**

- (i) Consider the following scenarios. For each, explain which type of scan listed in part (i) will be used by the Oracle DBMS and why:

- Suppose there are no constraints or indexes applied and the query `SELECT student_module_name, student_marks FROM studentgrade;` is executed.
- Suppose that `student_module_name`, and `student_marks` are a composite key in an index and the query `SELECT student_module_name, student_marks FROM studentgrade WHERE student_marks > 60 ORDER BY student_module_name;` is executed.
- Suppose the `student_module_name` column is indexed and the query `SELECT student_module_name FROM studentgrade WHERE student_module_name like '%Programming%';` is executed.

**(3 x 3 marks)**

- (b) You are requested to recommend a RAID solution for a medium sized online retail company. You have three possible choices:

1. RAID 10
2. RAID 5
3. RAID 0.

Briefly compare and contrast each option discussing for each storage efficiency, writing and reading performance and fault-tolerance level.

Make a recommendation, justifying your choice.

**(10 marks)**

4. (a) What is the *grain* in a dimensional model?

(3 marks)

- (b) An online beverage company requires a data warehouse to be designed to record the quantity and sales of its beers to its customers. Part of the original database is composed by the following tables:

**CUSTOMER** (Code, Name, Address, Phone)

**BEER** (Code, Name, Type, BottlePrice, CasePrice, Class)

**CLASS** (Code, Name, Region)

**TIME** (TimeStamp, Date, Year)

**ORDER** (Customer, Wine, Time, nrBottles, nrCases)

Produce a star schema for the above ER schema.

The star schema should support queries about quantity sold and total sales revenue.

Justify your choices (grain, facts and dimensions).

(17 marks)

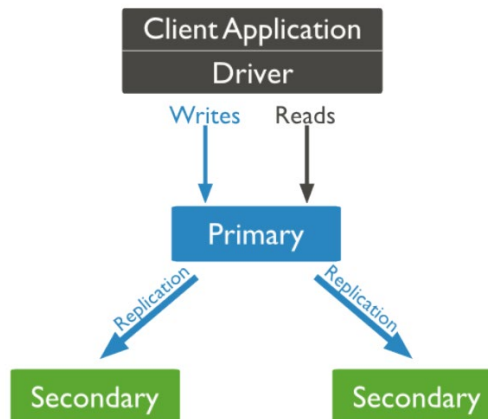
- (c) Write an SQL query to get the total quantity of beer sold for each region in 2020.

(5 marks)

5. (a) Describe the strengths of a Dimensional Model, addressing in particular the advantages a dimensional model offers over an ER model.

**(9 marks)**

- (b) Consider the figure provided below.



- (i) Explain the concept of replica set in MongoDB.

**(2 marks)**

- (ii) Discuss how a replica set operates in MongoDB under normal conditions and during a failover.

**(3 marks)**

- (iii) Explain the difference between “sharding” and “replication” in MongoDB.

**(2 marks)**

- (b) (i) Describe the ACID properties of a relational database

**(3 marks)**

- (ii) Describe the BASE properties of a NOSQL database.

**(3 marks)**

- (iii) Discuss the difference between the ACID and BASE and explain for which type of application the BASE approach is more suitable.

**(3 marks)**