

# 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:**

	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:**

	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_Department	Number_of_Employees	Total_Hours_Per_Week
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:

```

28 | ✓ 28 | INSERT INTO EMPLOYEE VALUES      You, 2 minutes ago • Uncommitted changes
29 |   ('Test', 'A', 'Valid', '111111110', '1990-01-01', '123 Test St', 'M', 25000, '333445555', 5);
30 |   -- Result: Success
31
32 | ↴Run
33 | ! 33 | INSERT INTO EMPLOYEE VALUES  Error: Supervisor must be older than the employee.
34 |   ('Test', 'B', 'Invalid', '111111111', '1940-01-01', '123 Test St', 'M', 25000, '333445555', 5); 4ms
35 |   -- Result: Error - Supervisor must be older than the employee.
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   IF NEW.Super_ssn IS NOT NULL THEN
9     SELECT Salary INTO supervisor_salary FROM EMPLOYEE WHERE Ssn =
10    NEW.Super_ssn;
11
12    IF supervisor_salary IS NOT NULL AND NEW.Salary >=
13      supervisor_salary THEN
14      SIGNAL SQLSTATE '45000'
15      SET MESSAGE_TEXT = 'Error: Employee salary must be less
16      than supervisor salary.';
17      END IF;
18    END IF;
19  END //;
20 DELIMITER ;
21
22 DROP TRIGGER IF EXISTS trg_salary_less_than_supervisor_update;
23 DELIMITER //
24 CREATE TRIGGER trg_salary_less_than_supervisor_update
25 BEFORE UPDATE ON EMPLOYEE
26 FOR EACH ROW
27 BEGIN
28   DECLARE supervisor_salary DECIMAL(10, 2);
29
30   IF NEW.Super_ssn IS NOT NULL THEN
31     SELECT Salary INTO supervisor_salary FROM EMPLOYEE WHERE Ssn =
32    NEW.Super_ssn;
33
34     IF supervisor_salary IS NOT NULL AND NEW.Salary >=
35       supervisor_salary THEN
36       SIGNAL SQLSTATE '45000'
37       SET MESSAGE_TEXT = 'Error: Employee salary must be less
38       than supervisor salary.';
39     END IF;
40   END IF;
41 END //;
42 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);
5 -- Result: Success
6
7 -- INVALID INSERT: Employee salary 50000 > Supervisor salary 40000
8 INSERT INTO EMPLOYEE VALUES
9 ('Test', 'D', 'Invalid', '111111113', '1990-01-01', '123 Test St', 'M',
  50000, '333445555', 5);
10 -- Result: Error - Employee salary cannot be greater than supervisor
11 salary.

```

## Expected Output:

```

40
41  -- Test Constraint a.2: Salary cannot exceed supervisor's salary
42  -----
43  -- VALID INSERT: Employee salary 35000, Supervisor salary 40000
▷Run
✓ 44  INSERT INTO EMPLOYEE VALUES
45  ('Test', 'C', 'Valid', '111111112', '1990-01-01', '123 Test St', 'M', 35000, '333445555', 5);
46  -- Result: Success
47

48  -- INVALID INSERT: Employee salary 50000 > Supervisor salary 40000
▷Run
! 49  INSERT INTO EMPLOYEE VALUES      You, 4 minutes ago • Uncommitted changes Error: Employee salary must be
50  ('Test', 'D', 'Invalid', '111111113', '1990-01-01', '123 Test St', 'M', 50000, '333445555', 5); 3ms
51  -- Result: Error - Employee salary cannot be greater than supervisor salary.
52

```

### 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:

```

16  -----
17  -- Test Constraint a.3: Salary can only increase
18  -----
19  -- VALID UPDATE: Increase salary from 30000 to 32000
▷Run
✓ 20  UPDATE EMPLOYEE SET Salary = 32000 WHERE Ssn = '123456789'; 14ms AffectedRows: 1
21  -- Result: Success
22

23  -----
24  -- INVALID UPDATE: Decrease salary from 32000 to 28000
▷Run
! 25  UPDATE EMPLOYEE SET Salary = 28000 WHERE Ssn = '123456789';  Yo
26  -- Result: Error - Employee salary can only increase, not decrease.
27

```

### 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:

```

72
73 -- VALID UPDATE: Increase salary by 15% (30000 -> 34500)
74 UPDATE EMPLOYEE SET Salary = 34500 WHERE Ssn = '123456789'; 15ms
75 -- Result: Success
76
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.
Essn;

```

```

10
11    IF project_count >= 4 THEN
12        SIGNAL SQLSTATE '45000',
13        SET MESSAGE_TEXT = 'Error: Employee cannot work on more than 4
14        projects.';
15    END IF;
16 END //
17 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
10 fewer projects)
11 -- Check available projects for employee in dept 5
12 SELECT Pnumber FROM PROJECT WHERE Pnumber NOT IN (SELECT Pno FROM
13 WORKS_ON WHERE Essn = '666884444') AND Dnum = 5;
14 INSERT INTO WORKS_ON VALUES ('666884444', 1, 10);
15 -- Result: Success

```

### Expected Output:

```

90 -- INVALID INSERT: Adding 5th project (employee already has 4 projects)
91 -- Note: Use existing project number (10, 20, 30 exist)
92 ! INSERT INTO WORKS_ON VALUES ('123456789', 10, 10); You, 41 seconds
93 -- Result: Error - An employee can work on at most 4 projects.

95 -- VALID INSERT: Employee with less than 4 projects (666884444 has fewer projects)
96 -- Check available projects for employee in dept 5
97 SELECT Pnumber FROM PROJECT WHERE Pnumber NOT IN (SELECT Pno FROM WORKS_ON WHERE Essn = '666884444')
98 ! INSERT INTO WORKS_ON VALUES ('666884444', 1, 10); AffectedRows: 1 8ms You, 20 seconds ago
99 -- 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
18 END //;
19 DELIMITER ;
20
21 DROP TRIGGER IF EXISTS trg_max_56_hours_update;
22 DELIMITER //
23 CREATE TRIGGER trg_max_56_hours_update
24 BEFORE UPDATE ON WORKS_ON
25 FOR EACH ROW
26 BEGIN
27   DECLARE total_hours DECIMAL(5, 1);
28
29   SELECT IFNULL(SUM(Hours), 0) INTO total_hours FROM WORKS_ON
30   WHERE Essn = NEW.Essn AND Pno != OLD.Pno;
31
32   IF (total_hours + IFNULL(NEW.Hours, 0)) > 56 THEN
33     SIGNAL SQLSTATE '45000'
34     SET MESSAGE_TEXT = 'Error: Total weekly hours cannot exceed 56.
35  ';
36   END IF;
37
38 END //;
39 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 -- Result: Success
10
11 -- INVALID INSERT: Adding hours that would exceed 56
12 -- First check if this would exceed: existing hours + new hours > 56
13 INSERT INTO WORKS_ON VALUES ('666884444', 2, 50);
14 -- Result: Error - Total hours per week cannot exceed 56.

```

## Expected Output:

```

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 ✓ INSERT INTO WORKS_ON VALUES ('123456789', 3, 5); 16ms AffectedRows: 1 You, 16 seconds
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
    ▷Run
! 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;
11
12     SELECT Dno INTO emp_dept FROM EMPLOYEE WHERE Ssn = NEW.Essn;
13     SELECT Dnum INTO project_dept FROM PROJECT WHERE Pnumber = NEW.Pno;
14
15     IF emp_dept != project_dept THEN
16         SIGNAL SQLSTATE '45000'
17         SET MESSAGE_TEXT = 'Error: Employee can only work on projects
18 controlled by their department.';
19     END IF;
20 END //
21 DELIMITER ;
22
23 -- Trigger 2: Ensure project location matches department location
24 DROP TRIGGER IF EXISTS trg_project_location_valid;
25 DELIMITER //
26 CREATE TRIGGER trg_project_location_valid
27 BEFORE INSERT ON PROJECT
28 FOR EACH ROW
29 BEGIN
30     DECLARE location_exists INT;
31
32     SELECT COUNT(*) INTO location_exists
33     FROM DEPT_LOCATIONS
34     WHERE Dnumber = NEW.Dnum AND Dlocation = NEW.Plocation;
35
36     IF location_exists = 0 THEN
37         SIGNAL SQLSTATE '45000'
38         SET MESSAGE_TEXT = 'Error: Project location must be one of its
39 department locations.';
```

**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:

```

129  -- VALID INSERT: Project in valid department location
    ▷Run
130  ✓ INSERT INTO PROJECT VALUES ('TestProject', 99, 'Houston', 5);  6ms  AffectedRows: 1
131  -- Result: Success

133  -- INVALID INSERT: Project in location not belonging to department
    ▷Run
134  ! INSERT INTO PROJECT VALUES ('BadProject', 100, 'New York', 5);  I 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
18         IF max_other_salary IS NOT NULL AND NEW.Salary <=
19             max_other_salary THEN
20             SIGNAL SQLSTATE '45000'
21             SET MESSAGE_TEXT = 'Error: Manager salary must be highest
22             in the department.';

```

```

21      END IF;
22  END IF;
23 END // 
24 DELIMITER ;

```

## 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:

```

147 -- VALID INSERT: Employee salary < Manager salary
148 ✓ INSERT INTO EMPLOYEE VALUES
149 ('Test', 'E', 'Valid', '111111114', '1990-01-01', '123 St', 'M', 35000, '333445555', 5);|T15ms
150 -- Result: Success

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

```

## Expected Output:

```

166 -- VALID INSERT: Manager (888665555, Dept 1 manager) working 3 hours on project 20 (dept 1)
167 -- Manager 888665555 currently works only on project 20 with NULL hours
168 ▷Run
168 UPDATE WORKS_ON SET Hours = 3 WHERE Essn = '888665555' AND Pno = 20; 13ms AffectedRows: 1
169 -- Result: Success (managers can work < 5 hours)

171 -- INVALID INSERT: Non-manager (453453453) working 3 hours on project 3 from dept 5
172 ▷Run
172 INSERT INTO WORKS_ON VALUES ('453453453', 3, 3); You, 42 seconds ago • Uncommitt
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',
3                               '123 St', 'M', 25000, '333445555', 5);
4 SELECT Dnumber, Num_of_Emp FROM DEPARTMENT WHERE Dnumber = 5;
5 -- Result: Num_of_Emp = 6 (incremented from 5)
6
7 -- Test DELETE: Remove the employee
8 DELETE FROM EMPLOYEE WHERE Ssn = '999999999';
9 SELECT Dnumber, Num_of_Emp FROM DEPARTMENT WHERE Dnumber = 5;
10 -- 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:**

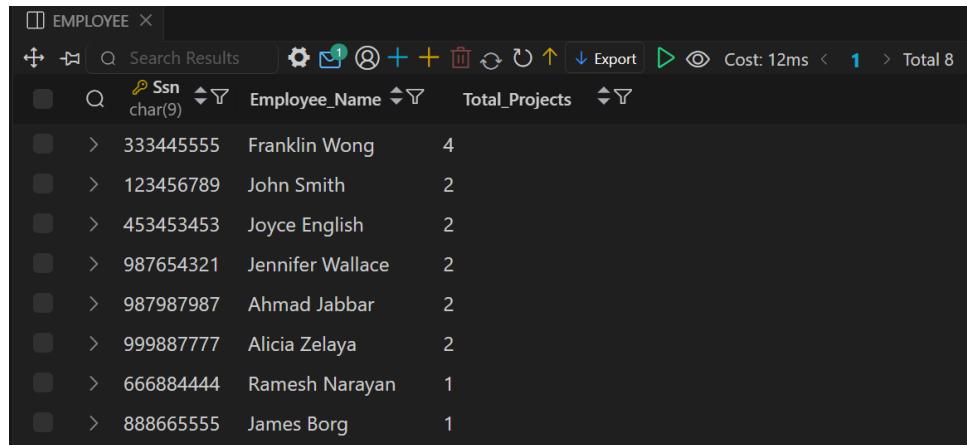
Employee_SSN	Total_Projects
123456789	2

```

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 white text. At the top, there are various icons for search, export, and navigation. Below the title, there is a header row with three columns: "Ssn" (datatype char(9)), "Employee\_Name", and "Total\_Projects". The data is presented in a table format with 8 rows. The first column contains small gray squares with arrows pointing right. The second column contains SSN numbers, and the third column contains employee names and their total projects worked on.

	Ssn char(9)	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 with various icons for search, refresh, export, and settings. The cost of the query is listed as 13ms. The table has four columns: SSN (string), Full\_Name (varchar), Department\_Name (varchar), and Annual\_Salary (decimal). The data consists of 8 rows:

	SSN	Full_Name	Department_Name	Annual_Salary
>	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

**Exercise:** Consider the following schema:

**Hotel**(hotelNo, hotelName, city)  
**Room**(roomNo, hotelNo, type, price) FK: hotelNo refs Hotel  
**Booking**(hotelNo, guestNo, dateFrom, dateTo, roomNo) FK: hotelNo refs Hotel, guestNo refs Guest, (hotelNo, roomNo) refs Room  
**Guest**(guestNo, guestName, guestAddress)

Write a constraint to implement each of the following requirements. For each constraint you should determine the most appropriate technique from the following:

- 1) a domain type, domain constraint, attribute constraint
- 2) a general (table level) constraint
- 3) an assertion
- 4) a trigger
- 5) embedded SQL

### 9.1 Constraint (a) - Room Price

**Requirement:** The price of a room must be between \$10 and \$100.

**Solution:**

```

1 -- Domain Type / Attribute Constraint
2 -- This is best implemented using an attribute/column constraint
3
4 ALTER TABLE Room
5 ADD CONSTRAINT chk_room_price
6 CHECK (price >= 10 AND price <= 100);

```

### Test Validation

```

1 -- Test 1: Try to insert room with price < 10 (should fail)
2 INSERT INTO Room VALUES (301, 1, 'Single', 5);
3
4 -- Test 2: Try to insert room with price > 100 (should fail)
5 INSERT INTO Room VALUES (302, 1, 'Suite', 150);
6
7 -- Test 3: Insert room with valid price (should succeed)
8 INSERT INTO Room VALUES (303, 1, 'Double', 50);

```

**Expected Results:**

Test	Action	Result
Test 1	INSERT price=5	Check constraint violated
Test 2	INSERT price=150	Check constraint violated
Test 3	INSERT price=50	Row inserted

## 9.2 Constraint (b) - Booking Validity

**Requirement:** A booking cannot be for a period of more than 14 days.

**Solution:**

```

1 -- Table Level Constraint
2 -- A CHECK constraint that compares two columns
3
4 ALTER TABLE Booking
5 ADD CONSTRAINT chk_booking_duration
6 CHECK (DATEDIFF(dateTo, dateFrom) <= 14);

```

### Test Validation

```

1 -- Test 1: Try to insert booking for 15 days (should fail)
2 INSERT INTO Booking VALUES
3     (1, 1, '2024-01-01', '2024-01-16', 101);
4
5 -- Test 2: Insert booking for exactly 14 days (should succeed)
6 INSERT INTO Booking VALUES
7     (1, 2, '2024-02-01', '2024-02-15', 102);
8
9 -- Test 3: Insert booking for 7 days (should succeed)
10 INSERT INTO Booking VALUES
11    (1, 3, '2024-03-01', '2024-03-08', 103);

```

**Expected Results:**

Test	Action	Result
Test 1	INSERT 15-day booking	Check constraint violated
Test 2	INSERT 14-day booking	Row inserted
Test 3	INSERT 7-day booking	Row inserted

## 9.3 Constraint (c) - No Double Booking

**Requirement:** No room can be double-booked (i.e., the same room in the same hotel cannot be booked by two different guests for the same dates, or dates that would overlap with an existing booking).

**Solution:**

```

1 -- Trigger (required for complex logic with overlapping dates)
2 DELIMITER //
3 CREATE TRIGGER trg_no_double_booking
4 BEFORE INSERT ON Booking
5 FOR EACH ROW
6 BEGIN
7     DECLARE conflict_count INT;
8
9     SELECT COUNT(*) INTO conflict_count
10    FROM Booking
11   WHERE hotelNo = NEW.hotelNo
12     AND roomNo = NEW.roomNo
13     AND (
14         (NEW.dateFrom BETWEEN dateFrom AND dateTo)
15        OR (NEW.dateTo BETWEEN dateFrom AND dateTo)
16        OR (dateFrom BETWEEN NEW.dateFrom AND NEW.dateTo)
17        OR (dateTo BETWEEN NEW.dateFrom AND NEW.dateTo)

```

```

18    );
19
20    IF conflict_count > 0 THEN
21        SIGNAL SQLSTATE '45000',
22        SET MESSAGE_TEXT = 'Room is already booked for overlapping
dates';
23    END IF;
24 END // 
25 DELIMITER ;

```

## Test Validation

```

1 -- Setup: Insert initial booking
2 INSERT INTO Booking VALUES
3     (1, 1, '2024-04-10', '2024-04-15', 101);
4
5 -- Test 1: Try overlapping booking (should fail)
6 INSERT INTO Booking VALUES
7     (1, 2, '2024-04-12', '2024-04-18', 101);
8
9 -- Test 2: Non-overlapping booking (should succeed)
10 INSERT INTO Booking VALUES
11     (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

## 9.4 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
23      for Grosvenor hotel';
24      END IF;
25  END IF;
26 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”.

## 9.5 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 FOR EACH ROW
6 BEGIN
7     DECLARE hotel_city VARCHAR(50);
8
9     SELECT city INTO hotel_city
10    FROM Hotel
11   WHERE hotelNo = NEW.hotelNo;
12
13    IF hotel_city = 'London' AND NEW.price > OLD.price * 1.10 THEN
14        SIGNAL SQLSTATE '45000'
15        SET MESSAGE_TEXT = 'Price increase for London hotels cannot
16        exceed 10%';
17    END IF;
17 END //
18 DELIMITER ;

```

## Test Validation

```

1 -- Setup: London hotel and room
2 INSERT INTO Hotel VALUES (20, 'Royal', 'London');
3 INSERT INTO Room VALUES (201, 20, 'Double', 80);

```

```

4
5 -- Test 1: Try to increase price by 15% (should fail)
6 UPDATE Room SET price = 92 WHERE roomNo = 201 AND hotelNo = 20;
7
8 -- Test 2: Increase price by 10% (should succeed)
9 UPDATE Room SET price = 88 WHERE roomNo = 201 AND hotelNo = 20;

```

**Expected Results:**

Test	Action	Result
Setup	INSERT Room price=80	Row inserted
Test 1	UPDATE to 92 (15% increase)	Trigger error
Test 2	UPDATE to 88 (10% increase)	Row updated

## 9.6 Constraint (f) - No Direct Deletes

**Requirement:** The users cannot directly delete the records from the Hotel table. However, they should still be able to delete records through the Vhotel1 view.

**Solution:**

This requirement needs a combination of:

1. A trigger to prevent direct DELETEs on the Hotel table
2. An INSTEAD OF trigger on the view to allow deletes through the view

**Part 1: Prevent direct deletes on Hotel table**

```

1 -- Trigger to prevent direct deletes on Hotel table
2 DELIMITER //
3 CREATE TRIGGER trg_prevent_hotel_delete
4 BEFORE DELETE ON Hotel
5 FOR EACH ROW
6 BEGIN
7     -- Check if delete is coming from view (using session variable)
8     IF @deleting_from_view IS NULL OR @deleting_from_view = FALSE THEN
9         SIGNAL SQLSTATE '45000'
10        SET MESSAGE_TEXT = 'Direct deletion from Hotel table is not
11        allowed. Use Vhotel1 view instead.';
12    END IF;
13 END //
14 DELIMITER ;

```

**Part 2: Create view and allow deletions through it**

```

1 -- Create the Vhotel1 view
2 CREATE OR REPLACE VIEW Vhotel1 AS
3 SELECT hotelNo, hotelName, city FROM Hotel;
4
5 -- Stored procedure to delete through view
6 DELIMITER //
7 CREATE PROCEDURE DeleteFromVhotel1(IN p_hotelNo INT)
8 BEGIN
9     SET @deleting_from_view = TRUE;
10    DELETE FROM Hotel WHERE hotelNo = p_hotelNo;
11    SET @deleting_from_view = FALSE;
12 END //
13 DELIMITER ;

```

## INSTEAD OF Trigger Syntax (Other DBMS)

### SQL Server:

```

1 -- SQL Server supports INSTEAD OF triggers on views
2 CREATE VIEW Vhotel1 AS
3 SELECT hotelNo, hotelName, city FROM Hotel;
4 GO
5
6 CREATE TRIGGER trg_vhotel1_delete
7 ON Vhotel1
8 INSTEAD OF DELETE
9 AS
10 BEGIN
11     DELETE FROM Hotel WHERE hotelNo IN (SELECT hotelNo FROM deleted);
12 END;
13 GO

```

### PostgreSQL:

```

1 -- PostgreSQL uses trigger functions
2 CREATE OR REPLACE VIEW Vhotel1 AS
3 SELECT hotelNo, hotelName, city FROM Hotel;
4
5 CREATE OR REPLACE FUNCTION fn_vhotel1_delete()
6 RETURNS TRIGGER AS $$$
7 BEGIN
8     DELETE FROM Hotel WHERE hotelNo = OLD.hotelNo;
9     RETURN OLD;
10 END;
11 $$ LANGUAGE plpgsql;
12
13 CREATE TRIGGER trg_vhotel1_delete
14 INSTEAD OF DELETE ON Vhotel1
15 FOR EACH ROW EXECUTE FUNCTION fn_vhotel1_delete();

```

### Oracle:

```

1 -- Oracle supports INSTEAD OF triggers on views
2 CREATE OR REPLACE VIEW Vhotel1 AS
3 SELECT hotelNo, hotelName, city FROM Hotel;
4
5 CREATE OR REPLACE TRIGGER trg_vhotel1_delete
6 INSTEAD OF DELETE ON Vhotel1
7 FOR EACH ROW
8 BEGIN
9     DELETE FROM Hotel WHERE hotelNo = :OLD.hotelNo;
10 END;
11 /

```

## Test Validation

```

1 -- Setup: Insert a test hotel
2 INSERT INTO Hotel VALUES (99, 'Test Hotel', 'Test City');
3
4 -- Test 1: Try direct delete (should fail)
5 DELETE FROM Hotel WHERE hotelNo = 99;
6
7 -- Test 2: Delete through view procedure (should succeed)
8 CALL DeleteFromVhotel1(99);

```

**Expected Results:**

Test	Action	Result
Setup	INSERT Hotel 99	Row inserted
Test 1	Direct DELETE	Trigger error
Test 2	CALL DeleteFromVhotel1(99)	Row deleted

## 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