CSA0562: DATABASE MANAGEMENT SYSTEMS-ASSIGNMENT QUESTIONS

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Question 1:

ER Diagram Question:

Traffic Flow Management System (TFMS) ER Diagram

TASKS

Task 1: Entity Identification and Attributes

Entities and Attributes:

1. ROADS

   Attributes:

   - RoadID (PK)
   - RoadName
   - Length (meters)
   - SpeedLimit (km/h)

2. INTERSECTIONS

   - Attributes:
   - IntersectionID (PK)
   - IntersectionName
   - Latitude
   - Longitude

3. TRAFFIC SIGNALS

   - Attributes:
   - SignalID (PK)

- SignalStatus (Green, Yellow, Red)

- Timer

4. TRAFFIC DATA

- Attributes:

- TrafficDataID (PK)

- Timestamp

- Speed (average speed on the road)

- CongestionLevel

Task 2: Relationship Modeling

Relationships:

1. Roads to Intersections

- Relationship: A road can be part of multiple intersections, and an intersection is formed by multiple roads.

- Cardinality: Many-to-Many

- Optionality: Mandatory (each intersection must be associated with at least one road)

2. Intersections to Traffic Signals

- Relationship: Each intersection can have multiple traffic signals.

- Cardinality: One-to-Many

- Optionality: Mandatory (each intersection must have at least one traffic signal)

3. Traffic Signals to Traffic Data

- Relationship: Traffic data is collected from sensors related to traffic signals.

- Cardinality: One-to-Many

- Optionality: Optional (traffic data may not always be available for every signal)

4. Roads to Traffic Data

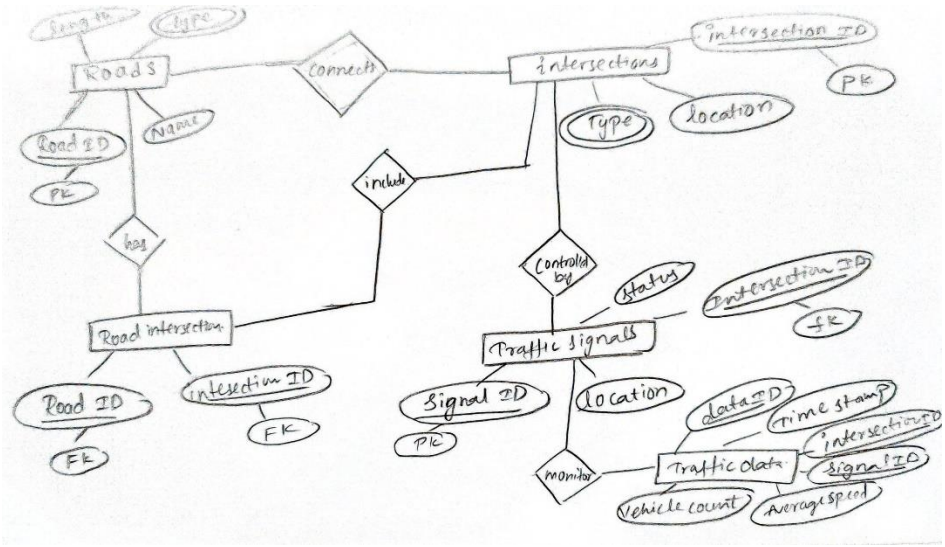
- Relationship:Traffic data is collected for each road.

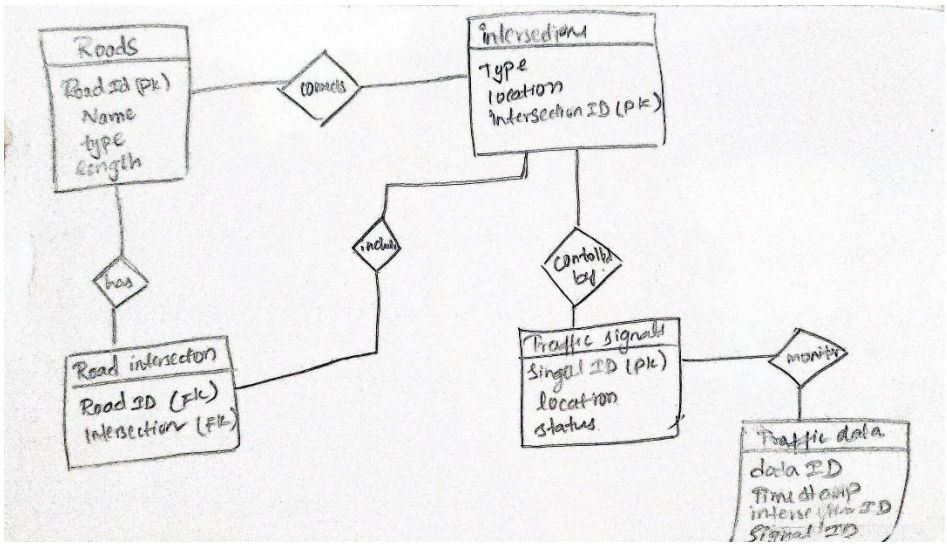
- Cardinality:One-to-Many

- Optionality: Optional (traffic data may not always be available for every road

Task 3: ER Diagram Design

Here's a simplified ER Diagram:





- Roads

- RoadID (PK)

- RoadName
- Length
- SpeedLimit

- Intersections
  - IntersectionID (PK)
  - IntersectionName
  - Latitude
  - Longitude

- Traffic Signals
  - SignalID (PK)
  - SignalStatus
  - Timer
  - IntersectionID (FK)

- Traffic Data
  - TrafficDataID (PK)
  - Timestamp
  - Speed
  - CongestionLevel
  - RoadID (FK)
  - SignalID (FK)

Relationships:

1. Roads to Intersections:
   - Many-to-Many (through a junction table, e.g., RoadIntersection)

2. Intersections to Traffic Signals:
   - One-to-Many (1 Intersection can have multiple Traffic Signals)

3. Traffic Signals to Traffic Data:

- One-to-Many (1 Traffic Signal can have multiple Traffic Data records)

4. Roads to Traffic Data:

- One-to-Many (1 Road can have multiple Traffic Data records)

Task 4: Justification and Normalization

1. Normalization Principles:

- 1NF (First Normal Form): Each table has a primary key, and attributes are atomic.

- 2NF (Second Normal Form): All non-key attributes are fully functional dependent on the primary key.

- 3NF (Third Normal Form): No transitive dependency (attributes are not dependent on other non-key attributes).

2. Design Justification:

- Scalability: The design supports adding new roads, intersections, and traffic signals without major schema changes.

- Real-Time Data Processing: Traffic Data entity captures real-time data for analysis and integration into traffic management algorithms.

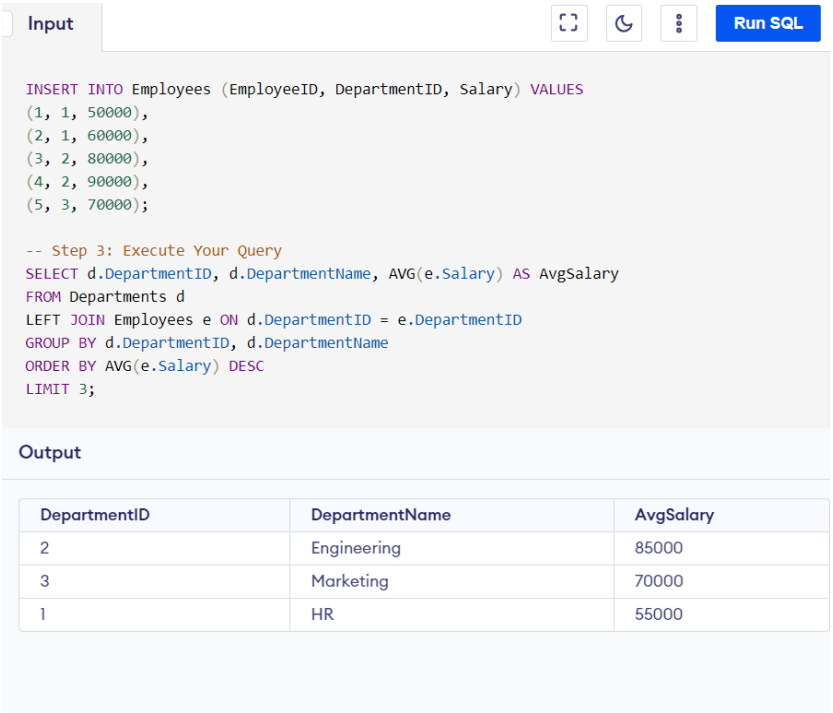
- Efficient Traffic Management: The relationships and attributes facilitate efficient retrieval and manipulation of data for route optimization and signal control.

Question 2:

SQL Queries

Question 1: Top 3 Departments with Highest Average Salary

```sql
SELECT d.DepartmentID, d.DepartmentName, AVG(e.Salary) AS AvgSalary
FROM Departments d
LEFT JOIN Employees e ON d.DepartmentID = e.DepartmentID
GROUP BY d.DepartmentID, d.DepartmentName
ORDER BY AVG(e.Salary) DESC
FETCH FIRST 3 ROWS ONLY;
```



Explanation:

- `LEFT JOIN` ensures departments with no employees show NULL for `AvgSalary`.

- `GROUP BY` groups data by department.

- `ORDER BY` sorts departments by average salary in descending order.

- `FETCH FIRST 3 ROWS ONLY` limits the result to the top 3 departments.

Question 2: Retrieving Hierarchical Category Paths

```sql
WITH RECURSIVE CategoryPaths AS (
    SELECT CategoryID, CategoryName, CAST(CategoryName AS VARCHAR(255)) AS Path
    FROM Categories
    WHERE ParentCategoryID IS NULL
    UNION ALL
    SELECT c.CategoryID, c.CategoryName, CONCAT(cp.Path, ' > ', c.CategoryName)
    FROM Categories c
    JOIN CategoryPaths cp ON c.ParentCategoryID = cp.CategoryID
)
SELECT CategoryID, CategoryName, Path
FROM CategoryPaths;
```

Input

Run SQL

```sql
INSERT INTO Categories (CategoryID, CategoryName, ParentCategoryID) VALUES
(1, 'Electronics', NULL),
(2, 'Computers', 1),
(3, 'Laptops', 2),
(4, 'Desktops', 2),
(5, 'Smartphones', 1),
(6, 'Cameras', 1),
(7, 'DSLR', 6),
(8, 'Mirrorless', 6);

-- Step 4: Execute Recursive CTE Query
WITH RECURSIVE CategoryPaths AS (
    SELECT CategoryID, CategoryName, CAST(CategoryName AS VARCHAR(255)) AS Path
    FROM Categories
    WHERE ParentCategoryID IS NULL
    UNION ALL
    SELECT c.CategoryID, c.CategoryName, cp.Path || ' > ' || c.CategoryName
    FROM Categories c
    JOIN CategoryPaths cp ON c.ParentCategoryID = cp.CategoryID
)
SELECT CategoryID, CategoryName, Path
FROM CategoryPaths;
```

Output

CategoryID	CategoryName	Path
1	Electronics	Electronics
2	Computers	Electronics > Computers
5	Smartphones	Electronics > Smartphones
6	Cameras	Electronics > Cameras
3	Laptops	Electronics > Computers > Laptops
4	Desktops	Electronics > Computers > Desktops
7	DSLR	Electronics > Cameras > DSLR
8	Mirrorless	Electronics > Cameras > Mirrorless

Explanation:

- `WITH RECURSIVE` defines a CTE that recursively builds the hierarchical path.

- The `UNION ALL` combines the base case with recursive case results.

- `CONCAT` builds the path from parent to child.

Question 3: Total Distinct Customers by Month

```sql
SELECT TO_CHAR(purchase_date, 'Month') AS MonthName,
    COUNT(DISTINCT customer_id) AS CustomerCount
FROM Purchases
WHERE EXTRACT(YEAR FROM purchase_date) = EXTRACT(YEAR FROM CURRENT_DATE)
GROUP BY TO_CHAR(purchase_date, 'Month')
ORDER BY TO_DATE(TO_CHAR(purchase_date, 'Month'), 'Month') ASC;
```

Input

Run SQL

```sql
CREATE TABLE Purchases (
    purchase_id INT PRIMARY KEY,
    customer_id INT,
    purchase_date DATE
);

-- Step 3: Insert Sample Data
INSERT INTO Purchases (purchase_id, customer_id, purchase_date) VALUES
(1, 101, '2024-01-15'),
(2, 102, '2024-01-20'),
(3, 101, '2024-02-15'),
(4, 103, '2024-03-25'),
(5, 104, '2024-03-30');

-- Step 4: Execute Your Query
SELECT strftime('%m', purchase_date) AS MonthNumber,
       strftime('%m', purchase_date) || ' - ' || strftime('%Y', purchase_date) AS MonthName,
       COUNT(DISTINCT customer_id) AS CustomerCount
FROM Purchases
WHERE strftime('%Y', purchase_date) = strftime('%Y', 'now')
GROUP BY strftime('%m', purchase_date)
ORDER BY MonthNumber;
```

Output

MonthNumber	MonthName	CustomerCount
01	01 - 2024	2
02	02 - 2024	1
03	03 - 2024	2

Explanation:

- `TO_CHAR` converts dates to month names.

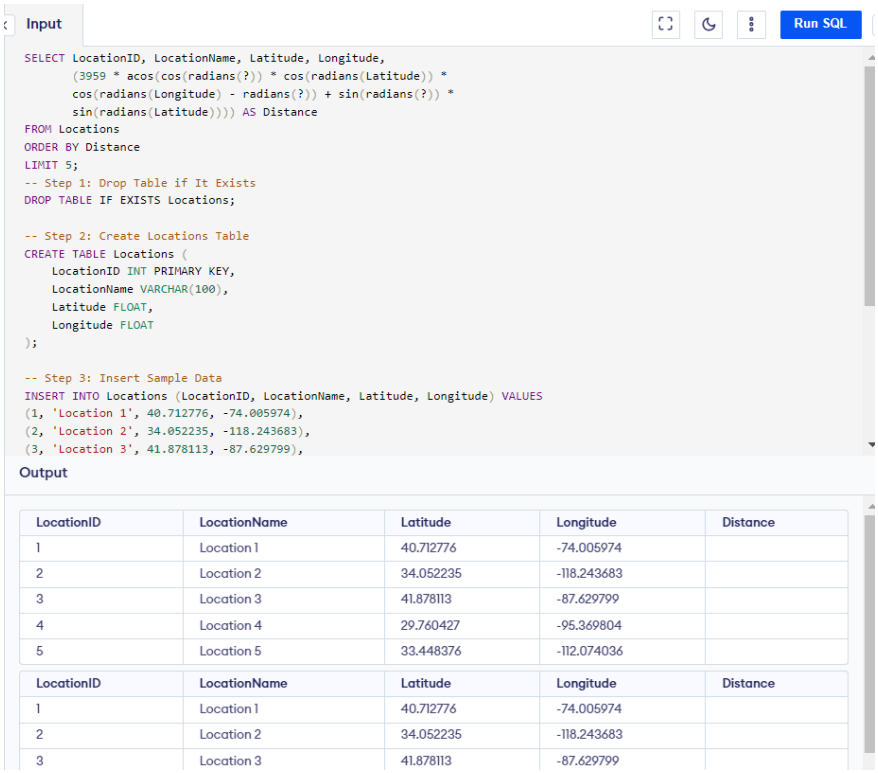
- `COUNT(DISTINCT customer_id)` counts unique customers.

- `EXTRACT` ensures only the current year's data is considered.

- `ORDER BY` sorts by month.

Question 4: Finding Closest Locations

```sql
SELECT LocationID, LocationName, Latitude, Longitude,
    (3959 * acos(cos(radians(:latitude)) * cos(radians(Latitude)) *
    cos(radians(Longitude) - radians(:longitude)) + sin(radians(:latitude)) *
    sin(radians(Latitude)))) AS Distance
FROM Locations
ORDER BY Distance
FETCH FIRST 5 ROWS ONLY;
```



Explanation:

- Haversine formula calculates distance between points.

- `:latitude` and `:longitude` are input parameters.

- `ORDER BY Distance` sorts locations by proximity.

Question 5: Optimizing Query for Orders Table

```sql
SELECT *
FROM Orders
WHERE OrderDate >= SYSDATE - INTERVAL '7' DAY
ORDER BY OrderDate DESC;
```

Input

Run SQL

```sql
-- Step 2: Create Orders Table
CREATE TABLE Orders (
    OrderID INT PRIMARY KEY,
    OrderDate DATE,
    CustomerID INT,
    Amount DECIMAL(10, 2)
);

-- Step 3: Insert Sample Data
INSERT INTO Orders (OrderID, OrderDate, CustomerID, Amount) VALUES
(1, DATE('now', '-1 day'), 101, 150.00),
(2, DATE('now', '-5 day'), 102, 200.00),
(3, DATE('now', '-8 day'), 103, 300.00),
(4, DATE('now', '-3 day'), 104, 100.00),
(5, DATE('now', '-7 day'), 105, 250.00);

-- Step 4: Execute Your Query
SELECT *
FROM Orders
WHERE OrderDate >= DATE('now', '-7 days')
ORDER BY OrderDate DESC;
```

Output

OrderID	OrderDate	CustomerID	Amount
1	2024-07-29	101	150
4	2024-07-27	104	100
2	2024-07-25	102	200
5	2024-07-23	105	250

Explanation:

- `SYSDATE - INTERVAL '7' DAY` retrieves orders from the last 7 days.

- `ORDER BY OrderDate DESC` sorts by the most recent orders.

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Question 3:

PL/SQL Questions

Question 1: Handling Division Operation

```plsql
DECLARE
    divisor NUMBER := &divisor_input;
    dividend NUMBER := &dividend_input;
    result NUMBER;
BEGIN
    IF divisor = 0 THEN
```

```
        DBMS_OUTPUT.PUT_LINE('Error: Division by zero is not allowed.');
    ELSE
        result := dividend / divisor;
        DBMS_OUTPUT.PUT_LINE('Result: ' || result);
    END IF;
EXCEPTION
    WHEN ZERO_DIVIDE THEN
        DBMS_OUTPUT.PUT_LINE('Error: Division by zero.');
END;
```

Explanation:

- Handles division by zero using an `IF` statement and `ZERO_DIVIDE` exception.
- `DBMS_OUTPUT.PUT_LINE` displays results or error messages.

Question 2: Updating Rows with FORALL

```plsql
DECLARE
    TYPE emp_id_array IS TABLE OF Employees.EmployeeID%TYPE;
    TYPE salary_array IS TABLE OF NUMBER;
    l_emp_ids emp_id_array := emp_id_array(101, 102, 103);
    l_salaries salary_array := salary_array(500, 600, 700);
BEGIN
    FORALL i IN INDICES OF l_emp_ids
        UPDATE Employees
        SET Salary = Salary + l_salaries(i)
        WHERE EmployeeID = l_emp_ids(i);
    COMMIT;
END;
```

Explanation:

- `FORALL` is used for bulk updates, enhancing performance by reducing context switches between SQL and PL/SQL.

Question 3: Implementing Nested Table Procedure

```plsql
CREATE OR REPLACE PROCEDURE GetEmployeesByDept(p_dept_id IN NUMBER, p_employees OUT SYS_REFCURSOR) AS
BEGIN
    OPEN p_employees FOR
        SELECT * FROM Employees WHERE DepartmentID = p_dept_id;
END;
```

Explanation:

- A procedure that retrieves employees based on department ID and returns them as a cursor.

Question 4: Using Cursor Variables and Dynamic SQL

```plsql
DECLARE
    TYPE emp_ref_cursor IS REF CURSOR;
    l_emp_cursor emp_ref_cursor;
    l_salary_threshold NUMBER := &salary_threshold;
BEGIN
    OPEN l_emp_cursor FOR
        'SELECT EmployeeID, FirstName, LastName
         FROM Employees
         WHERE Salary > :1'
        USING l_salary_threshold;
```

```
    -- Use l_emp_cursor as needed
    CLOSE l_emp_cursor;
END;
```

Explanation:

- Demonstrates use of REF CURSOR and dynamic SQL to query employees based on a salary threshold.

Question 5: Designing P

ipelined Function for Sales Data

```plsql
CREATE OR REPLACE FUNCTION get_sales_data(p_month IN NUMBER, p_year IN NUMBER)
RETURN sales_data_tab_type PIPELINED AS
BEGIN
    FOR rec IN (
        SELECT OrderID, CustomerID, OrderAmount
        FROM Orders
        WHERE EXTRACT(MONTH FROM OrderDate) = p_month
          AND EXTRACT(YEAR FROM OrderDate) = p_year
    ) LOOP
        PIPE ROW (rec);
    END LOOP;
END;
```

Explanation:

- `PIPELINED` function allows efficient processing of large datasets by returning rows incrementally.

DELIVERABLES

1. ER Diagram:

   - Provides a visual representation of the TFMS entities, attributes, and relationships.

2. Entity Definitions:

   - Clear descriptions of each entity and their attributes.

3. Relationship Descriptions:

   - Details of relationships between entities, including cardinality and optionality.

4. Justification Document:

   - Explanation of design choices, normalization adherence, and considerations for efficiency and scalability.