Expanded SQL Concepts with Explanations and Examples

1. Index in SQL:

An index is a database object that improves the speed of data retrieval operations on a table. It is created on one or more columns of a table. Indexes are especially useful for queries that filter using WHERE, or sort using ORDER BY.

Advantages:

- Speeds up SELECT queries.

- Helps maintain uniqueness with UNIQUE indexes.

Disadvantages:

- Takes up additional space.

- Slows down INSERT, UPDATE, DELETE operations because the index needs to be updated.

Example:

CREATE INDEX idx_name ON Students(Name);

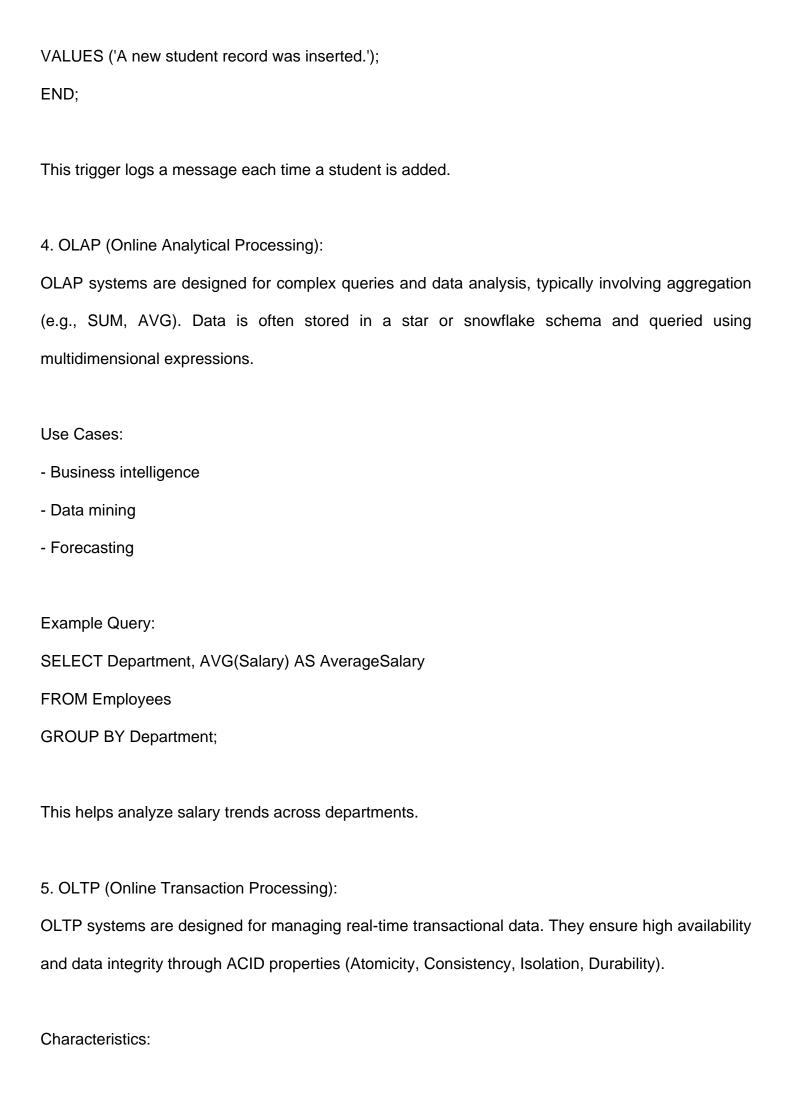This creates an index on the Name column to speed up name-based searches.

2. Stored Procedure:

A stored procedure is a precompiled collection of SQL statements stored in the database and executed as a single unit. It allows reusability and modular code structure.

Benefits:

- Improved performance due to precompilation.

- Helps in code reuse and encapsulation.

- Enhances security by restricting direct table access.

Example:

```
CREATE PROCEDURE GetStudentsByGrade(@Grade CHAR(1))
AS
BEGIN
SELECT * FROM Students WHERE Grade = @Grade;
END;
```

Execution:

```
EXEC GetStudentsByGrade 'A';
```

3. Trigger in SQL:

Triggers are special procedures that are automatically executed when a specific event occurs in a table. Common events include INSERT, UPDATE, DELETE.

Use Cases:

- Auditing changes to a table.

- Enforcing business rules.

- Maintaining derived values automatically.

Example:

```
CREATE TRIGGER trg_after_insert_student
ON Students
AFTER INSERT
AS
BEGIN
INSERT INTO LogTable (Message)
```

```
VALUES ('A new student record was inserted.');

END;
```

This trigger logs a message each time a student is added.

4. OLAP (Online Analytical Processing):

OLAP systems are designed for complex queries and data analysis, typically involving aggregation (e.g., SUM, AVG). Data is often stored in a star or snowflake schema and queried using multidimensional expressions.

Use Cases:

- Business intelligence

- Data mining

- Forecasting

Example Query:

```
SELECT Department, AVG(Salary) AS AverageSalary

FROM Employees

GROUP BY Department;
```

This helps analyze salary trends across departments.

5. OLTP (Online Transaction Processing):

OLTP systems are designed for managing real-time transactional data. They ensure high availability and data integrity through ACID properties (Atomicity, Consistency, Isolation, Durability).

Characteristics:

- Fast query processing

- High concurrency

- Frequent updates

Example Query:

BEGIN TRANSACTION;

INSERT INTO Orders (OrderID, CustomerID, OrderDate) VALUES (1001, 'C100', GETDATE());

COMMIT;

This processes a new order transactionally to ensure consistency.

Summary of OLAP vs OLTP:

- OLAP: Used for complex data analysis, slower but analytical.

- OLTP: Used for daily operations, faster but with simple queries.