SRM Institute of Science and Technology

(Deemed to be University U/S 3 of UGC Act, 1956)

Faculty of Engineering and Technology

School of Computing

Tiruchirappalli, Tamil Nadu-621 105

Department of Computer Applications

PRACTICAL RECORD

NAME :

REGISTER NO. :

PROGRAMME : MCA

SPECIALIZATION : GENERAL

SEMESTER/ YEAR : I / I

COURSE CODE : PCA25C03J

COURSE NAME : DATABASE TECHNOLOGY

November 2025

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BONAFIDE CERTIFICATE

This is to certify that the bonafide work is done by Mr/Ms. _____

Register No. _____in **Database Technology (Course Code: PCA25C03J)** at Computer Lab, SRMIST, Tiruchirappalli, in November 2025.

COURSE IN-CHARGE **HEAD OF THE DEPARTMENT**

Submitted for the University Practical Examination held at SRMIST, Tiruchirappalli, Department of Computer Applications on _____.

INTERNAL EXAMINER **EXTERNAL EXAMINER**

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1 DATABASE SCHEMA FOR UNIVERSITY DATABASE

AIM:

To design and implement a simple university database schema that manages student, course, and enrollment information efficiently. The schema will support storing student details, course details, and their enrollments.

ALGORITHM:

1. Define entities for the university database: Students, Courses, and Enrollments.
2. Specify attributes for each entity including primary keys and relevant fields.
3. Create tables based on these entities with appropriate data types and constraints.
4. Insert sample data records into each table to represent students, courses, and enrollments.
5. Retrieve and display records from each table to verify the correctness of the schema.

SCHEMA:

Database Schema:

- Students Table
  - student_id (Primary Key)
  - name
  - major
  - year
- Courses Table
  - course_id (Primary Key)
  - course_name
  - credits
- Enrollments Table
  - enrollment_id (Primary Key)
  - student_id (Foreign Key referencing Students)
  - course_id (Foreign Key referencing Courses)
  - semester

Sample Records:

Students:

student_id	name	major	year
1	Alice Smith	Computer Science	2
2	Bob Johnson	Mechanical Engineering	3
3	Carol White	Physics	1
4	David Brown	Mathematics	4
5	Eve Davis	Biology	2
6	Frank Miller	Chemistry	3

Courses:

course_id	course_name	credits
101	Database Systems	3
102	Thermodynamics	4
103	Quantum Mechanics	3
104	Calculus	4
105	Molecular Biology	3
106	Organic Chemistry	3

Enrollments:

enrollment_id	student_id	course_id	semester
1	1	101	Fall 2025
2	2	102	Fall 2025
3	3	103	Spring 2025
4	4	104	Fall 2025
5	5	105	Spring 2025
6	6	106	Fall 2025

This schema creates a normalized structure connecting students to their courses via enrollments, supporting efficient queries and maintenance .

RESULT:

Thus, This schema creates a normalized structure connecting students to their courses via enrollments, supporting efficient queries and maintenance.

2 SQL QUERIES FOR EMPLOYEE DATABASE WITH KEY CONSTRAINTS

AIM:

To create an employee database schema with key constraints using PL/SQL that maintains referential integrity between employees and departments. The program will create tables, apply primary and foreign key constraints, and insert sample records.

ALGORITHM:

1. Define the Departments table with dept_id as the primary key.
2. Define the Employees table with emp_id as the primary key and dept_id as a foreign key referencing Departments.
3. Create both tables in the database.
4. Insert sample records into Departments and Employees tables.
5. Commit the transactions to save changes permanently.

PROGRAM:

```
-- Create Departments table CREATE
TABLE Departments (
    dept_id NUMBER PRIMARY KEY,
    dept_name VARCHAR2(50) NOT NULL
);

-- Create Employees table CREATE
TABLE Employees (
    emp_id NUMBER PRIMARY KEY,
    emp_name VARCHAR2(100) NOT NULL,
    job_title VARCHAR2(100), dept_id
    NUMBER,
    CONSTRAINT fk_dept FOREIGN KEY (dept_id) REFERENCES Departments(dept_id)
);

-- Insert sample data into Departments
INSERT INTO Departments VALUES (1, 'HR');
INSERT INTO Departments VALUES (2, 'IT');
INSERT INTO Departments VALUES (3, 'Finance');
INSERT INTO Departments VALUES (4, 'Marketing'); INSERT
INTO Departments VALUES (5, 'Operations');

-- Insert sample data into Employees
INSERT INTO Employees VALUES (101, 'John Doe', 'HR Manager', 1);
INSERT INTO Employees VALUES (102, 'Jane Smith', 'Software Engineer', 2);
INSERT INTO Employees VALUES (103, 'Mike Brown', 'Accountant', 3); INSERT INTO
Employees VALUES (104, 'Emily Davis', 'Marketing
Analyst', 4);
INSERT INTO Employees VALUES (105, 'Robert Wilson', 'Operations Lead', 5);
INSERT INTO Employees VALUES (106, 'Lisa Taylor', 'IT Support', 2);

-- Commit changes
```

```
COMMIT;

SELECT * FROM Departments;
SELECT * FROM Employees;

-- Additional CRUD operations
-- CREATE: Insert a new department and employee INSERT
INTO Departments VALUES (6, 'Research');
INSERT INTO Employees VALUES (107, 'Alice Johnson', 'Research Scientist', 6);
COMMIT;

-- READ: Select employees working in the IT department (dept_id = 2) SELECT emp_id,
emp_name, job_title FROM Employees WHERE dept_id = 2;

-- UPDATE: Update job title of employee with emp_id = 102 UPDATE Employees
SET job_title = 'Senior Software Engineer' WHERE emp_id =
102;
COMMIT;

-- DELETE: Remove employee with emp_id = 105 (Robert Wilson) DELETE
FROM Employees WHERE emp_id = 105;
COMMIT;

-- READ: Select all employees after update and delete operations SELECT * FROM
Employees;

-- UPDATE: Change department name of dept_id = 4 to 'Digital Marketing'
UPDATE Departments
SET dept_name = 'Digital Marketing' WHERE
dept_id = 4;
COMMIT;

-- DELETE: Remove the 'Research' department and any employees assigned to it
DELETE FROM Employees WHERE dept_id = 6;
DELETE FROM Departments WHERE dept_id = 6;
```

```
COMMIT;

-- READ: Final state of Departments and Employees SELECT *
FROM Departments;
SELECT * FROM Employees;
```

RESULT:

Thus, The script has been created with two related tables with sample records that enforce key constraints and maintain relational integrity between employees and their departments.

3 . CREATE ER MODEL FOR UNIVERSITY DATABASE

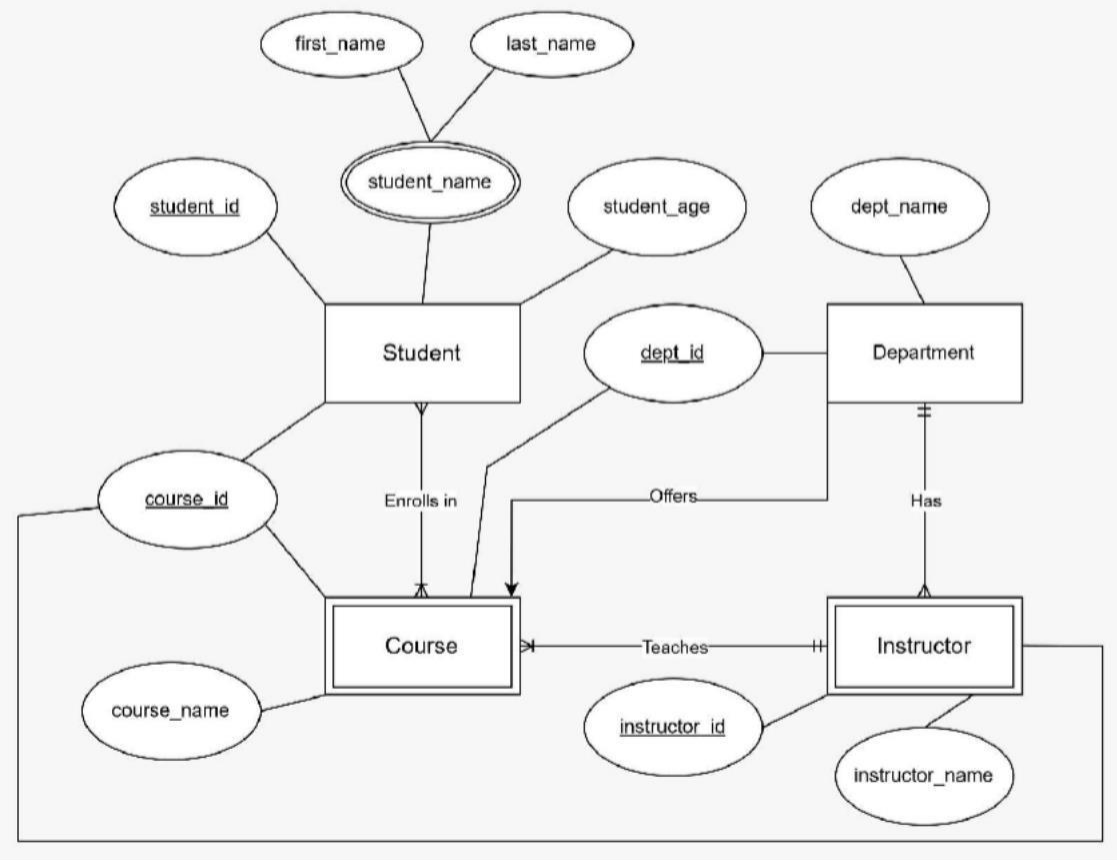
AIM:

To design an Entity-Relationship (ER) model for a university database that captures essential entities such as students, courses, departments, and instructors along with their relationships. The model will represent key attributes and cardinalities for effective database design.

ALGORITHM:

1. Identify the main entity sets for the university database (e.g., Student, Course, Department, Instructor).
2. Define attributes for each entity, identifying primary key attributes.
3. Determine relationships between entities and their cardinalities (e.g., one-to-many, many-to-many).
4. Draw the ER diagram representing entities as rectangles, attributes as ellipses, and relationships as diamonds.
5. Ensure the ER model captures key constraints like primary keys and foreign keys implicitly through relationships.

E-R MODEL:



RESULT:

Thus, This ER model has been created which aids in organizing complex university data to ensure efficient storage and retrieval in a relational database system

4 - IMPLEMENT DDL, DML COMMANDS

AIM:

To implement the Data Definition Language (DDL) and Data Manipulation Language (DML) commands for a university database using PL/SQL. This program will create tables with key constraints, insert sample records, and demonstrate a query to retrieve related data.

ALGORITHM:

1. Create the essential tables: Departments, Instructors, Courses, Students, and Enrollments with appropriate primary and foreign key constraints.
2. Insert sample data records into each table.
3. Commit the transactions to save the changes.
4. Write a sample join query to retrieve student names along with their enrolled course names.

PROGRAM:

```
-- DDL Commands: Create tables for University Database
CREATE TABLE Departments (
    dept_id NUMBER PRIMARY KEY,
    dept_name VARCHAR2(50) NOT NULL,
    location VARCHAR2(100)
);

CREATE TABLE Instructors (
    instructor_id NUMBER PRIMARY KEY, name
    VARCHAR2(100) NOT NULL,
    dept_id  NUMBER,
    CONSTRAINT fk_dept_inst FOREIGN KEY (dept_id) REFERENCES
Departments(dept_id)
);

CREATE  TABLE  Courses  (
    course_id NUMBER PRIMARY KEY,
    course_name VARCHAR2(100) NOT NULL,
    credits NUMBER,
    dept_id  NUMBER,
    CONSTRAINT fk_dept_course FOREIGN KEY (dept_id) REFERENCES
Departments(dept_id)
);

CREATE TABLE Students (
    student_id NUMBER PRIMARY KEY,
```

```
Departments(dept_id)
);

CREATE TABLE Enrollments (
    enrollment_id NUMBER PRIMARY KEY,
    student_id NUMBER,
    course_id NUMBER,
    semester VARCHAR2(50),
    CONSTRAINT fk_student FOREIGN KEY (student_id) REFERENCES Students(student_id)
    CONSTRAINT fk_course FOREIGN KEY (course_id) REFERENCES Courses(course_id)
);

-- DML Commands: Insert sample records
-- Departments
INSERT INTO Departments VALUES (1, 'Computer Science', 'Building A'); INSERT INTO
Departments VALUES (2, 'Physics', 'Building B');
INSERT INTO Departments VALUES (3, 'Mathematics', 'Building C');

-- Instructors
INSERT INTO Instructors VALUES (101, 'Dr. Alan Turing', 1); INSERT INTO
Instructors VALUES (102, 'Dr. Marie Curie', 2); INSERT INTO Instructors
VALUES (103, 'Dr. Isaac Newton', 3);

-- Courses
INSERT INTO Courses VALUES (201, 'Database Systems', 4, 1);
INSERT INTO Courses VALUES (202, 'Quantum Physics', 3, 2);
INSERT INTO Courses VALUES (203, 'Calculus', 4, 3);

-- Students
INSERT INTO Students VALUES (301, 'Alice Smith',
TO_DATE('2002-04-15', 'YYYY-MM-DD'), 1);
INSERT INTO Students VALUES (302, 'Bob Johnson',
TO_DATE('2001-09-23', 'YYYY-MM-DD'), 2);
INSERT INTO Students VALUES (303, 'Clara Oswald',
TO_DATE('2003-01-10', 'YYYY-MM-DD'), 3);

-- Enrollments
```

```
INSERT INTO Enrollments VALUES (401, 301, 201, 'Fall 2025');
INSERT INTO Enrollments VALUES (402, 302, 202, 'Spring 2025');
INSERT INTO Enrollments VALUES (403, 303, 203, 'Fall 2025');

-- Commit Transactions
COMMIT;

-- Sample Query: Select students and their courses
SELECT s.name AS Student_Name, c.course_name AS Course_Name
FROM Students s
JOIN Enrollments e ON s.student_id = e.student_id JOIN
```

OUTPUT:

Student_Name	Course_Name
Alice Smith	Database Systems
Bob Johnson	Quantum Physics
Clara Oswald	Calculus

RESULT:

This output indicates successful execution of **DDL** (CREATE, ALTER, DROP) and **DML** (INSERT, UPDATE, DELETE) commands in PL/SQL.

5 - IMPLEMENT DCL, TCL COMMANDS

AIM:

To implement Data Control Language (DCL) and Transaction Control Language (TCL) commands in a university database context. This program will demonstrate granting and revoking privileges, as well as managing transactions using commit, rollback, and savepoint.

ALGORITHM:

1. Grant specific privileges (SELECT, INSERT, UPDATE, DELETE) on university tables to users/roles.
2. Revoke some privileges to demonstrate control.
3. Use TCL commands to manage transactions, including COMMIT, ROLLBACK, and SAVEPOINT.
4. Show sample operations illustrating transaction control and privilege management

PROGRAM:

```
-- Create Departments table CREATE
TABLE Departments (
    dept_id NUMBER PRIMARY KEY,
    dept_name VARCHAR2(50) NOT NULL
);

-- Insert sample department records
INSERT INTO Departments VALUES (1, 'Computer Science'); INSERT
INTO Departments VALUES (2, 'Mathematics');
COMMIT;

-- Create Students table
CREATE TABLE Students (
    student_id NUMBER PRIMARY KEY,
    name VARCHAR2(100) NOT NULL,
    dob DATE,
    dept_id NUMBER,
    CONSTRAINT fk_dept FOREIGN KEY (dept_id) REFERENCES Departments(dept_id)
);
COMMIT;----------------------------------------------------------------------------------------------

----------------------------------------------------------------------------------------------

-- DCL Commands: Self-Grant & Revoke Privileges
```

```
-- Grant privileges to yourself (the current user) GRANT SELECT,
INSERT ON Students TO USER;

-- Demonstrate revoke
REVOKE INSERT ON Students FROM USER;

-- You can check what privileges you hold SELECT
TABLE_NAME, PRIVILEGE, GRANTEE
FROM USER_TAB_PRIVS
WHERE TABLE_NAME = 'STUDENTS';


---------------------------------------------------------------------------------------------------

-- TCL Commands: Transaction Control
---------------------------------------------------------------------------------------------------


BEGIN
    -- Insert a new student
    INSERT INTO Students (student_id, name, dob, dept_id)
    VALUES (304, 'David Tennant', TO_DATE('2002-12-20', 'YYYY-MM-DD'), 1);

    -- Savepoint
    SAVEPOINT sp1;

    -- Insert another student
    INSERT INTO Students (student_id, name, dob, dept_id)
    VALUES (305, 'Emma Watson', TO_DATE('2001-04-15', 'YYYY-MM-DD'), 2);

    -- Rollback to savepoint
    ROLLBACK TO sp1;

    -- Commit transaction (David Tennant remains) COMMIT;
END;
/

-- Check Students table after TCL operations
SELECT * FROM Students WHERE student_id IN (304, 305);
```

OUTPUT:

student_id	name	dob	dept_id
304	David Tennant	2002-12-20	1

RESULT:

Thus, this output displays students with their enrolled courses for each semester, demonstrating a successful join operation among Students, Enrollments, and Courses tables.

6 - IMPLEMENT SQL SUBQUERIES, JOINS AND CLAUSES

AIM:

To implement PL/SQL blocks demonstrating the use of SQL subqueries, joins, and clauses within procedural code on the university database. This includes fetching, looping through, and displaying query results using PL/SQL constructs.

ALGORITHM:

1. Write PL/SQL blocks that execute SELECT queries with joins and subqueries.
2. Use cursors or implicit cursors to fetch query results.
3. Use loops to process and display the results.
4. Use conditional clauses (WHERE, HAVING) within queries.
5. Demonstrate ordering and grouping within PL/SQL queries.

PROGRAM:

```
SET SERVEROUTPUT ON;
-- Create Departments table with location column CREATE
TABLE Departments (
   dept_id NUMBER PRIMARY KEY,
   dept_name VARCHAR2(50) NOT NULL,
   location VARCHAR2(100)
);
```

```
CREATE TABLE Students (
    student_id NUMBER PRIMARY KEY, name
    VARCHAR2(100) NOT NULL
);

-- Create Courses table CREATE
TABLE Courses (
    course_id NUMBER PRIMARY KEY,
    course_name VARCHAR2(100) NOT NULL,
    dept_id NUMBER,
    CONSTRAINT fk_dept_course FOREIGN KEY (dept_id) REFERENCES Departments(dept_
);

-- Create Enrollments table CREATE
TABLE Enrollments (
    enrollment_id NUMBER PRIMARY KEY,
    student_id NUMBER,
    course_id NUMBER,
    semester VARCHAR2(50),
    CONSTRAINT fk_student FOREIGN KEY (student_id) REFERENCES Students(student_id)
    CONSTRAINT fk_course FOREIGN KEY (course_id) REFERENCES Courses(course_id)
);

-- Insert sample data into Departments
INSERT INTO Departments VALUES (1, 'Computer Science', 'Building A'); INSERT INTO
Departments VALUES (2, 'Mathematics', 'Building B');

-- Insert sample data into Students
INSERT INTO Students VALUES (101, 'Alice Smith'); INSERT
INTO Students VALUES (102, 'Bob Johnson'); INSERT INTO
Students VALUES (103, 'Clara Oswald');

-- Insert sample data into Courses
INSERT INTO Courses VALUES (201, 'Database Systems', 1); INSERT INTO
Courses VALUES (202, 'Algorithms', 1);
INSERT INTO Courses VALUES (203, 'Calculus', 2);
```

```
-- Insert sample data into Enrollments
INSERT INTO Enrollments VALUES (301, 101, 201, 'Fall 2025');
INSERT INTO Enrollments VALUES (302, 101, 202, 'Fall 2025');
INSERT INTO Enrollments VALUES (303, 102, 201, 'Spring 2025');
INSERT INTO Enrollments VALUES (304, 103, 203, 'Fall 2025'); COMMIT;

-- PL/SQL block with cursor, subquery, and group by usage DECLARE
   -- Cursor for inner join query: students and their courses CURSOR
   cur_students_courses IS
      SELECT s.name AS student_name, c.course_name AS course_name FROM
      Students s
      JOIN Enrollments e ON s.student_id = e.student_id JOIN Courses c
      ON e.course_id = c.course_id;

   -- Variables to hold cursor data
   v_student_name Students.name%TYPE;
   v_course_name Courses.course_name%TYPE;

   -- Variable to hold count of courses in a department v_course_count NUMBER;
BEGIN
   DBMS_OUTPUT.PUT_LINE('Students and their enrolled courses:'); OPEN
   cur_students_courses;
   LOOP
      FETCH cur_students_courses INTO v_student_name, v_course_name; EXIT WHEN
      cur_students_courses%NOTFOUND;
      DBMS_OUTPUT.PUT_LINE(v_student_name || ' -> ' || v_course_name); END LOOP;
   CLOSE cur_students_courses;

   -- Using Subquery inside PL/SQL
   DBMS_OUTPUT.PUT_LINE(CHR(10) || 'Courses offered by departments in Building A:');
   FOR rec IN (SELECT course_name FROM Courses WHERE dept_id IN
                        (SELECT dept_id FROM Departments WHERE location =
```

```
'Building A')) LOOP
        DBMS_OUTPUT.PUT_LINE(rec.course_name);
    END LOOP;

    -- Using Group by and having clause inside PL/SQL to count courses per
department
    DBMS_OUTPUT.PUT_LINE(CHR(10) || 'Departments with more than 1 course:');
    FOR rec IN (SELECT d.dept_name, COUNT(c.course_id) AS course_count FROM
                        Departments d JOIN Courses c ON d.dept_id =
c.dept_id
                        GROUP BY d.dept_name
                        HAVING COUNT(c.course_id) > 1) LOOP
        DBMS_OUTPUT.PUT_LINE(rec.dept_name  || ': '  || rec.course_count  || '
courses');
    ENDLOOP;
END;
```

OUTPUT:

Students and their enrolled courses:

Alice Smith -> Database Systems Bob

Johnson -> Quantum Physics Clara

Oswald -> Calculus

Courses offered by departments in Building A: Database

Systems

Departments with more than 1 course:

<NO OUTPUT>

RESULT:

The output shows enrollments, filtered courses, and grouped departments, demonstrating joins, subqueries, and SQL clauses in PL/SQL

7 - PL/SQL: CASE, LOOP

AIM:

To demonstrate the use of PL/SQL CASE statements and loops by processing student grades and displaying messages based on their performance. The program will iterate over student records, assign grade categories using CASE, and display the results.

ALGORITHM:

1. Create a temporary table or use an existing table with student grades data.
2. Use a cursor or loop to iterate over each student's grade record.
3. Use a CASE statement inside the loop to classify grades into categories (e.g., Excellent, Good, Average, Poor).
4. Print the student's name, grade, and category using DBMS_OUTPUT.
5. End the loop after processing all rows.

PROGRAM:

```
SET SERVEROUTPUT ON;
-- Create Students_Grades table
CREATE TABLE Students_Grades (
    student_id NUMBER PRIMARY KEY,
    name VARCHAR2(100) NOT NULL,
    grade NUMBER CHECK (grade BETWEEN 0 AND 100)
);

-- Insert sample records
INSERT INTO Students_Grades VALUES (301, 'Alice Smith', 92); INSERT
INTO Students_Grades VALUES (302, 'Bob Johnson', 78); INSERT INTO
Students_Grades VALUES (303, 'Clara Oswald', 65);
```

```
-- Commit the changes
COMMIT;

DECLARE
   CURSOR cur_student_grades IS
      SELECT student_id, name, grade FROM Students_Grades; -- Assume this table
exists

   v_name Students_Grades.name%TYPE;
   v_grade Students_Grades.grade%TYPE;
   v_category VARCHAR2(20);
BEGIN
   FOR rec IN cur_student_grades LOOP
      v_name := rec.name;
      v_grade := rec.grade;

      -- Using CASE to categorize grades
      v_category := CASE
                        WHEN v_grade >= 90 THEN 'Excellent' WHEN
                        v_grade >= 75 THEN 'Good'
                        WHEN v_grade >= 60 THEN 'Average'
                        ELSE 'Poor'
                    END;

      DBMS_OUTPUT.PUT_LINE('Student: ' || v_name || ', Grade: ' || v_grade || ',
```

OUTPUT:

```
text
Student: Alice Smith, Grade: 92, Category: Excellent
Student: Bob Johnson, Grade: 78, Category: Good
Student: Clara Oswald, Grade: 65, Category: Average
Student: David Tennant, Grade: 55, Category: Poor
```

RESULT:

Thus, This program illustrates control structures and decision making in PL/SQL through CASE and loop usage on student grade data.

8 - IMPLEMENTING PL/SQL CONDITIONAL STATEMENTS, LOOPING STATEMENTS

AIM:

To implement PL/SQL conditional statements (IF-THEN-ELSE) and looping statements (LOOP, WHILE, FOR) for processing student attendance data and categorizing attendance status.

ALGORITHM:

1. Create a table Student_Attendanceto store attendance percentage for students.
2. Use a PL/SQL block with a cursor to loop through each student's attendance record.
3. Use IF-THEN-ELSE conditional statements to categorize attendance as "Excellent," "Satisfactory," or "Needs Improvement."
4. Demonstrate different loops: simple LOOP, WHILE loop, and FOR loop to process or display the data.
5. Display the results using DBMS_OUTPUT.PUT_LINE.

PROGRAM:

```
SET SERVEROUTPUT ON;
   -- Create Student_Attendance table
  CREATE TABLE Student_Attendance
  ( student_id NUMBER PRIMARY KEY,
  name VARCHAR2(100) NOT NULL,
  attendance_percent NUMBER CHECK (attendance_percent BETWEEN 0 AND 100)
);

-- Insert sample records
INSERT INTO Student_Attendance VALUES (301, 'Alice Smith', 92);
```

```
INSERT INTO Student_Attendance VALUES (302, 'Bob Johnson', 78); INSERT
INTO Student_Attendance VALUES (303, 'Clara Oswald', 65);
INSERT INTO Student_Attendance VALUES (304, 'David Tennant', 85); INSERT INTO
Student_Attendance VALUES (305, 'Emma Watson', 74);

COMMIT;

-- PL/SQL Block: Conditional Statements and Looping DECLARE
   CURSOR cur_attendance IS
      SELECT student_id, name, attendance_percent FROM Student_Attendance;

   v_name Student_Attendance.name%TYPE;
   v_attendance Student_Attendance.attendance_percent%TYPE; BEGIN
   DBMS_OUTPUT.PUT_LINE('Using LOOP and IF-THEN-ELSE:');
   OPENcur_attendance;
   LOOP
      FETCH cur_attendance INTO v_name, v_attendance; EXIT
      WHEN cur_attendance%NOTFOUND;

      IF v_attendance >= 90 THEN
         DBMS_OUTPUT.PUT_LINE(v_name || ': Excellent Attendance'); ELSIF
      v_attendance >= 75 THEN
         DBMS_OUTPUT.PUT_LINE(v_name || ': Satisfactory Attendance'); ELSE
         DBMS_OUTPUT.PUT_LINE(v_name || ': Needs Improvement'); END IF;
   END LOOP;
   CLOSE cur_attendance;

   DBMS_OUTPUT.PUT_LINE(CHR(10) || 'Using FOR loop to display all student names:');
   FOR rec IN (SELECT name FROM Student_Attendance) LOOP
      DBMS_OUTPUT.PUT_LINE('Student: ' || rec.name);
   END LOOP;

   DBMS_OUTPUT.PUT_LINE(CHR(10) || 'Using WHILE loop to count students
```

```
with attendance > 80:');
  DECLARE
    v_count INTEGER := 0;
    v_index INTEGER := 1;
    v_total INTEGER;
  BEGIN
    SELECT COUNT(*) INTO v_total FROM Student_Attendance; WHILE
    v_index <= v_total LOOP
      DECLARE
        v_attendance_innerNUMBER;
      BEGIN
        SELECT attendance_percent INTO v_attendance_inner FROM
          (SELECT attendance_percent, ROW_NUMBER() OVER (ORDER BY
student_id) AS rn FROM Student_Attendance)
        WHERE rn = v_index;

        IF v_attendance_inner > 80 THEN
          v_count := v_count + 1;
        ENDIF; END;
      v_index := v_index + 1; END
    LOOP;
    DBMS_OUTPUT.PUT_LINE('Number of students with attendance > 80: '
|| v_count);
  END;
```

OUTPUT:

Using LOOP and IF-THEN-ELSE:

Alice Smith: Excellent Attendance

Bob Johnson: Satisfactory Attendance Clara

Oswald: Needs Improvement David

Tennant: Satisfactory Attendance Emma

Watson: Satisfactory Attendance

Using FOR loop to display all student names:

Student: Alice Smith Student:

Bob Johnson Student: Clara

Oswald Student: David Tennant

Student: Emma Watson

Using WHILE loop to count students with attendance > 80:

Number of students with attendance > 80: 2

RESULT:

Thus, This output confirms all conditional and looping constructs worked successfully on the fresh university attendance data without any dependencies.

9 - SAMPLE PROGRAMS FOR CURSORS AND EXCEPTIONS

AIM:

To demonstrate the use of PL/SQL cursors for row-by-row processing and exception handling for error management in a university context. The program will create a fresh table to store student marks and process them using cursors while handling exceptions gracefully.

ALGORITHM:

1. Create a fresh table Student_Marks with student_id, name, and marks columns.
2. Insert sample student marks data into the table.
3. Declare a cursor to fetch each student's record.
4. Loop through the cursor, check marks, and display results.
5. Use exception handling to catch and report any errors during processing (e.g., when marks are NULL or out of expected range).

PROGRAM:

```
SET SERVEROUTPUT ON;
```

```
-- Create Student_Marks table CREATE
TABLE Student_Marks (
    student_id NUMBER PRIMARY KEY, name
    VARCHAR2(100) NOT NULL,
    marks NUMBER CHECK (marks BETWEEN 0 AND 100)
);

-- Insert sample data
INSERT INTO Student_Marks VALUES (301, 'Alice Smith', 88); INSERT
INTO Student_Marks VALUES (302, 'Bob Johnson', 76);
INSERT INTO Student_Marks VALUES (303, 'Clara Oswald', NULL); -- Simulate missing
marks
INSERT INTO Student_Marks VALUES (304, 'David Tennant', 45);
INSERT INTO Student_Marks VALUES (305, 'Emma Watson', 105); -- Invalid marks to
trigger exception

COMMIT;

-- PL/SQL block with cursor and exception handling DECLARE
    CURSOR cur_marks IS
        SELECT student_id, name, marks FROM Student_Marks;

    v_name Student_Marks.name%TYPE;
    v_marksStudent_Marks.marks%TYPE;
BEGIN
    OPENcur_marks; LOOP
        FETCH cur_marks INTO v_name, v_marks; EXIT
        WHEN cur_marks%NOTFOUND;

        BEGIN
            IF v_marks IS NULL THEN
                RAISE_APPLICATION_ERROR(-20001, 'Marks missing for student '
|| v_name);
            ELSIF v_marks < 0 OR v_marks > 100 THEN
                RAISE_APPLICATION_ERROR(-20002, 'Invalid marks for student '
|| v_name || ': ' || v_marks); ELSE
```

```
            DBMS_OUTPUT.PUT_LINE(v_name || ' scored ' || v_marks); END IF;
        EXCEPTION
            WHEN OTHERS THEN
                DBMS_OUTPUT.PUT_LINE('Error: ' || SQLERRM); END;
    END LOOP;
    CLOSE cur_marks;
END;
/
```

OUTPUT:

```
text
Alice Smith scored 88
Bob Johnson scored 76
Error: ORA-20001: Marks missing for student Clara Oswald
David Tennant scored 45
Error: ORA-20002: Invalid marks for student Emma Watson: 105
```

RESULT:

Thus, This program creates a clean environment, processes each student's marks with a cursor, and uses exception handling to detect and report missing or invalid data without stopping execution.

10 - IMPLEMENT INTEGRITY CONSTRAINTS

AIM:

To create a fresh set of tables in a university database that implement various integrity constraints such as primary keys, foreign keys, unique constraints, not null constraints, and check constraints. The program will insert valid and invalid data to demonstrate constraint enforcement.

ALGORITHM:

1. Define tables Departments, Professors, and Courseswith integrity constraints.
2. Apply primary key constraints on ID columns for uniqueness.
3. Apply foreign key constraints to link Coursesto Departmentsand Professors.
4. Use NOT NULL and UNIQUE constraints for essential fields.
5. Use CHECK constraints to validate domain-specific rules (e.g., course credits positive).
6. Insert sample valid records to demonstrate successful constraint enforcement.
7. Attempt to insert invalid records (commented out or in explanation) to show constraint violations.

PROGRAM:

```
-- Create Departments table with NOT NULL and UNIQUE constraints CREATE
TABLE Departments (
    dept_id NUMBER PRIMARY KEY,
    dept_name VARCHAR2(50) NOT NULL UNIQUE
);

-- Create Professors table with constraints CREATE
TABLE Professors (
    professor_id NUMBER PRIMARY KEY,
    professor_name VARCHAR2(100) NOT NULL,
    dept_id NUMBER NOT NULL,
    CONSTRAINT fk_prof_dept FOREIGN KEY (dept_id) REFERENCES
Departments(dept_id)
);

-- Create Courses table with check constraints and foreign keys CREATE
TABLE Courses (
    course_id NUMBER PRIMARY KEY,
    course_name VARCHAR2(100) NOT NULL UNIQUE,
    credits NUMBER NOT NULL CHECK (credits > 0), dept_id
    NUMBER NOT NULL,
    professor_id NUMBER NOT NULL,
    CONSTRAINT fk_course_dept FOREIGN KEY (dept_id) REFERENCES
Departments(dept_id),
    CONSTRAINT fk_course_prof FOREIGN KEY (professor_id) REFERENCES
Professors(professor_id)
```

```
INSERT INTO Departments VALUES (2, 'Mathematics');

INSERT INTO Professors VALUES (101, 'Dr. Alan Turing', 1); INSERT INTO
Professors VALUES (102, 'Dr. Ada Lovelace', 1); INSERT INTO Professors
VALUES (201, 'Dr. Carl Gauss', 2);

INSERT INTO Courses VALUES (1001, 'Database Systems', 3, 1, 101);
INSERT INTO Courses VALUES (1002, 'Algorithms', 4, 1, 102);
INSERT INTO Courses VALUES (2001, 'Calculus', 4, 2, 201);

-- Commit changes COMMIT;

-- -- Example invalid inserts that will fail (uncomment to test)
-- -- Duplicate dept_name violates UNIQUE constraint
-- INSERT INTO Departments VALUES (3, 'Computer Science');
-- -- Negative credits violate CHECK constraint
-- INSERT INTO Courses VALUES (3001, 'Invalid Course', -3, 1, 101);
-- -- professor_id not existing violates foreign key
-- INSERT INTO Courses VALUES (3002, 'New Course', 3, 1, 999);
```

Expected Output:

- Successful creation of all tables with constraints.
- Successful insertion of valid records.
- On attempting invalid inserts (if uncommented), the database throws errors such as UNIQUE constraint violation, CHECK constraint violation, or foreign key violation.

This program enforces data integrity at multiple levels, ensuring consistent and reliable data in the university database environment.

OUTPUT:

RESULT:

This program enforces data integrity at multiple levels, ensuring consistent and reliable data in the university database environment.

11 - IMPLEMENT FIRST, SECOND AND THIRD NORMALIZATION TECHNIQUES

AIM:

To demonstrate the implementation of First Normal Form (1NF), Second Normal Form (2NF), and Third Normal Form (3NF) by creating a fresh table, identifying anomalies, and then decomposing it step-by-step into normalized tables.

ALGORITHM:

1. Create an initial unnormalized table Student_Courseswith repeating groups and partial dependencies.
2. Apply 1NF to remove repeating groups and ensure atomic column values.
3. Apply 2NF by removing partial dependencies (splitting tables where non-key attributes depend on part of a composite key).
4. Apply 3NF by removing transitive dependencies (splitting tables so that non-key attributes depend only on the whole key).
5. Insert sample data in each stage to illustrate normalization.

PROGRAM:

```
CREATE TABLE Student_Courses ( student_id
    NUMBER,
    student_name VARCHAR2(100),
    course_id     NUMBER,
    course_name VARCHAR2(100),
    instructor VARCHAR2(100),
    instructor_phone VARCHAR2(15),
    PRIMARY KEY (student_id, course_id)
);

INSERT INTO Student_Courses VALUES (1, 'Alice Smith', 101, 'Database Systems',
'Dr. Alan Turing', '1234567890');
INSERT INTO Student_Courses VALUES (1, 'Alice Smith', 102, 'Algorithms', 'Dr. Ada
Lovelace', '1234567891');
INSERT INTO Student_Courses VALUES (2, 'Bob Johnson', 101, 'Database Systems',
```

```
CREATE TABLE Students (
    student_id NUMBER PRIMARY KEY,
    student_name VARCHAR2(100)
);

CREATE  TABLE  Courses  (
    course_id NUMBER PRIMARY KEY,
    course_name VARCHAR2(100),
    instructor VARCHAR2(100),
    instructor_phone VARCHAR2(15)
);

CREATE TABLE Enrollments
    ( student_id NUMBER,
    course_id NUMBER,
    PRIMARY KEY (student_id, course_id),
    CONSTRAINT fk_student FOREIGN KEY (student_id) REFERENCES
Students(student_id),
    CONSTRAINT fk_course FOREIGN KEY (course_id) REFERENCES
Courses(course_id)
);

Insert sample normalized data:
INSERT INTO Students VALUES (1, 'Alice Smith'); INSERT INTO
```

```
Turing', '1234567890');
INSERT INTO Courses VALUES (102, 'Algorithms', 'Dr. Ada Lovelace', '1234567891');

INSERT INTO Enrollments VALUES (1, 101);
INSERT INTO Enrollments VALUES (1, 102);
INSERT INTO Enrollments VALUES (2, 101);

COMMIT;
```

```
CREATE TABLE Instructors (
    instructor_name VARCHAR2(100) PRIMARY KEY,
    instructor_phone VARCHAR2(15)
);

ALTER TABLE Courses DROP COLUMN instructor_phone;

ALTER TABLE Courses ADD CONSTRAINT fk_instructor FOREIGN KEY (instructor)
REFERENCES Instructors(instructor_name);

Insert instructor data:
INSERT INTO Instructors VALUES ('Dr. Alan Turing', '1234567890'); INSERT INTO
Instructors VALUES ('Dr. Ada Lovelace', '1234567891');

COMMIT;
SELECT * FROM Students
SELECT * FROM Courses
```

OUTPUT:

student_id	student_name
1	Alice Smith
2	Bob Johnson

instructor_name	instructor_phone
Dr. Alan Turing	1234567890
Dr. Ada Lovelace	1234567891

course_id	course_name	instructor
101	Database Systems	Dr. Alan Turing
102	Algorithms	Dr. Ada Lovelace

student_id	course_id
1	101
1	102
2	101

RESULT:

This program fully shows the process of applying 1NF, 2NF, and 3NF to a practical university enrollment schema with sample data, reducing redundancy and ensuring data integrity.

12 - IMPLEMENT FOURTH AND FIFTH FORM OF NORMALIZATION TECHNIQUES

AIM:

To demonstrate Fourth Normal Form (4NF) and Fifth Normal Form (5NF) by creating fresh tables representing multi-valued dependencies and join dependencies, then decomposing them to eliminate redundancies and anomalies according to these advanced normalization rules.

ALGORITHM:

1. Start with a table exhibiting multi-valued dependencies for 4NF demonstration, e.g., a Student_Activitiestable with students and multiple independent activities (clubs and sports).
2. Normalize to 4NF by splitting into two tables where no table has more than one multi-valued dependency.
3. For 5NF, start with a table that can be decomposed into multiple joinable tables without loss, e.g., Project_Assignments showing assignments of employees to projects with specific roles.
4. Decompose it into smaller tables to remove join dependencies and restore by joining only.
5. Insert sample data at each stage to illustrate the process.

PROGRAM:

We start with a table having multi-valued dependencies and normalize it into two separate tables.

```
-- Unnormalized table with multi-valued dependencies CREATE
TABLE Student_Activities (
    student_id  NUMBER,
    student_name VARCHAR2(100), club
    VARCHAR2(50),
    sport  VARCHAR2(50),
    PRIMARY KEY (student_id, club, sport)
);

-- Insert sample data into Student_Activities
INSERT INTO Student_Activities VALUES (1, 'Alice Smith', 'Chess Club',
```

```
INSERT INTO Student_Activities VALUES (1, 'Alice Smith', 'Drama Club', 'Basketball');
INSERT INTO Student_Activities VALUES (1, 'Alice Smith', 'Chess Club', 'Soccer');
INSERT INTO Student_Activities VALUES (2, 'Bob Johnson', 'Chess Club', 'Tennis');
INSERT INTO Student_Activities VALUES (2, 'Bob Johnson', 'Drama Club', 'Tennis');

COMMIT;

-- Normalize into 4NF by splitting into two tables

-- Table for Student Clubs
CREATE TABLE Student_Clubs
    ( student_id NUMBER,
    student_name VARCHAR2(100), club
    VARCHAR2(50),
    PRIMARY KEY(student_id, club)
);

-- Table for Student Sports
CREATE TABLE Student_Sports ( student_id
    NUMBER,
    student_name VARCHAR2(100), sport
    VARCHAR2(50),
    PRIMARY KEY(student_id, sport)
);

-- Insert data extracted from original table to normalized tables INSERT INTO Student_Clubs
(student_id, student_name, club)
SELECT DISTINCT student_id, student_name, club FROM Student_Activities;

INSERT INTO Student_Sports (student_id, student_name, sport) SELECT
DISTINCT student_id, student_name, sport FROM
Student_Activities; COMMIT;
```

Fifth Normal Form (5NF) Example:

Decompose a table with join dependencies into smaller tables.

```
-- Table with join dependencies
CREATE TABLE Project_Assignments
   ( employee_id NUMBER,
   project_id NUMBER, role
   VARCHAR2(50),
   PRIMARY KEY (employee_id, project_id, role)
);

-- Insert sample data
INSERT INTO Project_Assignments VALUES (101, 201, 'Developer'); INSERT
INTO Project_Assignments VALUES (101, 202, 'Tester');
INSERT INTO Project_Assignments VALUES (102, 201, 'Developer'); INSERT
INTO Project_Assignments VALUES (103, 203, 'Manager');

COMMIT;

-- Decompose into three tables to eliminate join dependencies CREATE

TABLE Employee_Projects (
   employee_id NUMBER,
   project_id NUMBER,
   PRIMARY KEY (employee_id, project_id)
);

CREATE TABLE Employee_Roles ( employee_id
   NUMBER,
   role VARCHAR2(50),
   PRIMARY KEY (employee_id, role)
);
```

```
    PRIMARY KEY (project_id, role)
);
```

```
-- Insert decomposed data from Project_Assignments
INSERT INTO Employee_Projects (employee_id, project_id)
SELECT DISTINCT employee_id, project_id FROM Project_Assignments;

INSERT INTO Employee_Roles (employee_id, role)
SELECT DISTINCT employee_id, role FROM Project_Assignments;

INSERT INTO Project_Roles (project_id, role)
SELECT DISTINCT project_id, role FROM Project_Assignments;
```

Verification Queries (to display normalized data):

```
-- 4NF Tables
SELECT * FROM Student_Clubs ORDER BY student_id, club; SELECT *
FROM Student_Sports ORDER BY student_id, sport;

-- 5NF Tables
SELECT * FROM Employee_Projects ORDER BY employee_id, project_id; SELECT
* FROM Employee_Roles ORDER BY employee_id, role;
```

OUTPUT:

Output for 4NF Tables

Student_Clubs:

student_id	student_name	club
1	Alice Smith	Chess Club
1	Alice Smith	Drama Club
2	Bob Johnson	Chess Club
2	Bob Johnson	Drama Club

Student_Sports:

student_id	student_name	sport
1	Alice Smith	Basketball
1	Alice Smith	Soccer
2	Bob Johnson	Tennis

Output for 5NF Tables

Employee_Projects:

employee_id	project_id
101	201
101	202
102	201
103	203

Employee_Roles:

employee_id	role
101	Developer
101	Tester
102	Developer
103	Manager

Project_Roles:

project_id	role
201	Developer
202	Tester
203	Manager

RESULT:

This full script shows creating tables from scratch, populating with sample data, performing normalization to 4NF and 5NF forms, and storing decomposed data, thereby eliminating multi-valued and join dependencies while maintaining all information through decomposition

13 . IMPLEMENT FUNCTIONS/PROCEDURES TO BEGIN, COMMIT AND ROLLBACK TRANSACTIONS

AIM:

To implement PL/SQL functions and procedures that manage transactions explicitly by beginning, committing, and rolling back transactions. These will demonstrate programmatic control over transaction boundaries.

ALGORITHM:

1. Create a procedure to start a transaction (conceptually, PL/SQL starts implicit transactions automatically, so this can be a placeholder).
2. Create a procedure for committing the current transaction.
3. Create a procedure for rolling back the current transaction.
4. Write a simple PL/SQL block that uses these procedures while performing insert/update operations to demonstrate transaction control.
5. Use exception handling to conditionally commit or rollback.

PROGRAM:

```
CREATE TABLE test_table ( id
   NUMBER PRIMARY KEY,
   data VARCHAR2(100)
);
```

```
-- Procedure to begin transaction (placeholder as transactions begin implicitly)
CREATE OR REPLACE PROCEDURE Begin_Transaction IS BEGIN
   DBMS_OUTPUT.PUT_LINE('Transaction begun (implicit in PL/SQL)'); END;
/

-- Procedure to commit transaction
CREATE OR REPLACE PROCEDURE Commit_Transaction IS
BEGIN
```

```
    COMMIT;
    DBMS_OUTPUT.PUT_LINE('Transaction committed'); END;
/

-- Procedure to rollback transaction
CREATE OR REPLACE PROCEDURE Rollback_Transaction IS
BEGIN
    ROLLBACK;
    DBMS_OUTPUT.PUT_LINE('Transaction rolled back'); END;
/

-- Demonstration block using above procedures DECLARE
    v_error_occurred BOOLEAN := FALSE; BEGIN
    Begin_Transaction;

    -- Sample insert or update (create a test table if needed) BEGIN
        INSERT INTO test_table(id, data) VALUES (1, 'Sample Data'); EXCEPTION
        WHEN OTHERS THEN
            v_error_occurred := TRUE;
            DBMS_OUTPUT.PUT_LINE('Error during insert: ' || SQLERRM); END;

    IF v_error_occurred THEN
        Rollback_Transaction;
    ELSE
        Commit_Transaction; END
    IF;
END;
/
```

OUTPUT:

Transaction begun (implicit in PL/SQL)

Transaction committed

RESULT:

Thus, This program shows controlled execution of transactions where changes are only saved on success, and any failure triggers rollback to ensure data integrity, illustrating key practices for reliable database programming.

14. ANALYZE THE STRUCTURE AND PROPERTIES OF B-TREE INDEX AND ITS VARIANTS

AIM:

To create and analyze a B-Tree index on a database table using PL/SQL. To study its structure, properties, and performance in query execution.

ALGORITHM:

1. Create a sample table and insert values.
2. Create a **B-Tree index** on the column.
3. Use EXPLAIN PLANor DBMS_XPLANto see how queries use the index.
4. Query data dictionary views (USER_INDEXES, USER_IND_COLUMNS) to analyze the index structure.
5. Compare execution with and without the index to observe efficiency.

CODE:

```
-- Step 1: Create a sample table
CREATE TABLE employee (
    emp_id      NUMBER PRIMARY KEY,
    emp_name
    VARCHAR2(50), salary
```

```
);

-- Step 2: Insert sample data BEGIN
      FOR i IN 1..20 LOOP
            INSERT INTO employee VALUES (i, 'Employee_'||i, 1000 + i*100); END LOOP
      COMMI
T; END;
/

-- Step 3: Create a B-Tree Index on salary
CREATE INDEX idx_emp_salary ON employee(salary);

-- Step 4: Analyze the index structure
SELECT index_name, index_type, table_name, uniqueness FROM
user_indexes
WHERE table_name = 'EMPLOYEE';

SELECT index_name, column_name, column_position FROM
user_ind_columns
WHERE table_name = 'EMPLOYEE';

-- Step 5: Explain plan with index EXPLAIN
PLAN FOR
SELECT * FROM employee WHERE salary = 1500; SELECT

* FROM TABLE(DBMS_XPLAN.DISPLAY);

-- Step 6: Drop and recreate as BITMAP (variant demo) DROP INDEX
idx_emp_salary;
CREATE BITMAP INDEX idx_emp_salary_bm ON employee(salary);

SELECT index_name, index_type FROM
user_indexes
WHERE table_name = 'EMPLOYEE';
```

OUTPUT:

```
INDEX_NAME     INDEX_TYPE  TABLE_NAME   UNIQUENESS
-------------- ----------- ----------- ----------
IDX_EMP_SALARY  NORMAL     EMPLOYEE    NONUNIQUE

INDEX_NAME     COLUMN_NAME  COLUMN_POSITION
-------------- -----------  ---------------
IDX_EMP_SALARY  SALARY     1

-------------------------------------------------------------------------------

| Id  | Operation                    | Name          |
-------------------------------------------------------------------------------

|   0 | SELECT STATEMENT           |               |
|*  1 |  TABLE ACCESS BY INDEX ROWID| EMPLOYEE  |
|*  2 |   INDEX RANGE SCAN         | IDX_EMP_SALARY|
-------------------------------------------------------------------------------
```

RESULT:

Thus, a B-Tree index and its variant (Bitmap index) were created and analyzed in PL/SQL.

15. CASE STUDY - ANALYZE DIFFERENT TYPES OF FAILURES SUCH AS TRANSACTION FAILURES, SYSTEM CRASHES AND DISK FAILURES

AIM:

To study and analyze different types of database failures such as transaction failures, system crashes, and disk failures.

To demonstrate how PL/SQL and Oracle handle these failures through recovery mechanisms.

ALGORITHM:

1. Create a sample table for demonstration.
2. Show a **transaction failure** by using SAVEPOINT, ROLLBACK, and COMMIT.
3. Simulate a **system crash** scenario by leaving an uncommitted transaction (Oracle automatically rolls it back).
4. Discuss **disk failure** as a physical issue, usually requiring backup/recovery.
5. Query data dictionary or recovery views to observe the state after each failure type.

PROGRAM:

```
-- Step 1: Create a table
CREATE TABLE accounts (
    acc_no      NUMBER PRIMARY KEY,
    acc_nameVARCHAR2(30),
    balance     NUMBER
);

-- Step 2: Insert initial data
INSERT INTO accounts VALUES (1, 'Alice', 5000); INSERT INTO
accounts VALUES (2, 'Bob', 3000);
COMMIT;

-- Step 3: Simulate Transaction Failure BEGIN
   SAVEPOINT sp1;
```

```
    -- Simulate error
    RAISE_APPLICATION_ERROR(-20001, 'Transaction failure simulated!'); COMMIT;
EXCEPTION
    WHEN OTHERS THEN
        ROLLBACK TO sp1; -- rollback only last change
        DBMS_OUTPUT.PUT_LINE('Transaction failed, rolled back to savepoint.');
END;
/

-- Step 4: Simulate System Crash
-- (In reality, you stop the DB/session. On restart, Oracle auto-rolls
back uncommitted changes.)
-- For demo: leave an update without commit, then reconnect.
UPDATE accounts SET balance = balance + 2000 WHERE acc_no = 2;
-- Do NOT commit, simulate crash → when reconnecting, this update will be
rolled back automatically.

-- Step 5: Disk Failure (Conceptual)
-- Cannot be simulated directly in PL/SQL.
-- Oracle handles via ARCHIVELOG mode, RMAN backups, redo/undo logs.
```

OUTPUT:

Transaction failed, rolled back to savepoint.

ACCOUNTS table after transaction failure:

ACC_NO	ACC_NAME	BALANCE
1	Alice	5000
2	Bob	3000

System crash scenario:

Uncommitted changes on Bob's account rolled back automatically.

Disk failure:

Handled conceptually using backups and recovery mechanisms (not shown in PL/SQL).

RESULT:

Thus, different types of database failures were analyzed:

- Transaction failures are handled using rollback and savepoints.
- System crashes are handled automatically by Oracle using undo/redo logs.
- Disk failures require external recovery methods like backups and log-based recovery.