

Database Systems

Lab 5: View, Trigger, Store Procedure, Function, Cursor

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1 Introduction

This lab report covers the implementation of Views, Triggers, Stored Procedures, Functions, and Cursors in MySQL. The exercises are based on the COMPANY database schema and a Hotel reservation system.

1.1 Database Schema: COMPANY

The COMPANY database consists of the following tables:

- EMPLOYEE - Employee information
- DEPARTMENT - Department information
- DEPT_LOCATIONS - Department locations
- PROJECT - Project information
- WORKS_ON - Employee-Project assignments
- DEPENDENT - Employee dependents

2 Views

Exercise: Specify the following views in SQL on the COMPANY database schema:

- a. A view that has the department name, manager name, and manager salary for every department.
- b. A view that has the employee name, supervisor name, and employee salary for each employee who works in the 'Research' department.
- c. A view that has the project name, controlling department name, number of employees, and total hours worked per week on the project for each project.
- d. A view that has the project name, controlling department name, number of employees, and total hours worked per week on the project for each project with more than two employees working on it.
- e. A view (SSN, Full Name of employee, Number of dependents) that includes information about employees who have the number of dependents greater than 2.
- f. A view (Full Name of employee, date of birth, gender) for those employees who have their birthdate in July.
- g. A view (Name of dependent, SSN of employee, date of birth of dependent) that includes information on all dependents who are less than 18 years old.

2.1 View (a): Department Manager Information

Requirement: A view that has the department name, manager name, and manager salary for every department.

```

1 DROP VIEW IF EXISTS DepartmentManagerInfo;
2 CREATE VIEW DepartmentManagerInfo AS
3 SELECT
4     d.Dname AS Department_Name ,
5     CONCAT(e.Fname, ' ', e.Minit, ' ', e.Lname) AS Manager_Name ,
6     e.Salary AS Manager_Salary
7 FROM DEPARTMENT d
8 JOIN EMPLOYEE e ON d.Mgr_ssn = e.Ssn;
```

Explanation: This view joins the DEPARTMENT and EMPLOYEE tables using the manager's SSN to retrieve the department name, manager's full name (concatenated), and the manager's salary.

Test Validation

```

1 -- Query the view
2 SELECT * FROM DepartmentManagerInfo;
```

Expected Output:

The screenshot shows a database interface with a title bar 'DepartmentManagerInfo'. Below it is a toolbar with various icons for search, export, and navigation. The main area displays a table with three columns: 'Department_Name' (varchar(25)), 'Manager_Name' (varchar(33)), and 'Manager_Salary' (decimal(10,2)). The data rows are: Headquarters (James E Borg, 55000.00), Administration (Jennifer S Wallace, 43000.00), and Research (Franklin T Wong, 40000.00). The total number of rows is 3.

| Department_Name | Manager_Name | Manager_Salary |
|-----------------|--------------------|----------------|
| Headquarters | James E Borg | 55000.00 |
| Administration | Jennifer S Wallace | 43000.00 |
| Research | Franklin T Wong | 40000.00 |

2.2 View (b): Research Department Employees and Supervisors

Requirement: A view that has the employee name, supervisor name, and employee salary for each employee who works in the 'Research' department.

```

1 DROP VIEW IF EXISTS ResearchEmployeeSupervisor;
2 CREATE VIEW ResearchEmployeeSupervisor AS
3 SELECT
4     CONCAT(e.Fname, ' ', e.Minit, ' ', e.Lname) AS Employee_Name,
5     CONCAT(s.Fname, ' ', s.Minit, ' ', s.Lname) AS Supervisor_Name,
6     e.Salary AS Employee_Salary
7 FROM EMPLOYEE e
8 LEFT JOIN EMPLOYEE s ON e.Super_ssn = s.Ssn
9 JOIN DEPARTMENT d ON e.Dno = d.Dnumber
10 WHERE d.Dname = 'Research';

```

Explanation: This view uses a self-join on the EMPLOYEE table to get supervisor information, with a LEFT JOIN to handle employees without supervisors. The WHERE clause filters for the Research department.

Test Validation

```

1 -- Query the view
2 SELECT * FROM ResearchEmployeeSupervisor;

```

Expected Output:

The screenshot shows a database interface with a title bar 'ResearchEmployeeSupervisor'. Below it is a toolbar with various icons for search, export, and navigation. The main area displays a table with three columns: 'Employee_Name' (varchar(33)), 'Supervisor_Name' (varchar(33)), and 'Employee_Salary' (decimal(10,2)). The data rows are: John B Smith (Franklin T Wong, 300000.00), Franklin T Wong (James E Borg, 40000.00), Joyce A English (Franklin T Wong, 25000.00), and Ramesh K Narayan (Franklin T Wong, 38000.00). The total number of rows is 4.

| Employee_Name | Supervisor_Name | Employee_Salary |
|------------------|-----------------|-----------------|
| John B Smith | Franklin T Wong | 300000.00 |
| Franklin T Wong | James E Borg | 40000.00 |
| Joyce A English | Franklin T Wong | 25000.00 |
| Ramesh K Narayan | Franklin T Wong | 38000.00 |

2.3 View (c): Project Information

Requirement: A view that has the project name, controlling department name, number of employees, and total hours worked per week on the project for each project.

```

1 DROP VIEW IF EXISTS ProjectInfo;
2 CREATE VIEW ProjectInfo AS
3 SELECT
4     p.Pname AS Project_Name,

```

```

5   d.Dname AS Controlling_Department,
6   COUNT(w.Essn) AS Number_of_Employees,
7   SUM(IFNULL(w.Hours, 0)) AS Total_Hours_Per_Week
8 FROM PROJECT p
9 JOIN DEPARTMENT d ON p.Dnum = d.Dnumber
10 LEFT JOIN WORKS_ON w ON p.Pnumber = w.Pno
11 GROUP BY p.Pnumber, p.Pname, d.Dname;

```

Explanation: This view joins PROJECT, DEPARTMENT, and WORKS_ON tables, using GROUP BY to aggregate employee counts and total hours per project.

Test Validation

```

1 -- Query the view
2 SELECT * FROM ProjectInfo;

```

Expected Output:

| | Project_Name | Controlling_Departm | Number_of_Employ | Total_Hours_Per_Wee |
|---|-----------------|---------------------|------------------|---------------------|
| | varchar(25) | varchar(25) | bigint | decimal(25,1) |
| > | Computerization | Administration | 3 | 55.0 |
| > | Newbenefits | Administration | 3 | 55.0 |
| > | Reorganization | Headquarters | 3 | 25.0 |
| > | ProductX | Research | 2 | 52.5 |
| > | ProductY | Research | 3 | 37.5 |
| > | ProductZ | Research | 2 | 50.0 |

2.4 View (d): Projects with More Than Two Employees

Requirement: A view that has the project name, controlling department name, number of employees, and total hours worked per week on the project for each project with more than two employees working on it.

```

1 DROP VIEW IF EXISTS ProjectInfoMoreThanTwo;
2 CREATE VIEW ProjectInfoMoreThanTwo AS
3 SELECT
4   p.Pname AS Project_Name,
5   d.Dname AS Controlling_Department,
6   COUNT(w.Essn) AS Number_of_Employees,
7   SUM(IFNULL(w.Hours, 0)) AS Total_Hours_Per_Week
8 FROM PROJECT p
9 JOIN DEPARTMENT d ON p.Dnum = d.Dnumber
10 LEFT JOIN WORKS_ON w ON p.Pnumber = w.Pno
11 GROUP BY p.Pnumber, p.Pname, d.Dname
12 HAVING COUNT(w.Essn) > 2;

```

Explanation: Similar to View (c), but with a HAVING clause to filter projects that have more than 2 employees.

Test Validation

```

1 -- Query the view
2 SELECT * FROM ProjectInfoMoreThanTwo;

```

Expected Output:

| | Project_Name | Controlling_Department | Number_of_Employees | Total_Hours_Per_Week |
|---|-----------------|------------------------|---------------------|----------------------|
| > | Computerization | Administration | 3 | 55.0 |
| > | Newbenefits | Administration | 3 | 55.0 |
| > | Reorganization | Headquarters | 3 | 25.0 |
| > | ProductY | Research | 3 | 37.5 |

2.5 View (e): Employees with More Than 2 Dependents

Requirement: A view (SSN, Full Name of employee, Number of dependents) that includes information about employees who have the number of dependents greater than 2.

```

1 DROP VIEW IF EXISTS EmployeesWithManyDependents;
2 CREATE VIEW EmployeesWithManyDependents AS
3 SELECT
4     e.Ssn AS SSN,
5     CONCAT(e.Fname, ' ', e.Minit, ' ', e.Lname) AS Full_Name,
6     COUNT(dep.Dependent_name) AS Number_of_Dependents
7 FROM EMPLOYEE e
8 JOIN DEPENDENT dep ON e.Ssn = dep.Essn
9 GROUP BY e.Ssn, e.Fname, e.Minit, e.Lname
10 HAVING COUNT(dep.Dependent_name) > 2;

```

Explanation: This view joins EMPLOYEE and DEPENDENT tables, groups by employee, and filters those with more than 2 dependents using HAVING.

Test Validation

```

1 -- Query the view
2 SELECT * FROM EmployeesWithManyDependents;

```

Expected Output:

| | SSN | Full_Name | Number_of_Dependents |
|---|-----------|-----------------|----------------------|
| > | 123456789 | John B Smith | 3 |
| > | 333445555 | Franklin T Wong | 3 |

2.6 View (f): July Birthday Employees

Requirement: A view (Full Name of employee, date of birth, gender) for those employees who have their birthdate in July.

```

1 DROP VIEW IF EXISTS JulyBirthdayEmployees;
2 CREATE VIEW JulyBirthdayEmployees AS
3 SELECT

```

```

4   CONCAT(e.Fname, ' ', e.Minit, ' ', e.Lname) AS Full_Name,
5   e.Bdate AS Date_of_Birth,
6   e.Sex AS Gender
7 FROM EMPLOYEE e
8 WHERE MONTH(e.Bdate) = 7;

```

Explanation: This view uses the MONTH() function to filter employees born in July (month 7).

Test Validation

```

1 -- Query the view
2 SELECT * FROM JulyBirthdayEmployees;

```

Expected Output:

| JulyBirthdayEmployees | | |
|-----------------------|-----------------|---------------|
| | Full_Name | Date_of_Birth |
| > | Joyce A English | 1972-07-31 |
| > | Alicia J Zelaya | 1968-07-19 |

2.7 View (g): Young Dependents (Under 18)

Requirement: A view (Name of dependent, SSN of employee, date of birth of dependent) that includes information on all dependents who are less than 18 years old.

```

1 DROP VIEW IF EXISTS YoungDependents;
2 CREATE VIEW YoungDependents AS
3 SELECT
4     dep.Dependent_name AS Dependent_Name,
5     dep.Essn AS Employee_SSN,
6     dep.Bdate AS Dependent_Date_of_Birth
7 FROM DEPENDENT dep
8 WHERE TIMESTAMPDIFF(YEAR, dep.Bdate, CURDATE()) < 18;

```

Explanation: This view uses TIMESTAMPDIFF() to calculate the age of dependents and filters those under 18 years old.

Test Validation

```

1 -- Query the view
2 SELECT * FROM YoungDependents;

```

Expected Output:

| YoungDependents | | |
|-----------------|------------------|----------------|
| | * Dependent_Name | * Employee_SSN |
| | | |

3 Trigger (a) - Business Rules

Exercise: Create a database trigger for the following situations:

- The supervisor of an employee must be older than the employee.
- The salary of an employee cannot be greater than the salary of his/her supervisor.
- The salary of an employee can only increase.
- When increasing salary of employee, the increasing amount must not be more than 20% of current salary.
- An employee works on at most 4 projects.
- The maximum number of hours an employee can work on all projects per week is 56.
- The location of a project must be one of the locations of its department.
- The salary of a department manager must be higher than the other employees working for that department.
- Only department managers can work less than 5 hours on a project.

3.1 Trigger (a.1): Supervisor Must Be Older

Requirement: The supervisor of an employee must be older than the employee.

```

1 DROP TRIGGER IF EXISTS trg_supervisor_older_insert;
2 DELIMITER //
3 CREATE TRIGGER trg_supervisor_older_insert
4 BEFORE INSERT ON EMPLOYEE
5 FOR EACH ROW
6 BEGIN
7     DECLARE supervisor_bdate DATE;
8
9     IF NEW.Super_ssn IS NOT NULL THEN
10         SELECT Bdate INTO supervisor_bdate FROM EMPLOYEE WHERE Ssn =
11             NEW.Super_ssn;
12
13         IF supervisor_bdate IS NOT NULL AND supervisor_bdate > NEW.
14             Bdate THEN
15             SIGNAL SQLSTATE '45000'
16             SET MESSAGE_TEXT = 'Error: Supervisor must be older than
17             the employee.';
18         END IF;
19     END IF;
20 END //
21 DELIMITER ;
22
23 DROP TRIGGER IF EXISTS trg_supervisor_older_update;
24 DELIMITER //
25 CREATE TRIGGER trg_supervisor_older_update
26 BEFORE UPDATE ON EMPLOYEE
27 FOR EACH ROW
28 BEGIN

```

```

26  DECLARE supervisor_bdate DATE;
27
28  IF NEW.Super_ssn IS NOT NULL THEN
29      SELECT Bdate INTO supervisor_bdate FROM EMPLOYEE WHERE Ssn =
30      NEW.Super_ssn;
31
32      IF supervisor_bdate IS NOT NULL AND supervisor_bdate > NEW.
33      Bdate THEN
34          SIGNAL SQLSTATE '45000'
35          SET MESSAGE_TEXT = 'Error: Supervisor must be older than
36          the employee.';
37      END IF;
38  END IF;
39
40 END //;
41 DELIMITER ;

```

Explanation: This trigger checks the birthdate of the supervisor before inserting an employee. If the supervisor is not older, it raises an error using SIGNAL.

Test Validation

```

1 -- VALID INSERT: Employee born 1990, Supervisor (333445555) born 1955
2 INSERT INTO EMPLOYEE VALUES
3 ('Test', 'A', 'Valid', '111111110', '1990-01-01', '123 Test St', 'M',
4 25000, '333445555', 5);
5 -- Result: Success
6
7 -- INVALID INSERT: Employee born 1940, Supervisor born 1955 (supervisor
8 younger)
9 INSERT INTO EMPLOYEE VALUES
10 ('Test', 'B', 'Invalid', '111111111', '1940-01-01', '123 Test St', 'M',
11 25000, '333445555', 5);
12 -- Result: Error - Supervisor must be older than the employee.

```

Expected Output:

```

25 -- Test Constraint a.1: Supervisor must be older
26 -----
27 -- VALID INSERT: Employee born 1990, Supervisor (333445555) born 1955
28 INSERT INTO EMPLOYEE VALUES      You, 2 hours ago • update
29 ('Test', 'A', 'Valid', '111111110', '1990-01-01', '123 Test St', 'M', 25000, '333445555', 5);
30 -- Result: Success
31
32 -- INVALID INSERT: Employee born 1940, Supervisor born 1955 (supervisor younger)
33 INSERT INTO EMPLOYEE VALUES
34 ('Test', 'B', 'Invalid', '111111111', '1940-01-01', '123 Test St', 'M', 25000, '333445555', 5);
35 -- Result: Error - Supervisor must be older than the employee.
36

employee ×

```

| | Fname | Minit | Lname | Ssn | Bdate | Address | Sex | Salary | Super_ssn | Dno |
|---|----------|-------|---------|-----------|------------|--------------------------|-----|----------|-----------|-----|
| > | Test | A | Valid | 111111110 | 1990-01-01 | 123 Test St | M | 25000.00 | 333445555 | 5 |
| > | John | B | Smith | 123456789 | 1965-01-09 | 731 Fondren, Houston, TX | M | 30000.00 | 333445555 | 5 |
| > | Franklin | T | Wong | 333445555 | 1955-12-08 | 638 Voss, Houston, TX | M | 40000.00 | 888665555 | 5 |
| > | Joyce | A | English | 453453453 | 1972-07-31 | 5631 Rice, Houston, TX | F | 25000.00 | 333445555 | 5 |
| > | Ramesh | K | Narayan | 666884444 | 1962-09-15 | 975 Fire Oak, Humble, TX | M | 38000.00 | 333445555 | 5 |
| > | Low | L | Earner | 777777777 | 1985-01-01 | 456 St | F | 52000.00 | (NULL) | 1 |
| > | James | E | Borg | 888665555 | 1937-11-10 | 450 Stone, Houston, TX | M | 55000.00 | (NULL) | 1 |
| > | High | H | Earner | 888888888 | 1980-01-01 | 123 St | M | 60000.00 | (NULL) | 1 |
| > | Jennifer | S | Wallace | 987654321 | 1941-06-20 | 291 Berry, Bellaire, TX | F | 43000.00 | 888665555 | 4 |
| > | Ahmad | V | Jabbar | 987987987 | 1969-03-29 | 980 Dallas, Houston, TX | M | 25000.00 | 987654321 | 4 |

```

1  ↗Run
2  33  INSERT INTO EMPLOYEE VALUES  Error: Supervisor must be older than the employee.
3  34  ('Test', 'B', 'Invalid', '111111111', '1940-01-01', '123 Test St', 'M', 25000, '333445555', 5);  4ms
4  35  -- Result: Error - Supervisor must be older than the employee.
5  36

```

3.2 Trigger (a.2): Salary Cannot Exceed Supervisor's Salary

Requirement: The salary of an employee cannot be greater than the salary of his/her supervisor.

```

1 DROP TRIGGER IF EXISTS trg_salary_less_than_supervisor;
2 DELIMITER //
3 CREATE TRIGGER trg_salary_less_than_supervisor
4 BEFORE INSERT ON EMPLOYEE
5 FOR EACH ROW
6 BEGIN
7     DECLARE supervisor_salary DECIMAL(10, 2);
8
9     IF NEW.Super_ssn IS NOT NULL THEN
10         SELECT Salary INTO supervisor_salary FROM EMPLOYEE WHERE Ssn =
11             NEW.Super_ssn;
12
13         IF supervisor_salary IS NOT NULL AND NEW.Salary >=
14             supervisor_salary THEN
15             SIGNAL SQLSTATE '45000'
16             SET MESSAGE_TEXT = 'Error: Employee salary must be less
17             than supervisor salary.';
18         END IF;
19     END IF;
20 END //
21 DELIMITER ;
22
23 DROP TRIGGER IF EXISTS trg_salary_less_than_supervisor_update;
24 DELIMITER //
25 CREATE TRIGGER trg_salary_less_than_supervisor_update
26 BEFORE UPDATE ON EMPLOYEE
27 FOR EACH ROW
28 BEGIN
29     DECLARE supervisor_salary DECIMAL(10, 2);
30
31     IF NEW.Super_ssn IS NOT NULL THEN
32         SELECT Salary INTO supervisor_salary FROM EMPLOYEE WHERE Ssn =
33             NEW.Super_ssn;
34
35         IF supervisor_salary IS NOT NULL AND NEW.Salary >=
36             supervisor_salary THEN
37             SIGNAL SQLSTATE '45000'
38             SET MESSAGE_TEXT = 'Error: Employee salary must be less
39             than supervisor salary.';
40         END IF;
41     END IF;
42 END //
43 DELIMITER ;

```

Test Validation

```

1 -- VALID INSERT: Employee salary 35000, Supervisor salary 40000

```

```

2 INSERT INTO EMPLOYEE VALUES
3 ('Test', 'C', 'Valid', '111111112', '1990-01-01', '123 Test St', 'M',
4   35000, '333445555', 5);
-- Result: Success
5
6 -- INVALID INSERT: Employee salary 50000 > Supervisor salary 40000
7 INSERT INTO EMPLOYEE VALUES
8 ('Test', 'D', 'Invalid', '111111113', '1990-01-01', '123 Test St', 'M',
9   50000, '333445555', 5);
-- Result: Error - Employee salary cannot be greater than supervisor
salary.

```

Expected Output:

The screenshot shows a database interface with the following details:

- Employee Table Data:**

| | *Fname | Minit | *Lname | Ssn | Bdate | Address | Sex | Salary | Super_ssn | Dno |
|---|----------|-------|---------|-----------|------------|--------------------------|-----|----------|-----------|-----|
| > | Test | C | Valid | 111111112 | 1990-01-01 | 123 Test St | M | 35000.00 | 333445555 | 5 |
| > | John | B | Smith | 123456789 | 1965-01-09 | 731 Fondren, Houston, TX | M | 30000.00 | 333445555 | 5 |
| > | Franklin | T | Wong | 333445555 | 1955-12-08 | 638 Voss, Houston, TX | M | 40000.00 | 888665555 | 5 |
| > | Joyce | A | English | 453453453 | 1972-07-31 | 5631 Rice, Houston, TX | F | 25000.00 | 333445555 | 5 |
| > | Ramesh | K | Narayan | 666884444 | 1962-09-15 | 975 Fire Oak, Humble, TX | M | 38000.00 | 333445555 | 5 |
| > | Low | L | Earner | 777777777 | 1985-01-01 | 456 St | F | 52000.00 | (NULL) | 1 |
| > | James | E | Borg | 888665555 | 1937-11-10 | 450 Stone, Houston, TX | M | 55000.00 | (NULL) | 1 |
| > | High | H | Earner | 888888888 | 1980-01-01 | 123 St | M | 60000.00 | (NULL) | 1 |
| > | Jennifer | S | Wallace | 987654321 | 1941-06-20 | 291 Berry, Bellaire, TX | F | 43000.00 | 888665555 | 4 |
| > | Ahmad | V | Jabbar | 987987987 | 1969-03-29 | 980 Dallas, Houston, TX | M | 25000.00 | 987654321 | 4 |
- Failed Insert Attempt:**

```

48 -- INVALID INSERT: Employee salary 50000 > Supervisor salary 40000
>Run
49 INSERT INTO EMPLOYEE VALUES
50 ('Test', 'D', 'Invalid', '111111113', '1990-01-01', '123 Test St', 'M',
51   50000, '333445555', 5);
-- Result: Error - Employee salary cannot be greater than supervisor
salary.

```

3.3 Trigger (a.3): Salary Can Only Increase

Requirement: The salary of an employee can only increase.

```

1 DROP TRIGGER IF EXISTS trg_salary_only_increase;
2 DELIMITER //
3 CREATE TRIGGER trg_salary_only_increase
4 BEFORE UPDATE ON EMPLOYEE
5 FOR EACH ROW
6 BEGIN
7   IF NEW.Salary < OLD.Salary THEN
8     SIGNAL SQLSTATE '45000'
9     SET MESSAGE_TEXT = 'Error: Salary can only increase, not
decrease.';
10    END IF;

```

```
11 END //  
12 DELIMITER ;
```

Test Validation

```
1 -- VALID UPDATE: Increase salary from 30000 to 32000  
2 UPDATE EMPLOYEE SET Salary = 32000 WHERE Ssn = '123456789';  
3 -- Result: Success  
4  
5 -- INVALID UPDATE: Decrease salary from 32000 to 28000  
6 UPDATE EMPLOYEE SET Salary = 28000 WHERE Ssn = '123456789';  
7 -- Result: Error - Employee salary can only increase, not decrease.
```

Expected Output:

56 -- -----
57 -- Test Constraint a.3: Salary can only increase
58 -----
59 -- VALID UPDATE: Increase salary from 30000 to 32000
▷Run
60 UPDATE EMPLOYEE SET Salary = 32000 WHERE Ssn = '123456789'; 15ms AffectedRows: 1
61 -- Result: Success
62
63 -- INVALID UPDATE: Decrease salary from 32000 to 28000
▷Run
64 UPDATE EMPLOYEE SET Salary = 28000 WHERE Ssn = '123456789';
65 -- Result: Error - Employee salary can only increase, not decrease.
66
67 -- Restore original salary

employee

| Fname | Minit | Lname | Ssn | Bdate | Address | Sex | Salary | Super_ssn | Dno |
|----------|-------|---------|-----------|------------|--------------------------|-----|----------|-----------|-----|
| John | B | Smith | 123456789 | 1965-01-09 | 731 Fondren, Houston, TX | M | 32000.00 | 333445555 | 5 |
| Franklin | T | Wong | 333445555 | 1955-12-08 | 638 Voss, Houston, TX | M | 40000.00 | 888665555 | 5 |
| Joyce | A | English | 453453453 | 1972-07-31 | 5631 Rice, Houston, TX | F | 25000.00 | 333445555 | 5 |
| Ramesh | K | Narayan | 666884444 | 1962-09-15 | 975 Fire Oak, Humble, TX | M | 38000.00 | 333445555 | 5 |
| Low | L | Earnier | 777777777 | 1985-01-01 | 456 St | F | 52000.00 | (NULL) | 1 |
| James | E | Borg | 888665555 | 1937-11-10 | 450 Stone, Houston, TX | M | 55000.00 | (NULL) | 1 |
| High | H | Earnier | 888888888 | 1980-01-01 | 123 St | M | 60000.00 | (NULL) | 1 |
| Jennifer | S | Wallace | 987654321 | 1941-06-20 | 291 Berry, Bellaire, TX | F | 43000.00 | 888665555 | 4 |
| Ahmad | V | Jabbar | 987987987 | 1969-03-29 | 980 Dallas, Houston, TX | M | 25000.00 | 987654321 | 4 |
| Alicia | J | Zelava | 999887777 | 1968-07-19 | 3321 Castle, Spring, TX | F | 25000.00 | 987654321 | 4 |

```
63 -- INVALID UPDATE: Decrease salary from 32000 to 28000  
▷Run  
64 UPDATE EMPLOYEE SET Salary = 28000 WHERE Ssn = '123456789';  
65 -- Result: Error - Employee salary can only increase, not decrease.  
66
```

3.4 Trigger (a.4): Maximum 20% Salary Increase

Requirement: When increasing salary of employee, the increasing amount must not be more than 20% of current salary.

```
1 DROP TRIGGER IF EXISTS trg_salary_increase_max_20_percent;  
2 DELIMITER //  
3 CREATE TRIGGER trg_salary_increase_max_20_percent  
4 BEFORE UPDATE ON EMPLOYEE  
5 FOR EACH ROW  
6 BEGIN
```

```

7      IF NEW.Salary > OLD.Salary * 1.20 THEN
8          SIGNAL SQLSTATE '45000'
9          SET MESSAGE_TEXT = 'Error: Salary increase cannot exceed 20%.';
10     END IF;
11 END //
12 DELIMITER ;

```

Test Validation

```

1 -- VALID UPDATE: Increase salary by 15% (30000 -> 34500)
2 UPDATE EMPLOYEE SET Salary = 34500 WHERE Ssn = '123456789';
3 -- Result: Success
4
5 -- INVALID UPDATE: Increase salary by 50% (30000 -> 45000)
6 UPDATE EMPLOYEE SET Salary = 45000 WHERE Ssn = '123456789';
7 -- Result: Error - Salary increase cannot exceed 20% of current salary.

```

Expected Output:

The screenshot shows a database interface with two sections. The top section contains the following SQL code:

```

74 UPDATE EMPLOYEE SET Salary = 34500 WHERE Ssn = '123456789'; AffectedRows: 1 8ms
75 -- Result: Success
76
77 -- INVALID UPDATE: Increase salary by 50% (30000 -> 45000)
78 UPDATE EMPLOYEE SET Salary = 45000 WHERE Ssn = '123456789';
79 -- Result: Error - Salary increase cannot exceed 20% of current salary.
80
81 -- Restore original salary
82 UPDATE EMPLOYEE SET Salary = 30000 WHERE Ssn = '123456789';

```

The bottom section shows a table named 'employee' with columns: Fname, Minit, Lname, Ssn, Bdate, Address, Sex, Salary, Super_ssn, and Dno. The data is as follows:

| Fname | Minit | Lname | Ssn | Bdate | Address | Sex | Salary | Super_ssn | Dno |
|----------|-------|---------|-----------|------------|--------------------------|-----|----------|-----------|-----|
| John | B | Smith | 123456789 | 1965-01-09 | 731 Fondren, Houston, TX | M | 34500.00 | 333445555 | 5 |
| Franklin | T | Wong | 333445555 | 1955-12-08 | 638 Voss, Houston, TX | M | 40000.00 | 888665555 | 5 |
| Joyce | A | English | 453453453 | 1972-07-31 | 5631 Rice, Houston, TX | F | 25000.00 | 333445555 | 5 |
| Ramesh | K | Narayan | 666884444 | 1962-09-15 | 975 Fire Oak, Humble, TX | M | 38000.00 | 333445555 | 5 |
| James | E | Borg | 888665555 | 1937-11-10 | 450 Stone, Houston, TX | M | 55000.00 | (NULL) | 1 |
| Jennifer | S | Wallace | 987654321 | 1941-06-20 | 291 Berry, Bellaire, TX | F | 43000.00 | 888665555 | 4 |
| Ahmad | V | Jabbar | 987987987 | 1969-03-29 | 980 Dallas, Houston, TX | M | 25000.00 | 987654321 | 4 |
| Alicia | J | Zelaya | 999887777 | 1968-07-19 | 3321 Castle, Spring, TX | F | 25000.00 | 987654321 | 4 |

```

77 -- INVALID UPDATE: Increase salary by 50% (30000 -> 45000)
78 UPDATE EMPLOYEE SET Salary = 45000 WHERE Ssn = '123456789'; You, 10
79 -- Result: Error - Salary increase cannot exceed 20% of current salary.
80

```

3.5 Trigger (a.5): Maximum 4 Projects Per Employee

Requirement: An employee works on at most 4 projects.

```

1 DROP TRIGGER IF EXISTS trg_max_4_projects;
2 DELIMITER //
3 CREATE TRIGGER trg_max_4_projects
4 BEFORE INSERT ON WORKS_ON
5 FOR EACH ROW
6 BEGIN
7     DECLARE project_count INT;
8

```

```
9    SELECT COUNT(*) INTO project_count FROM WORKS_ON WHERE Essn = NEW.  
10   Essn;  
11  
12   IF project_count >= 4 THEN  
13       SIGNAL SQLSTATE '45000'  
14       SET MESSAGE_TEXT = 'Error: Employee cannot work on more than 4  
15 projects.';  
16   END IF;  
17  
18 END //  
19 DELIMITER ;
```

Test Validation

```

1 -- Check current projects for employee '123456789'
2 SELECT Essn, Pno FROM WORKS_ON WHERE Essn = '123456789';
3
4 -- INVALID INSERT: Adding 5th project (employee already has 4 projects)
5 -- Note: Use existing project number (10, 20, 30 exist)
6 INSERT INTO WORKS_ON VALUES ('123456789', 10, 10);
7 -- Result: Error - An employee can work on at most 4 projects.
8
9 -- VALID INSERT: Employee with less than 4 projects (666884444 has
   fewer projects)
10 -- Check available projects for employee in dept 5
11 SELECT Pnumber FROM PROJECT WHERE Pnumber NOT IN (SELECT Pno FROM
   WORKS_ON WHERE Essn = '666884444') AND Dnum = 5;
12 INSERT INTO WORKS_ON VALUES ('666884444', 1, 10);
13 -- Result: Success

```

Expected Output:

```
97 SELECT Pnumber FROM PROJECT WHERE Pnumber NOT IN (SELECT Pno FROM WORKS_ON WHERE Essn = '666884444') AND Dnum = 5;
98 ┏━ Run | Job | JSON
98 ✓ 98 INSERT INTO WORKS_ON VALUES ('666884444', 1, 10); 14ms AffectedRows: 1
99 -- Result: Success
100
101 -- Cleanup
101 ┏━ Run
102 DELETE FROM WORKS_ON WHERE Essn = '666884444' AND Pno = 1;
102
```

employee works_on

| | Essn | Pno | Hours |
|---|-----------|-----|--------------|
| Q | char(9) | int | decimal(3,1) |
| > | 453453453 | 1 | 20.0 |
| > | 453453453 | 2 | 20.0 |
| > | 666884444 | 1 | 10.0 |
| > | 666884444 | 3 | 40.0 |
| > | 888665555 | 20 | (NULL) |
| > | 987654321 | 20 | 15.0 |
| > | 987654321 | 30 | 20.0 |
| > | 987987987 | 10 | 35.0 |
| > | 987987987 | 30 | 5.0 |

```
95 -- VALID INSERT: Employee with less than 4 projects (666884444 has fewer projects)
96 -- Check available projects for employee in dept 5
97 >Run | +Tab | JSON
98 SELECT Pnumber FROM PROJECT WHERE Pnumber NOT IN (SELECT Pno FROM WORKS_ON WHERE Essn = '666884444')
99 >Run
100 INSERT INTO WORKS_ON VALUES ('666884444', 1, 10); AffectedRows: 1 8ms You, 20 seconds ago
101 -- Result: Success
```

3.6 Trigger (a.6): Maximum 56 Hours Per Week

Requirement: The maximum number of hours an employee can work on all projects per week is 56.

```

1  DROP TRIGGER IF EXISTS trg_max_56_hours;
2  DELIMITER //
3  CREATE TRIGGER trg_max_56_hours
4  BEFORE INSERT ON WORKS_ON
5  FOR EACH ROW
6  BEGIN
7      DECLARE total_hours DECIMAL(5, 1);
8
9      SELECT IFNULL(SUM(Hours), 0) INTO total_hours FROM WORKS_ON WHERE
10     Essn = NEW.Essn;
11
12     IF (total_hours + IFNULL(NEW.Hours, 0)) > 56 THEN
13         SIGNAL SQLSTATE '45000'
14         SET MESSAGE_TEXT = 'Error: Total weekly hours cannot exceed 56.
15     ';
16     END IF;
17 END //
18 DELIMITER ;
19
20 DROP TRIGGER IF EXISTS trg_max_56_hours_update;
21 DELIMITER //
22 CREATE TRIGGER trg_max_56_hours_update
23 BEFORE UPDATE ON WORKS_ON
24 FOR EACH ROW
25 BEGIN
26     DECLARE total_hours DECIMAL(5, 1);
27
28     SELECT IFNULL(SUM(Hours), 0) INTO total_hours FROM WORKS_ON
29     WHERE Essn = NEW.Essn AND Pno != OLD.Pno;
30
31     IF (total_hours + IFNULL(NEW.Hours, 0)) > 56 THEN
32         SIGNAL SQLSTATE '45000'
33         SET MESSAGE_TEXT = 'Error: Total weekly hours cannot exceed 56.
34     ';
35     END IF;
36 END //
37 DELIMITER ;

```

Test Validation

```

1  -- Check current hours for employee '123456789'
2  SELECT Essn, SUM(Hours) AS Total_Hours FROM WORKS_ON WHERE Essn = ,
3          123456789';
4
5  -- VALID INSERT: Adding hours that don't exceed 56 total
6  -- Note: Use existing project number that employee isn't working on yet
7  -- (project 3, dept 5)
8  INSERT INTO WORKS_ON VALUES ('123456789', 3, 5);
9
10 -- Result: Success
11
12 -- INVALID INSERT: Adding hours that would exceed 56
13 -- First check if this would exceed: existing hours + new hours > 56

```

```

11 INSERT INTO WORKS_ON VALUES ('666884444', 2, 50);
12 -- Result: Error - Total hours per week cannot exceed 56.

```

Expected Output:

SQL code showing the validation of the WORKS_ON table:

```

108 SELECT Essn, SUM(Hours) AS Total_Hours FROM WORKS_ON WHERE Essn = '123456789';
109
110 -- VALID INSERT: Adding hours that don't exceed 56 total
111 -- Note: Use existing project number that employee isn't working on yet (project 3, dept 5)
112 ✓ 112 INSERT INTO WORKS_ON VALUES ('123456789', 3, 5); 13ms AffectedRows: 1
113 -- Result: Success
114
115 -- INVALID INSERT: Adding hours that would exceed 56
116 -- First check if this would exceed: existing hours + new hours > 56
117 INSERT INTO WORKS_ON VALUES ('666884444', 2, 50);

```

Screenshot of a database management system showing the WORKS_ON table:

| | Essn | Pno | Hours |
|---|-----------|-----|-------|
| > | 123456789 | 1 | 32.5 |
| > | 123456789 | 2 | 7.5 |
| > | 123456789 | 3 | 5.0 |
| > | 333445555 | 2 | 10.0 |
| > | 333445555 | 3 | 10.0 |
| > | 333445555 | 10 | 10.0 |
| > | 333445555 | 20 | 10.0 |
| > | 453453453 | 1 | 20.0 |
| > | 453453453 | 2 | 20.0 |
| > | 666884444 | 3 | 40.0 |

```

115 -- INVALID INSERT: Adding hours that would exceed 56
116 -- First check if this would exceed: existing hours + new hours > 56
117 ! 117 INSERT INTO WORKS_ON VALUES ('666884444', 2, 50); [ You, 1 minute ago ]
118 -- Result: Error - Total hours per week cannot exceed 56.
119

```

3.7 Trigger (a.7): Project Location Must Match Department Location

Requirement: The location of a project must be one of the locations of its department.

```

1 -- Trigger 1: Ensure employees only work on projects from their
2   department
3 DROP TRIGGER IF EXISTS trg_project_dept_valid;
4 DELIMITER //
5 CREATE TRIGGER trg_project_dept_valid
6 BEFORE INSERT ON WORKS_ON
7 FOR EACH ROW
8 BEGIN
9   DECLARE emp_dept INT;
10  DECLARE project_dept INT;

```

```

10
11    SELECT Dno INTO emp_dept FROM EMPLOYEE WHERE Ssn = NEW.Essn;
12    SELECT Dnum INTO project_dept FROM PROJECT WHERE Pnumber = NEW.Pno;
13
14    IF emp_dept != project_dept THEN
15        SIGNAL SQLSTATE '45000'
16        SET MESSAGE_TEXT = 'Error: Employee can only work on projects
17        controlled by their department.';
18    END IF;
19
20
21 -- Trigger 2: Ensure project location matches department location
22 DROP TRIGGER IF EXISTS trg_project_location_valid;
23 DELIMITER //
24 CREATE TRIGGER trg_project_location_valid
25 BEFORE INSERT ON PROJECT
26 FOR EACH ROW
27 BEGIN
28     DECLARE location_exists INT;
29
30     SELECT COUNT(*) INTO location_exists
31     FROM DEPT_LOCATIONS
32     WHERE Dnumber = NEW.Dnum AND Dlocation = NEW.Plocation;
33
34     IF location_exists = 0 THEN
35         SIGNAL SQLSTATE '45000'
36         SET MESSAGE_TEXT = 'Error: Project location must be one of its
37         department locations.';
38     END IF;
39
40 END //
41 DELIMITER ;

```

Explanation: Two triggers enforce this constraint: the first ensures employees work on projects from their department, and the second validates that when inserting a new project, its location is one of the department's registered locations.

Test Validation

```

1 -- Check Dept 5 locations
2 SELECT Dnumber, Dlocation FROM DEPT_LOCATIONS WHERE Dnumber = 5;
3
4 -- VALID INSERT: Project in valid department location
5 INSERT INTO PROJECT VALUES ('TestProject', 99, 'Houston', 5);
6 -- Result: Success
7
8 -- INVALID INSERT: Project in location not belonging to department
9 INSERT INTO PROJECT VALUES ('BadProject', 100, 'New York', 5);
10 -- Result: Error - Project location must be one of its department
locations.

```

Expected Output:

```

125  -- -----
126  -- Check Dept 5 locations
127  SELECT Dnumber, Dlocation FROM DEPT_LOCATIONS WHERE Dnumber = 5;
128
129  -- VALID INSERT: Project in valid department location
130  INSERT INTO PROJECT VALUES ('TestProject', 99, 'Houston', 5);
131  -- Result: Success
132
133  -- INVALID INSERT: Project in location not belonging to department
134  INSERT INTO PROJECT VALUES ('BadProject', 100, 'New York', 5);      You, 2 hours ago • update
135  -- Result: Error - Project location must be one of its department locations.
136
137  -- Cleanup

```

employee works_on WORKS_ON project

| | Pname | Pnuml | Plocation | Dnum |
|---|-----------------|-------|-----------|------|
| > | ProductX | 1 | Bellaire | 5 |
| > | ProductY | 2 | Sugarland | 5 |
| > | ProductZ | 3 | Houston | 5 |
| > | Computerization | 10 | Stafford | 4 |
| > | Reorganization | 20 | Houston | 1 |
| > | Newbenefits | 30 | Stafford | 4 |
| > | TestProject | 99 | Houston | 5 |

```

133  -- INVALID INSERT: Project in location not belonging to department
134  INSERT INTO PROJECT VALUES ('BadProject', 100, 'New York', 5);      You, 18 m
135  -- Result: Error - Project location must be one of its department locations.
136

```

3.8 Trigger (a.8): Manager Salary Must Be Highest

Requirement: The salary of a department manager must be higher than the other employees working for that department.

```

1 DROP TRIGGER IF EXISTS trg_manager_salary_highest;
2 DELIMITER //
3 CREATE TRIGGER trg_manager_salary_highest
4 BEFORE UPDATE ON EMPLOYEE
5 FOR EACH ROW
6 BEGIN
7     DECLARE is_manager INT;
8     DECLARE max_other_salary DECIMAL(10, 2);
9
10    SELECT COUNT(*) INTO is_manager FROM DEPARTMENT WHERE Mgr_ssn = NEW.Ssn;
11
12    IF is_manager > 0 THEN
13        SELECT MAX(Salary) INTO max_other_salary
14        FROM EMPLOYEE e
15        JOIN DEPARTMENT d ON d.Dnumber = e.Dno
16        WHERE d.Mgr_ssn = NEW.Ssn AND e.Ssn != NEW.Ssn;

```

```

17      IF max_other_salary IS NOT NULL AND NEW.Salary <=
max_other_salary THEN
18          SIGNAL SQLSTATE '45000'
19          SET MESSAGE_TEXT = 'Error: Manager salary must be highest
in the department.';
20      END IF;
21  END IF;
22END //
23DELIMITER ;

```

Test Validation

```

1 -- Check Dept 5 manager and salaries
2 SELECT Mgr_ssn, (SELECT Salary FROM EMPLOYEE WHERE Ssn = Mgr_ssn) AS
  Manager_Salary
3 FROM DEPARTMENT WHERE Dnumber = 5;
4
5 -- VALID INSERT: Employee salary < Manager salary
6 INSERT INTO EMPLOYEE VALUES
7 ('Test', 'E', 'Valid', '111111114', '1990-01-01', '123 St', 'M', 35000,
  '333445555', 5);
8 -- Result: Success
9
10 -- INVALID INSERT: Employee salary >= Manager salary
11 INSERT INTO EMPLOYEE VALUES
12 ('Test', 'F', 'Invalid', '111111115', '1990-01-01', '123 St', 'M',
  50000, '333445555', 5);
13 -- Result: Error - Employee salary cannot be equal or greater than
  manager salary.

```

Expected Output:

The screenshot shows the MySQL Workbench interface. At the top, the command window displays the execution of the stored procedure and its results. Below the command window is a table viewer showing the 'employee' table with 9 rows of data. The table has columns: Name, Minit, Lname, Ssn, Bdate, Address, Sex, Salary, Super_ssn, and Dno. The bottom part of the screenshot shows the error message for the invalid insert attempt.

| Name | Minit | Lname | Ssn | Bdate | Address | Sex | Salary | Super_ssn | Dno |
|----------|-------|---------|-----------|------------|--------------------------|-----|----------|-----------|-----|
| Test | E | Valid | 111111114 | 1990-01-01 | 123 St | M | 35000.00 | 333445555 | 5 |
| John | B | Smith | 123456789 | 1965-01-09 | 731 Fondren, Houston, TX | M | 30000.00 | 333445555 | 5 |
| Franklin | T | Wong | 333445555 | 1955-12-08 | 638 Voss, Houston, TX | M | 40000.00 | 888665555 | 5 |
| Joyce | A | English | 453453453 | 1972-07-31 | 5631 Rice, Houston, TX | F | 25000.00 | 333445555 | 5 |
| Ramesh | K | Narayan | 666884444 | 1962-09-15 | 975 Fire Oak, Humble, TX | M | 38000.00 | 333445555 | 5 |
| James | E | Borg | 888665555 | 1937-11-10 | 450 Stone, Houston, TX | M | 55000.00 | (NULL) | 1 |
| Jennifer | S | Wallace | 987654321 | 1941-06-20 | 291 Berry, Bellaire, TX | F | 43000.00 | 888665555 | 4 |
| Ahmad | V | Jabbar | 987987987 | 1969-03-29 | 980 Dallas, Houston, TX | M | 25000.00 | 987654321 | 4 |
| Alicia | J | Zelaya | 999887777 | 1968-07-19 | 3321 Castle, Spring, TX | F | 25000.00 | 987654321 | 4 |

```

152 -- INVALID INSERT: Employee salary >= Manager salary
153 INSERT INTO EMPLOYEE VALUES Error: Employee salary must be less than supervisor salary.
154 ('Test', 'F', 'Invalid', '111111115', '1990-01-01', '123 St', 'M', 50000, '333445555', 5);
155 -- Result: Error - Employee salary cannot be equal or greater than manager salary.
156

```

3.9 Trigger (a.9): Only Managers Can Work Less Than 5 Hours

Requirement: Only department managers can work less than 5 hours on a project.

```

1 DROP TRIGGER IF EXISTS trg_min_5_hours_non_manager;
2 DELIMITER //
3 CREATE TRIGGER trg_min_5_hours_non_manager
4 BEFORE INSERT ON WORKS_ON
5 FOR EACH ROW
6 BEGIN
7     DECLARE is_manager INT;
8
9     SELECT COUNT(*) INTO is_manager FROM DEPARTMENT WHERE Mgr_ssn = NEW.Essn;
10
11    IF is_manager = 0 AND (NEW.Hours IS NULL OR NEW.Hours < 5) THEN
12        SIGNAL SQLSTATE '45000'
13        SET MESSAGE_TEXT = 'Error: Non-manager employee must work at
14        least 5 hours on a project.';
15    END IF;
16 END //
17 DELIMITER ;
18
19 DROP TRIGGER IF EXISTS trg_min_5_hours_non_manager_update;
20 DELIMITER //
21 CREATE TRIGGER trg_min_5_hours_non_manager_update
22 BEFORE UPDATE ON WORKS_ON
23 FOR EACH ROW
24 BEGIN
25     DECLARE is_manager INT;
26
27     SELECT COUNT(*) INTO is_manager FROM DEPARTMENT WHERE Mgr_ssn = NEW.Essn;
28
29    IF is_manager = 0 AND (NEW.Hours IS NULL OR NEW.Hours < 5) THEN
30        SIGNAL SQLSTATE '45000'
31        SET MESSAGE_TEXT = 'Error: Non-manager employee must work at
32        least 5 hours on a project.';
33    END IF;
34 END //
35 DELIMITER ;

```

Test Validation

```

1 -- Check which projects each person works on
2 SELECT Essn, COUNT(*) AS Project_Count FROM WORKS_ON GROUP BY Essn;
3
4 -- VALID INSERT: Manager (888665555, Dept 1 manager) working 3 hours on
5 -- project 20 (dept 1)
6 -- Manager 888665555 currently works only on project 20 with NULL hours
7 UPDATE WORKS_ON SET Hours = 3 WHERE Essn = '888665555' AND Pno = 20;
8 -- Result: Success (managers can work < 5 hours)
9
10 -- INVALID INSERT: Non-manager (453453453) working 3 hours on project 3
11 -- from dept 5
12 INSERT INTO WORKS_ON VALUES ('453453453', 3, 3);
13 -- Result: Error - Only department managers can work less than 5 hours.

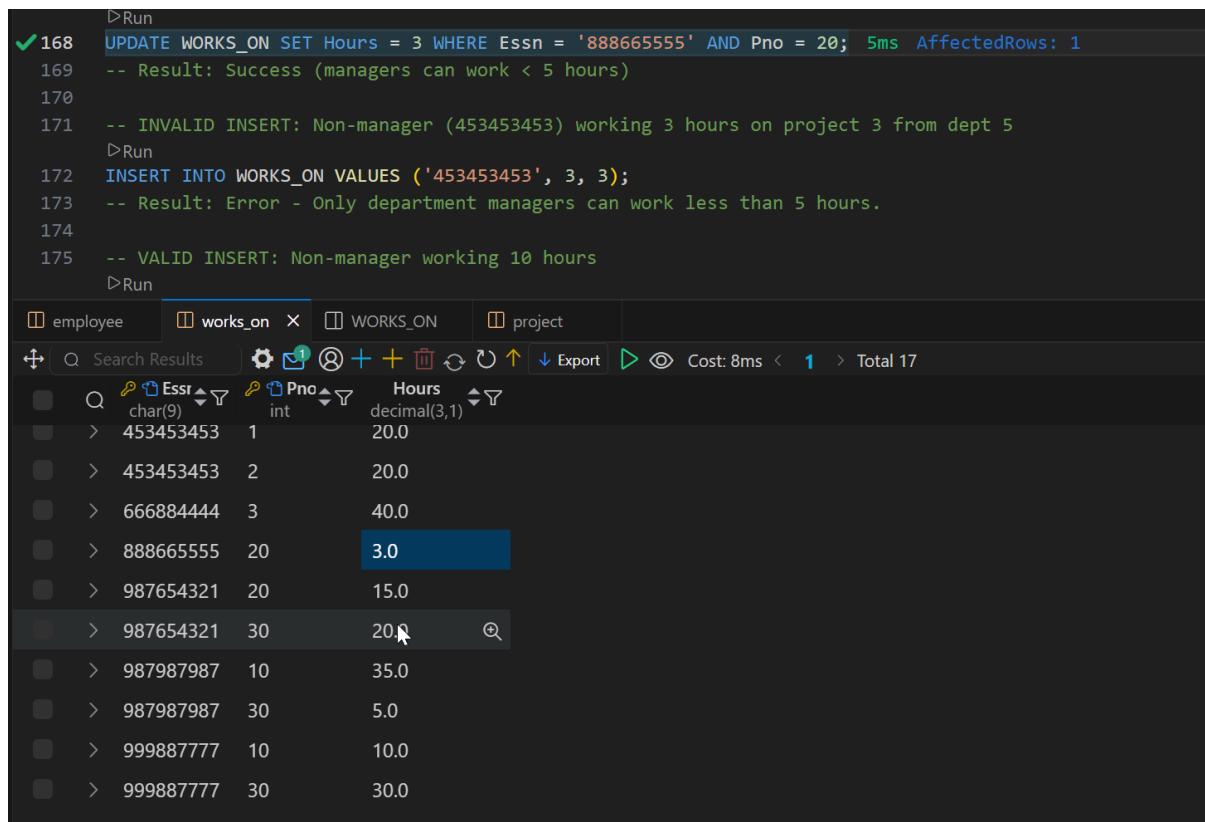
```

```

13 -- VALID INSERT: Non-manager working 10 hours
14 INSERT INTO WORKS_ON VALUES ('453453453', 3, 10);
15 -- Result: Success

```

Expected Output:



The screenshot shows a database interface with a table named WORKS_ON. The columns are Essn, Pno, and Hours. A row for project 3 is selected, highlighted in blue. The table data is as follows:

| | Essn | Pno | Hours |
|---|-----------|-----|-------|
| > | 453453453 | 1 | 20.0 |
| > | 453453453 | 2 | 20.0 |
| > | 666884444 | 3 | 40.0 |
| > | 888665555 | 20 | 3.0 |
| > | 987654321 | 20 | 15.0 |
| > | 987654321 | 30 | 20.0 |
| > | 987987987 | 10 | 35.0 |
| > | 987987987 | 30 | 5.0 |
| > | 999887777 | 10 | 10.0 |
| > | 999887777 | 30 | 30.0 |

```

171 -- INVALID INSERT: Non-manager (453453453) working 3 hours on project 3 from dept 5
172 INSERT INTO WORKS_ON VALUES ('453453453', 3, 3); You, 42 seconds ago • Uncommitted transaction
173 -- Result: Error - Only department managers can work less than 5 hours.

```

4 Task (b) - Num_of_Emp Derived Attribute

Exercise: Alter table Department to add the attribute Num_of_Emp that stores the number of employees working for each department. This attribute is a derived attribute from Employee.DNO and its value must be automatically calculated.

Solution:

```

1  -- Add the column
2 ALTER TABLE DEPARTMENT ADD COLUMN Num_of_Emp INT DEFAULT 0;
3
4  -- Initialize the column with current counts
5 UPDATE DEPARTMENT d
6 SET Num_of_Emp = (SELECT COUNT(*) FROM EMPLOYEE e WHERE e.Dno = d.
Dnumber);
7
8  -- Trigger for INSERT
9 DROP TRIGGER IF EXISTS trg_update_num_emp_insert;
10 DELIMITER //
11 CREATE TRIGGER trg_update_num_emp_insert
12 AFTER INSERT ON EMPLOYEE
13 FOR EACH ROW
14 BEGIN
15     IF NEW.Dno IS NOT NULL THEN
16         UPDATE DEPARTMENT
17             SET Num_of_Emp = Num_of_Emp + 1
18             WHERE Dnumber = NEW.Dno;
19     END IF;
20 END //
21 DELIMITER ;
22
23  -- Trigger for DELETE
24 DROP TRIGGER IF EXISTS trg_update_num_emp_delete;
25 DELIMITER //
26 CREATE TRIGGER trg_update_num_emp_delete
27 AFTER DELETE ON EMPLOYEE
28 FOR EACH ROW
29 BEGIN
30     IF OLD.Dno IS NOT NULL THEN
31         UPDATE DEPARTMENT
32             SET Num_of_Emp = Num_of_Emp - 1
33             WHERE Dnumber = OLD.Dno;
34     END IF;
35 END //
36 DELIMITER ;
37
38  -- Trigger for UPDATE
39 DROP TRIGGER IF EXISTS trg_update_num_emp_update;
40 DELIMITER //
41 CREATE TRIGGER trg_update_num_emp_update
42 AFTER UPDATE ON EMPLOYEE
43 FOR EACH ROW
44 BEGIN
45     -- Check if department changed
46     IF OLD.Dno != NEW.Dno OR (OLD.Dno IS NULL AND NEW.Dno IS NOT NULL)
47     OR (OLD.Dno IS NOT NULL AND NEW.Dno IS NULL) THEN
48         -- Decrement old department
49         IF OLD.Dno IS NOT NULL THEN
            UPDATE DEPARTMENT

```

```

50      SET Num_of_Emp = Num_of_Emp - 1
51      WHERE Dnumber = OLD.Dno;
52  END IF;
53
54      -- Increment new department
55  IF NEW.Dno IS NOT NULL THEN
56      UPDATE DEPARTMENT
57      SET Num_of_Emp = Num_of_Emp + 1
58      WHERE Dnumber = NEW.Dno;
59  END IF;
60 END IF;
61 END // 
62 DELIMITER ;

```

Test Validation

```

1 -- Check current department counts
2 SELECT Dnumber, Dname, Num_of_Emp FROM DEPARTMENT;

```

Expected Output:

| DEPARTMENT X | | | |
|--------------|------|-------------|------------|
| | Dnum | Dname | Num_of_Emp |
| | int | varchar(25) | int |
| | 5 | Research | 4 |

```

1 -- Test INSERT: Add new employee to Dept 5
2 INSERT INTO EMPLOYEE VALUES ('New', 'N', 'Emp', '999999999', ,
3                               '1990-01-01',
4                               '123 St', 'M', 25000, '333445555', 5);
5 SELECT Dnumber, Num_of_Emp FROM DEPARTMENT WHERE Dnumber = 5;
6 -- Result: Num_of_Emp = 6 (incremented from 5)
7
8 -- Test DELETE: Remove the employee
9 DELETE FROM EMPLOYEE WHERE Ssn = '999999999';
10 SELECT Dnumber, Num_of_Emp FROM DEPARTMENT WHERE Dnumber = 5;
11 -- Result: Num_of_Emp = 5 (decremented back)

```

5 Function (c) - Get Total Projects

Exercise: Write a function that returns the total number of projects when given an employee's ID.

- **Input:** employee ID
- **Output:** total number of projects

Solution:

```

1  DROP FUNCTION IF EXISTS GetTotalProjectsForEmployee;
2  DELIMITER //
3  CREATE FUNCTION GetTotalProjectsForEmployee(emp_ssn CHAR(9))
4  RETURNS INT
5  DETERMINISTIC
6  READS SQL DATA
7  BEGIN
8      DECLARE total_projects INT;
9
10     SELECT COUNT(*) INTO total_projects
11     FROM WORKS_ON
12     WHERE Essn = emp_ssn;
13
14     RETURN total_projects;
15 END //
16 DELIMITER ;
17
18 -- Example usage:
19 SELECT GetTotalProjectsForEmployee('123456789') AS Total_Projects;
20 SELECT GetTotalProjectsForEmployee('333445555') AS Total_Projects;

```

Explanation: This function takes an employee SSN as input and returns the count of projects that employee works on from the WORKS_ON table.

Test Validation

```

1  -- Call function for employee '123456789'
2  SELECT GetTotalProjectsForEmployee('123456789') AS Total_Projects;

```

Expected Output:

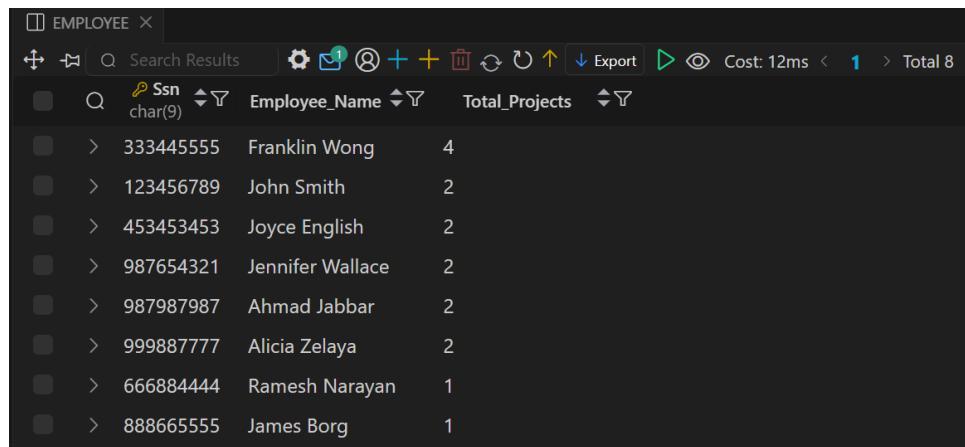
| Employee_SSN | Total_Projects |
|--------------|----------------|
| 123456789 | 2 |

```

1  -- List all employees with their project counts
2  SELECT Ssn, CONCAT(Fname, ' ', Lname) AS Name,
3         GetTotalProjectsForEmployee(Ssn) AS Projects
4  FROM EMPLOYEE ORDER BY Projects DESC;

```

Expected Output:



The screenshot shows a database query results window titled "EMPLOYEE X". The window has a dark theme with light-colored text. At the top, there are various icons for search, export, and navigation. Below the title, the table structure is defined with columns: "Ssn" (char(9)), "Employee_Name", and "Total_Projects". The data is presented in a grid format with 8 rows, each containing an icon, an ID, a name, and a project count.

| | Ssn | Employee_Name | Total_Projects |
|---|-----------|------------------|----------------|
| > | 333445555 | Franklin Wong | 4 |
| > | 123456789 | John Smith | 2 |
| > | 453453453 | Joyce English | 2 |
| > | 987654321 | Jennifer Wallace | 2 |
| > | 987987987 | Ahmad Jabbar | 2 |
| > | 999887777 | Alicia Zelaya | 2 |
| > | 666884444 | Ramesh Narayan | 1 |
| > | 888665555 | James Borg | 1 |

6 Procedure (d) - Print Employee Details

Exercise: Create a stored procedure that prints SSN, Full name, Department name, and annual salary of all employees.

Solution:

```

1 DROP PROCEDURE IF EXISTS PrintEmployeeDetails;
2 DELIMITER //
3 CREATE PROCEDURE PrintEmployeeDetails()
4 BEGIN
5     DECLARE done INT DEFAULT FALSE;
6     DECLARE v_ssn CHAR(9);
7     DECLARE v_fullname VARCHAR(50);
8     DECLARE v_dname VARCHAR(25);
9     DECLARE v_annual_salary DECIMAL(12, 2);
10
11    DECLARE emp_cursor CURSOR FOR
12        SELECT
13            e.Ssn,
14            CONCAT(e.Fname, ' ', e.Minit, ' ', e.Lname) AS Full_Name,
15            d.Dname,
16            e.Salary * 12 AS Annual_Salary
17        FROM EMPLOYEE e
18        LEFT JOIN DEPARTMENT d ON e.Dno = d.Dnumber;
19
20    DECLARE CONTINUE HANDLER FOR NOT FOUND SET done = TRUE;
21
22    DROP TEMPORARY TABLE IF EXISTS temp_employee_details;
23    CREATE TEMPORARY TABLE temp_employee_details (
24        SSN CHAR(9),
25        Full_Name VARCHAR(50),
26        Department_Name VARCHAR(25),
27        Annual_Salary DECIMAL(12, 2)
28    );
29
30    OPEN emp_cursor;
31
32    read_loop: LOOP
33        FETCH emp_cursor INTO v_ssn, v_fullname, v_dname,
34        v_annual_salary;
35        IF done THEN
36            LEAVE read_loop;
37        END IF;
38        INSERT INTO temp_employee_details
39        VALUES (v_ssn, v_fullname, v_dname, v_annual_salary);
40    END LOOP;
41
42    CLOSE emp_cursor;
43    SELECT * FROM temp_employee_details;
44    DROP TEMPORARY TABLE IF EXISTS temp_employee_details;
45 END //
DELIMITER ;

```

Test Validation

```

1 -- Call the procedure
2 CALL PrintEmployeeDetails();

```

Expected Output:

The screenshot shows a database query results window titled "Result1". The window has a toolbar at the top with various icons for search, refresh, export, and settings. The cost of the query is listed as "Cost: 13ms". Below the toolbar is a table with four columns: "SSN", "Full_Name", "Department_Name", and "Annual_Salary". The "SSN" column is defined as a string, "Full_Name" as varchar, "Department_Name" as varchar, and "Annual_Salary" as decimal. The table contains 8 rows of data.

| | SSN string | Full_Name varchar | Department_Name varchar | Annual_Salary decimal |
|---|---------------|----------------------|----------------------------|--------------------------|
| > | 123456789 | John B Smith | Research | 360000.00 |
| > | 333445555 | Franklin T Wong | Research | 480000.00 |
| > | 453453453 | Joyce A English | Research | 300000.00 |
| > | 666884444 | Ramesh K Narayan | Research | 456000.00 |
| > | 888665555 | James E Borg | Headquarters | 660000.00 |
| > | 987654321 | Jennifer S Wallace | Administration | 516000.00 |
| > | 987987987 | Ahmad V Jabbar | Administration | 300000.00 |
| > | 999887777 | Alicia J Zelaya | Administration | 300000.00 |

7 Trigger (e) - Salary Log

Exercise: Write the trigger(s) to maintain a log table containing information about the changes of employees' salaries.

Log table structure: (User, Date, ESSN, Old_Salary, New_Salary)

Solution:

```

1 -- Create the log table if it doesn't exist
2 DROP TABLE IF EXISTS SALARY_LOG;
3 CREATE TABLE SALARY_LOG (
4     Log_ID INT AUTO_INCREMENT PRIMARY KEY,
5     User_Name VARCHAR(100),
6     Change_Date DATETIME,
7     ESSN CHAR(9),
8     Old_Salary DECIMAL(10, 2),
9     New_Salary DECIMAL(10, 2)
10 );
11
12 -- Trigger for INSERT: Log initial salary when employee is created
13 DROP TRIGGER IF EXISTS trg_log_salary_insert;
14 DELIMITER //
15 CREATE TRIGGER trg_log_salary_insert
16 AFTER INSERT ON EMPLOYEE
17 FOR EACH ROW
18 BEGIN
19     INSERT INTO SALARY_LOG (User_Name, Change_Date, ESSN, Old_Salary,
20     New_Salary)
21     VALUES (CURRENT_USER(), NOW(), NEW.Ssn, NULL, NEW.Salary);
22 END //
23 DELIMITER ;
24
25 -- Trigger for UPDATE: Log salary changes
26 DROP TRIGGER IF EXISTS trg_log_salary_update;
27 DELIMITER //
28 CREATE TRIGGER trg_log_salary_update
29 AFTER UPDATE ON EMPLOYEE
30 FOR EACH ROW
31 BEGIN
32     IF OLD.Salary != NEW.Salary THEN
33         INSERT INTO SALARY_LOG (User_Name, Change_Date, ESSN,
34         Old_Salary, New_Salary)
35         VALUES (CURRENT_USER(), NOW(), NEW.Ssn, OLD.Salary, NEW.Salary)
36     ;
37     END IF;
38 END //
39 DELIMITER ;

```

Test Validation

```

1 -- Test INSERT: Add new employee
2 INSERT INTO EMPLOYEE VALUES ('New', 'N', 'Employee', '999999999', '',
3                             '1990-01-01',
4                             '123 St', 'M', 28000, '333445555', 5);
5
6 -- Check the log
7 SELECT * FROM SALARY_LOG WHERE ESSN = '999999999';

```

Expected Output:

| SALARY_LOG | | | | | | |
|------------|--------|----------------|---------------------|-----------|------------|------------|
| | Log_ID | User_Name | Change_Date | ESSN | Old_Salary | New_Salary |
| | 1 | root@localhost | 2025-12-06 09:42:52 | 888888888 | (NULL) | 55000.00 |

```
1 -- Test UPDATE: Change salary
2 UPDATE EMPLOYEE SET Salary = 30000 WHERE Ssn = '999999999';
3 SELECT * FROM SALARY_LOG WHERE ESSN = '999999999';
```

Expected Output:

| SALARY_LOG | | | | | | |
|------------|--------|----------------|---------------------|-----------|------------|------------|
| | Log_ID | User_Name | Change_Date | ESSN | Old_Salary | New_Salary |
| | 2 | root@localhost | 2025-12-06 09:43:38 | 888888888 | 55000.00 | 60000.00 |
| | 1 | root@localhost | 2025-12-06 09:42:52 | 888888888 | (NULL) | 55000.00 |

8 Procedure (f) - Employee Salary Levels

Exercise: Write a stored procedure that prints out the level of salary for each employee.

Rules:

- if (salary < 20000) then “level C”
- if (salary between 20000 and 50000) then “level B”
- if (salary > 50000) then “level A”

Example Output:

```
123456789, John B Smith, level B
333445555, Franklin T Wong, level B
...
```

Solution:

```

1 DROP PROCEDURE IF EXISTS PrintEmployeeSalaryLevel ;
2 DELIMITER //
3 CREATE PROCEDURE PrintEmployeeSalaryLevel()
4 BEGIN
5     DECLARE done INT DEFAULT FALSE;
6     DECLARE v_ssn CHAR(9);
7     DECLARE v_fullname VARCHAR(50);
8     DECLARE v_salary DECIMAL(10, 2);
9     DECLARE v_level VARCHAR(10);
10
11    DECLARE emp_cursor CURSOR FOR
12        SELECT
13            e.Ssn,
14            CONCAT(e.Fname, ' ', e.Minit, ' ', e.Lname) AS Full_Name,
15            e.Salary
16        FROM EMPLOYEE e;
17
18    DECLARE CONTINUE HANDLER FOR NOT FOUND SET done = TRUE;
19
20    DROP TEMPORARY TABLE IF EXISTS temp_salary_levels;
21    CREATE TEMPORARY TABLE temp_salary_levels (
22        SSN CHAR(9),
23        Full_Name VARCHAR(50),
24        Salary_Level VARCHAR(10)
25    );
26
27    OPEN emp_cursor;
28
29    read_loop: LOOP
30        FETCH emp_cursor INTO v_ssn, v_fullname, v_salary;
31        IF done THEN
32            LEAVE read_loop;
33        END IF;
34
35        IF v_salary < 20000 THEN
36            SET v_level = 'level C';
37        ELSEIF v_salary >= 20000 AND v_salary <= 50000 THEN
38            SET v_level = 'level B';
39        ELSE

```

```

40      SET v_level = 'level A';
41  END IF;
42
43  INSERT INTO temp_salary_levels VALUES (v_ssn, v_fullname,
44    v_level);
45  END LOOP;
46
47  CLOSE emp_cursor;
48  SELECT * FROM temp_salary_levels;
49  DROP TEMPORARY TABLE IF EXISTS temp_salary_levels;
50 END //
50 DELIMITER ;

```

Test Validation

```

1 -- Call the procedure
2 CALL PrintEmployeeSalaryLevel();

```

Expected Output:

| | SSN | Full_Name | Salary_Level |
|---|-----------|--------------------|--------------|
| | string | varchar | varchar |
| > | 123456789 | John B Smith | level B |
| > | 333445555 | Franklin T Wong | level B |
| > | 453453453 | Joyce A English | level B |
| > | 666884444 | Ramesh K Narayan | level B |
| > | 888665555 | James E Borg | level A |
| > | 987654321 | Jennifer S Wallace | level B |
| > | 987987987 | Ahmad V Jabbar | level B |
| > | 999887777 | Alicia J Zelaya | level B |

Note: The salary levels are determined by:

- level C: salary < 20000
- level B: $20000 \leq \text{salary} \leq 50000$
- level A: salary > 50000

9 Exercise 2 - Hotel Database Constraints

Database Schema:

Hotel(hotelNo, hotelName, city)
Room(roomNo, hotelNo, type, price, NumAdultMax) FK: hotelNo → Hotel
Booking(hotelNo, dateFrom, roomNo, guestNo, dateTo, NumOfAdult)
 FK: (roomNo, hotelNo) → Room, guestNo → Guest
Guest(guestNo, guestName, guestAddress, TotalAmount)

Constraints to implement:

- a. The price of all double rooms must be greater than \$100.
- b. In a hotel, the price of double rooms must be greater than the price of the highest single room.
- c. A guest cannot make two bookings with overlapping dates.
- d. A guest cannot make a booking with number of adults greater than NumAdultMax value of booked room.
- e. Automatically calculate the value for totalAmount column of Guest relation.
- f. Create an INSTEAD OF database trigger that will allow data to be inserted into the LondonHotelRoom view.

9.1 Constraint (a) - Double Room Price Minimum

Requirement: The price of all double rooms must be greater than \$100.

Solution: Using CHECK constraint (attribute constraint)

```
1 ALTER TABLE Room
2 ADD CONSTRAINT chk_double_room_price
3 CHECK (type != 'double' OR price > 100);
```

Explanation: This CHECK constraint ensures that whenever a room has type 'double', its price must be greater than 100. The constraint is evaluated as (NOT double OR price > 100), which is logically equivalent to (IF double THEN price > 100).

Test Validation

```
1 -- Test 1: Valid double room with price > 100
2 INSERT INTO Room (roomNo, hotelNo, type, price, NumAdultMax)
3 VALUES (999, 1, 'double', 150, 2);
4 -- Result: Success
5
6 -- Test 2: Invalid double room with price < 100
7 INSERT INTO Room (roomNo, hotelNo, type, price, NumAdultMax)
8 VALUES (998, 1, 'double', 80, 2);
9 -- Result: Error - Check constraint violation
10
11 -- Test 3: Invalid double room with price = 100
12 INSERT INTO Room (roomNo, hotelNo, type, price, NumAdultMax)
13 VALUES (997, 1, 'double', 100, 2);
14 -- Result: Error - Must be GREATER than 100
15
```

```

16 -- Test 4: Valid single room with any price
17 INSERT INTO Room (roomNo, hotelNo, type, price, NumAdultMax)
18 VALUES (996, 1, 'single', 50, 1);
19 -- Result: Success

1 -- Test 1: Try overlapping booking (should fail)
2 INSERT INTO Booking VALUES
3     (1, 2, '2024-04-12', '2024-04-18', 101);
4
5 -- Test 2: Non-overlapping booking (should succeed)
6 INSERT INTO Booking VALUES
7     (1, 2, '2024-04-20', '2024-04-25', 101);

```

Expected Results:

| Test | Action | Result |
|--------|----------------------------|-------------------------|
| Setup | INSERT Apr 10-15, Room 101 | Row inserted |
| Test 1 | INSERT Apr 12-18, Room 101 | Trigger error - overlap |
| Test 2 | INSERT Apr 20-25, Room 101 | Row inserted |

9.2 Constraint (d) - Maximum Grosvenor Bookings

Requirement: No guest can make more than 10 bookings for the same hotel with name 'Grosvenor'.

Solution:

```

1 -- Trigger (required for counting bookings per guest per hotel)
2 DELIMITER //
3 CREATE TRIGGER trg_max_grosvenor_bookings
4 BEFORE INSERT ON Booking
5 FOR EACH ROW
6 BEGIN
7     DECLARE booking_count INT;
8     DECLARE hotel_name VARCHAR(50);
9
10    SELECT hotelName INTO hotel_name
11    FROM Hotel
12    WHERE hotelNo = NEW.hotelNo;
13
14    IF hotel_name = 'Grosvenor' THEN
15        SELECT COUNT(*) INTO booking_count
16        FROM Booking
17        WHERE guestNo = NEW.guestNo
18        AND hotelNo = NEW.hotelNo;
19
20        IF booking_count >= 10 THEN
21            SIGNAL SQLSTATE '45000'
22            SET MESSAGE_TEXT = 'Guest cannot make more than 10 bookings
for Grosvenor hotel';
23        END IF;
24    END IF;
25 END //
26 DELIMITER ;

```

Test Validation

```

1  -- Setup: Insert Grosvenor hotel
2  INSERT INTO Hotel VALUES (10, 'Grosvenor', 'London');
3
4  -- Insert 10 bookings for guest 1 at Grosvenor
5  -- (simplified - in practice, dates would vary)
6  -- After 10 bookings exist...
7
8  -- Test: Try to insert 11th booking (should fail)
9  INSERT INTO Booking VALUES
10   (10, 1, '2024-12-01', '2024-12-05', 101);

```

Expected Result: After 10 existing bookings, the 11th booking attempt will fail with the error message “Guest cannot make more than 10 bookings for Grosvenor hotel”.

9.3 Constraint (e) - London Room Increase

Requirement: The price of rooms at hotels in London cannot be increased by more than 10%.

Solution:

```

1  -- Trigger (required for comparing old and new values on UPDATE)
2  DELIMITER //
3  CREATE TRIGGER trg_london_price_increase
4  BEFORE UPDATE ON Room
5  %
6  \subsection{Constraint (b) - Double Room Pricing Hierarchy}
7  %
8
9  \textbf{Requirement:} In a hotel, the price of double rooms must be
10 greater than the price of the highest single room.
11 \textbf{Solution:} Using Triggers (requires querying existing data)
12
13 \begin{lstlisting}
14 DROP TRIGGER IF EXISTS trg_double_greater_single_insert;
15 DELIMITER //
16 CREATE TRIGGER trg_double_greater_single_insert
17 BEFORE INSERT ON Room
18 FOR EACH ROW
19 BEGIN
20     DECLARE max_single_price DECIMAL(10, 2);
21
22     IF NEW.type = 'double' THEN
23         SELECT IFNULL(MAX(price), 0) INTO max_single_price
24         FROM Room
25         WHERE hotelNo = NEW.hotelNo AND type = 'single';
26
27         IF NEW.price <= max_single_price THEN
28             SIGNAL SQLSTATE '45000'
29             SET MESSAGE_TEXT = 'Error: Double room price must be
30 greater than highest single room price.';
31         END IF;
32     END IF;
33 END //
34
35 DROP TRIGGER IF EXISTS trg_double_greater_single_update;
36 DELIMITER //

```

```

37 CREATE TRIGGER trg_double_greater_single_update
38 BEFORE UPDATE ON Room
39 -- Result: Success

```

9.4 Constraint (b) - Double Room Pricing Hierarchy

Requirement: In a hotel, the price of double rooms must be greater than the price of the highest single room.

Solution: Using Triggers (requires querying existing data)

```

1 DROP TRIGGER IF EXISTS trg_double_greater_single_insert;
2 DELIMITER //
3 CREATE TRIGGER trg_double_greater_single_insert
4 BEFORE INSERT ON Room
5 FOR EACH ROW
6 BEGIN
7     DECLARE max_single_price DECIMAL(10, 2);
8
9     IF NEW.type = 'double' THEN
10        SELECT IFNULL(MAX(price), 0) INTO max_single_price
11        FROM Room
12        WHERE hotelNo = NEW.hotelNo AND type = 'single';
13
14        IF NEW.price <= max_single_price THEN
15            SIGNAL SQLSTATE '45000'
16            SET MESSAGE_TEXT = 'Error: Double room price must be
greater than highest single room price.';
17        END IF;
18    END IF;
19 END //
20 DELIMITER ;
21
22 DROP TRIGGER IF EXISTS trg_double_greater_single_update;
23 DELIMITER //
24 CREATE TRIGGER trg_double_greater_single_update
25 BEFORE UPDATE ON Room
26 FOR EACH ROW
27 BEGIN
28     DECLARE max_single_price DECIMAL(10, 2);
29
30     IF NEW.type = 'double' THEN
31        SELECT IFNULL(MAX(price), 0) INTO max_single_price
32        FROM Room
33        WHERE hotelNo = NEW.hotelNo AND type = 'single' AND roomNo != NEW.roomNo;
34
35        IF NEW.price <= max_single_price THEN
36            SIGNAL SQLSTATE '45000'
37            SET MESSAGE_TEXT = 'Error: Double room price must be
greater than highest single room price.';
38        END IF;
39    END IF;
40 END //
41 DELIMITER ;

```

Explanation: Triggers are necessary because this constraint requires comparing the new room price with existing prices in the database, which cannot be done with simple

CHECK constraints.

9.5 Constraint (c) - No Overlapping Bookings

Requirement: A guest cannot make two bookings with overlapping dates.

Solution: Using Triggers

```

1 DROP TRIGGER IF EXISTS trg_no_overlapping_bookings_insert;
2 DELIMITER //
3 CREATE TRIGGER trg_no_overlapping_bookings_insert
4 BEFORE INSERT ON Booking
5 FOR EACH ROW
6 BEGIN
7     DECLARE overlap_count INT;
8
9     SELECT COUNT(*) INTO overlap_count
10    FROM Booking
11   WHERE guestNo = NEW.guestNo
12     AND NOT (NEW.dateTo <= dateFrom OR NEW.dateFrom >= dateTo);
13
14    IF overlap_count > 0 THEN
15        SIGNAL SQLSTATE '45000',
16        SET MESSAGE_TEXT = 'Error: Guest cannot have overlapping
bookings.' ;
17    END IF;
18 END //
19 DELIMITER ;
20
21 DROP TRIGGER IF EXISTS trg_no_overlapping_bookings_update;
22 DELIMITER //
23 CREATE TRIGGER trg_no_overlapping_bookings_update
24 BEFORE UPDATE ON Booking
25 FOR EACH ROW
26 BEGIN
27     DECLARE overlap_count INT;
28
29     SELECT COUNT(*) INTO overlap_count
30    FROM Booking
31   WHERE guestNo = NEW.guestNo
32     AND NOT (hotelNo = OLD.hotelNo AND dateFrom = OLD.dateFrom AND
roomNo = OLD.roomNo)
33     AND NOT (NEW.dateTo <= dateFrom OR NEW.dateFrom >= dateTo);
34
35    IF overlap_count > 0 THEN
36        SIGNAL SQLSTATE '45000',
37        SET MESSAGE_TEXT = 'Error: Guest cannot have overlapping
bookings.' ;
38    END IF;
39 END //
40 DELIMITER ;

```

Explanation: This trigger checks if a guest already has any booking where the dates overlap. The overlap condition is checked using: NOT (new_end \leq existing_start OR new_start \geq existing_end).

9.6 Constraint (d) - Adult Capacity Validation

Requirement: A guest cannot make a booking with number of adults greater than NumAdultMax value of booked room.

Solution: Using Triggers

```

1 DROP TRIGGER IF EXISTS trg_check_num_adults_insert;
2 DELIMITER //
3 CREATE TRIGGER trg_check_num_adults_insert
4 BEFORE INSERT ON Booking
5 FOR EACH ROW
6 BEGIN
7     DECLARE max_adults INT;
8
9     SELECT NumAdultMax INTO max_adults
10    FROM Room
11   WHERE roomNo = NEW.roomNo AND hotelNo = NEW.hotelNo;
12
13    IF NEW.NumOfAdult > max_adults THEN
14        SIGNAL SQLSTATE '45000'
15        SET MESSAGE_TEXT = 'Error: Number of adults exceeds room
capacity.';
16    END IF;
17 END //
18 DELIMITER ;
19
20 DROP TRIGGER IF EXISTS trg_check_num_adults_update;
21 DELIMITER //
22 CREATE TRIGGER trg_check_num_adults_update
23 BEFORE UPDATE ON Booking
24 FOR EACH ROW
25 BEGIN
26     DECLARE max_adults INT;
27
28     SELECT NumAdultMax INTO max_adults
29    FROM Room
30   WHERE roomNo = NEW.roomNo AND hotelNo = NEW.hotelNo;
31
32    IF NEW.NumOfAdult > max_adults THEN
33        SIGNAL SQLSTATE '45000'
34        SET MESSAGE_TEXT = 'Error: Number of adults exceeds room
capacity.';
35    END IF;
36 END //
37 DELIMITER ;

```

Explanation: This trigger retrieves the maximum adult capacity of the room and validates that the booking does not exceed this limit.

9.7 Constraint (e) - Automatic TotalAmount Calculation

Requirement: Automatically calculate the value for totalAmount column of Guest relation.

Solution: Using Triggers (Derived Attribute)

```

1 -- Trigger for INSERT: Add booking cost to guest's total
2 DROP TRIGGER IF EXISTS trg_update_total_amount_insert;
3 DELIMITER //

```

```

4 CREATE TRIGGER trg_update_total_amount_insert
5 AFTER INSERT ON Booking
6 FOR EACH ROW
7 BEGIN
8     DECLARE room_price DECIMAL(10, 2);
9     DECLARE num_days INT;
10    DECLARE booking_cost DECIMAL(12, 2);
11
12    SELECT price INTO room_price FROM Room
13    WHERE roomNo = NEW.roomNo AND hotelNo = NEW.hotelNo;
14
15    SET num_days = DATEDIFF(NEW.dateTo, NEW.dateFrom);
16    SET booking_cost = room_price * num_days;
17
18    UPDATE Guest
19    SET TotalAmount = TotalAmount + booking_cost
20    WHERE guestNo = NEW.guestNo;
21 END //
22 DELIMITER ;
23
24 -- Trigger for DELETE: Subtract booking cost from guest's total
25 DROP TRIGGER IF EXISTS trg_update_total_amount_delete;
26 DELIMITER //
27 CREATE TRIGGER trg_update_total_amount_delete
28 AFTER DELETE ON Booking
29 FOR EACH ROW
30 BEGIN
31     DECLARE room_price DECIMAL(10, 2);
32     DECLARE num_days INT;
33     DECLARE booking_cost DECIMAL(12, 2);
34
35     SELECT price INTO room_price FROM Room
36     WHERE roomNo = OLD.roomNo AND hotelNo = OLD.hotelNo;
37
38     SET num_days = DATEDIFF(OLD.dateTo, OLD.dateFrom);
39     SET booking_cost = room_price * num_days;
40
41     UPDATE Guest
42     SET TotalAmount = TotalAmount - booking_cost
43     WHERE guestNo = OLD.guestNo;
44 END //
45 DELIMITER ;
46
47 -- Trigger for UPDATE: Adjust both guests' totals
48 DROP TRIGGER IF EXISTS trg_update_total_amount_update;
49 DELIMITER //
50 CREATE TRIGGER trg_update_total_amount_update
51 AFTER UPDATE ON Booking
52 FOR EACH ROW
53 BEGIN
54     DECLARE old_room_price DECIMAL(10, 2);
55     DECLARE new_room_price DECIMAL(10, 2);
56     DECLARE old_num_days INT;
57     DECLARE new_num_days INT;
58     DECLARE old_booking_cost DECIMAL(12, 2);
59     DECLARE new_booking_cost DECIMAL(12, 2);
60
61     SELECT price INTO old_room_price FROM Room

```

```

62 WHERE roomNo = OLD.roomNo AND hotelNo = OLD.hotelNo;
63 SELECT price INTO new_room_price FROM Room
64 WHERE roomNo = NEW.roomNo AND hotelNo = NEW.hotelNo;
65
66 SET old_num_days = DATEDIFF(OLD.dateTo, OLD.dateFrom);
67 SET new_num_days = DATEDIFF(NEW.dateTo, NEW.dateFrom);
68 SET old_booking_cost = old_room_price * old_num_days;
69 SET new_booking_cost = new_room_price * new_num_days;
70
71 UPDATE Guest SET TotalAmount = TotalAmount - old_booking_cost
72 WHERE guestNo = OLD.guestNo;
73
74 UPDATE Guest SET TotalAmount = TotalAmount + new_booking_cost
75 WHERE guestNo = NEW.guestNo;
76 END //
77 DELIMITER ;

```

Explanation: Three triggers maintain the TotalAmount: INSERT adds cost (room price \times days), DELETE subtracts cost, and UPDATE adjusts both guests' totals when booking details change.

9.8 Constraint (f) - INSTEAD OF Trigger for View

Requirement: Create an INSTEAD OF database trigger that will allow data to be inserted into the LondonHotelRoom view.

View Definition:

```

1 CREATE VIEW LondonHotelRoom AS
2 SELECT h.hotelNo, hotelName, city, roomNo, type, price
3 FROM Hotel h, Room r
4 WHERE h.hotelNo = r.hotelNo AND city = 'London';

```

MySQL Solution: Stored Procedure (MySQL does not support INSTEAD OF triggers)

```

1 DROP PROCEDURE IF EXISTS InsertIntoLondonHotelRoom;
2 DELIMITER //
3 CREATE PROCEDURE InsertIntoLondonHotelRoom(
4     IN p_hotelNo INT,
5     IN p_hotelName VARCHAR(50),
6     IN p_roomNo INT,
7     IN p_type VARCHAR(20),
8     IN p_price DECIMAL(10, 2)
9 )
10 BEGIN
11     DECLARE hotel_exists INT;
12
13     SELECT COUNT(*) INTO hotel_exists FROM Hotel WHERE hotelNo =
14         p_hotelNo;
15
16     IF hotel_exists = 0 THEN
17         INSERT INTO Hotel (hotelNo, hotelName, city)
18             VALUES (p_hotelNo, p_hotelName, 'London');
19     ELSE
20         UPDATE Hotel SET hotelName = p_hotelName WHERE hotelNo =
21             p_hotelNo;
22     END IF;

```

```

22     INSERT INTO Room (roomNo, hotelNo, type, price)
23         VALUES (p_roomNo, p_hotelNo, p_type, p_price);
24 END // 
25 DELIMITER ;
26
27 -- Usage:
28 -- CALL InsertIntoLondonHotelRoom(99, 'New London Hotel', 901, 'single
   ', 110);

```

Standard SQL (SQL Server/PostgreSQL/Oracle): SQL Server:

```

1 CREATE TRIGGER trg_instead_of_insert_LondonHotelRoom
2 ON LondonHotelRoom
3 INSTEAD OF INSERT
4 AS
5 BEGIN
6     -- Insert/update Hotel table
7     MERGE Hotel AS target
8     USING inserted AS source
9     ON target.hotelNo = source.hotelNo
10    WHEN MATCHED THEN
11        UPDATE SET hotelName = source.hotelName
12    WHEN NOT MATCHED THEN
13        INSERT (hotelNo, hotelName, city)
14        VALUES (source.hotelNo, source.hotelName, 'London');
15
16    -- Insert into Room table
17    INSERT INTO Room (roomNo, hotelNo, type, price)
18        SELECT roomNo, hotelNo, type, price FROM inserted;
19 END;

```

PostgreSQL:

```

1 CREATE OR REPLACE FUNCTION fn_instead_of_insert_LondonHotelRoom()
2 RETURNS TRIGGER AS $$$
3 BEGIN
4     IF NOT EXISTS (SELECT 1 FROM Hotel WHERE hotelNo = NEW.hotelNo)
5     THEN
6         INSERT INTO Hotel (hotelNo, hotelName, city)
7             VALUES (NEW.hotelNo, NEW.hotelName, 'London');
8     ELSE
9         UPDATE Hotel SET hotelName = NEW.hotelName WHERE hotelNo = NEW.
10            hotelNo;
11     END IF;
12
13     INSERT INTO Room (roomNo, hotelNo, type, price)
14         VALUES (NEW.roomNo, NEW.hotelNo, NEW.type, NEW.price);
15
16     RETURN NEW;
17 END;
18 $$ LANGUAGE plpgsql;
19
20 CREATE TRIGGER trg_instead_of_insert_LondonHotelRoom
21 INSTEAD OF INSERT ON LondonHotelRoom
22 FOR EACH ROW
23 EXECUTE FUNCTION fn_instead_of_insert_LondonHotelRoom();

```

Explanation: INSTEAD OF triggers intercept INSERT/UPDATE/DELETE operations on views and execute custom logic instead. For the LondonHotelRoom view, the

trigger inserts into both Hotel and Room tables, ensuring the city is always 'London'.

10 Conclusion

This laboratory exercise demonstrated the implementation of various database constraints and programming constructs in MySQL. The key concepts covered include:

- **Views:** Created multiple views to simplify complex queries and provide different perspectives on the data, including employee department views, project views, and supervisor/supervisee relationships.
- **Triggers:** Implemented triggers for enforcing business rules (salary limits, supervision rules, project management constraints), maintaining derived attributes, logging changes, and preventing unwanted operations.
- **Stored Functions:** Created user-defined functions to encapsulate reusable logic, such as counting employee project assignments.
- **Stored Procedures:** Developed procedures using cursors and control flow statements to process and display data with formatted output.
- **Constraint Types:** Explored different constraint implementation techniques including:
 - Domain/attribute constraints (CHECK constraints)
 - Table-level constraints
 - Triggers for complex business rules
 - INSTEAD OF triggers for view operations

The exercises also highlighted the differences between various database management systems (MySQL, SQL Server, PostgreSQL, Oracle) in their support for features like INSTEAD OF triggers and assertion constraints.

Understanding these database programming concepts is essential for:

- Maintaining data integrity
- Enforcing business rules at the database level
- Creating efficient and reusable database code
- Designing robust database applications