

# PL sql programs with solutions

## PL/SQL Programs with Solutions: Unleashing the Power of Oracle Databases

Imagine a bustling city, its intricate networks of roads and highways meticulously managed by a powerful, unseen system. That system, in the digital world, is often a relational database, and PL/SQL, the procedural language for Oracle, is the skilled architect crafting and maintaining its efficient operations. This delves into the captivating world of PL/SQL programs, showcasing their power and providing solutions to common challenges, much like a seasoned city planner tackling urban complexities. **The Foundation: Understanding PL/SQL's Role** PL/SQL, a block structured language, seamlessly integrates with Oracle's robust database management system. It's more than just a scripting language; it's a tool enabling database developers to create complex procedures, functions, and packages that manipulate data with speed and precision. Think of it as the master control panel for your database, allowing you to automate tasks, enforce data integrity, and build sophisticated applications. From Simple Scripts to Sophisticated Solutions Let's embark on a journey through a series of examples, each showcasing the increasing complexity and versatility of PL/SQL. Imagine a scenario where you need to generate reports on customer transactions. A

simple PL/SQL program could query the database for relevant data and present it in a user-friendly format. This is like having a dedicated clerk sorting through mountains of paperwork and distilling the critical information for analysis. Example 1: Retrieving and Displaying Data DECLARE v\_customer\_name VARCHAR2(50); v\_total\_spent NUMBER; BEGIN SELECT customer\_name, SUM(amount) INTO v\_customer\_name, v\_total\_spent FROM transactions WHERE customer\_id = 12345 GROUP BY customer\_name; DBMS\_OUTPUT.PUT\_LINE('Customer: ' || v\_customer\_name || ', Total Spent: ' || v\_total\_spent); END; / This concise code snippet demonstrates basic data retrieval, akin to a librarian quickly locating and providing specific information.

*Example 2: Handling Exceptions and Validations* DECLARE v\_salary NUMBER; BEGIN SELECT salary INTO v\_salary FROM employees WHERE employee\_id = 1001; IF v\_salary < 20000 THEN RAISE\_APPLICATION\_ERROR(-20001, 'Salary too low!'); END IF; DBMS\_OUTPUT.PUT\_LINE('Valid Salary: ' || v\_salary); EXCEPTION WHEN NO\_DATA\_FOUND THEN DBMS\_OUTPUT.PUT\_LINE('Employee not found.');

WHEN OTHERS THEN DBMS\_OUTPUT.PUT\_LINE('An error occurred: ' || SQLERRM); END; / This example highlights the importance of error handling, akin to a safety protocol in a manufacturing plant. Handling exceptions prevents the entire operation from collapsing if one part fails. **Beyond the Basics:**

**PL/SQL Packages and Functions** As the complexity increases, we transition from individual procedures to modular packages. These contain multiple functions and procedures, allowing for better organization and reusability. Imagine developing a complex city planning application; packages act like the separate departments (engineering, finance, etc.) each with their own specialised tasks, yet working cohesively. *Building Reusable Components: Packages and Functions* -- Package specification CREATE OR REPLACE PACKAGE payroll\_processing AS FUNCTION calculate\_bonus (employee\_id IN employees.employee\_id%TYPE) RETURN NUMBER;

```
END payroll_processing; / -- Package body CREATE OR REPLACE
PACKAGE BODY payroll_processing AS FUNCTION calculate_bonus
(employee_id IN employees.employee_id%TYPE) RETURN NUMBER
IS v_salary employees.salary%TYPE; BEGIN SELECT salary INTO
v_salary FROM employees WHERE employee_id = employee_id;
RETURN v_salary * 0.10; -- 10% bonus END; END payroll_processing;
/ These packages ensure code maintainability and readability.
```

Functions such as ``calculate_bonus`` encapsulate specific tasks, mirroring dedicated teams focusing on particular aspects of city development. **Actionable Takeaways:** • Mastering PL/SQL empowers database administrators and developers to automate tasks, optimize performance, and enhance data integrity. •

Understanding error handling is crucial for robust and reliable applications, preventing unexpected crashes and data corruption. • Modularity (using packages and functions) promotes reusability, maintainability, and code organization. **Frequently Asked**

**Questions (FAQs):** 1. *What is the difference between PL/SQL and SQL?* SQL is a declarative language focused on querying and manipulating data, while PL/SQL is a procedural language allowing control flow and complex operations. 2. **Why is PL/SQL important for Oracle databases?** PL/SQL is essential for automating tasks, enhancing performance, and creating complex applications interacting with Oracle databases. 3. **How can I learn more about PL/SQL?** Online courses, tutorials, and documentation are readily available to deepen your understanding. 4. **When should I use PL/SQL instead of SQL?** Use PL/SQL for complex data manipulation, triggers, and stored procedures requiring control flow and error handling beyond SQL's capabilities. 5. **What are some real-world applications of PL/SQL?** PL/SQL is used in banking systems, e-commerce platforms, inventory management, and many other applications requiring complex data manipulation and automation. By understanding the nuances of PL/SQL, you're not just programming; you're building the infrastructure that powers a

digitally-connected world, much like the intricate network of a bustling city. Now go forth and build your own powerful PL/SQL programs!

## **PL/SQL Programs with Solutions: Your Comprehensive Guide for Success**

Ah, PL/SQL! The unsung hero of Oracle database development. If you've ever worked with Oracle, chances are you've encountered this powerful procedural extension to SQL. It's the secret sauce that allows you to add logic, control flow, and complex processing to your database operations. But let's be honest, while incredibly powerful, PL/SQL can sometimes feel a bit like a riddle wrapped in an enigma, especially when you're just starting out or tackling a particularly tricky problem. That's where a good collection of PL/SQL programs with solutions comes in handy!

In this comprehensive guide, we're going to dive deep into the world of PL/SQL programming. We'll explore common scenarios, break down practical examples, and provide clear, actionable solutions. Whether you're a junior developer looking to build your foundational knowledge, a seasoned pro seeking a quick refresher, or a student trying to master database programming, this article is designed to be your go-to resource. We'll cover everything from basic procedural blocks to more advanced concepts, equipping you with the confidence and know-how to tackle your own PL/SQL challenges.

# Why PL/SQL? The Power of Procedural SQL

Before we jump into the "how," let's quickly touch upon the "why." Why bother with PL/SQL when SQL itself is so powerful for data manipulation? The answer lies in its ability to introduce procedural logic. Think of it this way:

1. **Data Integrity:** PL/SQL allows you to enforce complex business rules that cannot be achieved with standard SQL constraints.
2. **Efficiency:** By processing data within the database itself, you reduce network traffic and improve overall performance.
3. **Automation:** Automate repetitive tasks, batch processing, and scheduled jobs with scheduled PL/SQL procedures.
4. **Complex Logic:** Handle intricate calculations, conditional logic, loops, and error handling that are essential for real-world applications.
5. **Reusability:** Create stored procedures, functions, and packages to encapsulate logic and reuse it across multiple applications.

In essence, PL/SQL transforms your database from a passive data storage system into an active, intelligent processing engine. It's the bridge between declarative SQL and imperative programming.

## Getting Started: Your First PL/SQL Program

Every journey begins with a single step, and for PL/SQL, that step is usually a simple anonymous block. This is a block of code that you execute immediately and isn't stored in the database for later reuse.

## Example 1: A Simple "Hello, World!" Program

Let's start with the classic. This program demonstrates the basic structure of a PL/SQL block.

```
BEGIN
    -- This is a comment.
    DBMS_OUTPUT.PUT_LINE('Hello, World!');
END;
/
```

### Explanation:

1. **BEGIN...END:** This defines the executable section of your PL/SQL block.
2. **DBMS\_OUTPUT.PUT\_LINE:** This is a built-in Oracle procedure used to display output. You'll need to enable `DBMS\_OUTPUT` in your SQL client (like SQL\*Plus or SQL Developer) to see the results. Typically, this is done by running `SET SERVEROUTPUT ON;`.
3. **/:** This forward slash is a command terminator in SQL\*Plus, signaling the end of the PL/SQL block and instructing the client to execute it.

## Example 2: Declaring and Using Variables

Variables are fundamental to any programming language. PL/SQL allows you to declare variables to store and manipulate data.

```

DECLARE
    v_message VARCHAR2(100) := 'Learning PL/SQL is fun!';
    v_counter NUMBER := 1;
BEGIN
    DBMS_OUTPUT.PUT_LINE(v_message);
    DBMS_OUTPUT.PUT_LINE('Current count: ' || v_counter);
    v_counter := v_counter + 1;
    DBMS_OUTPUT.PUT_LINE('Updated count: ' || v_counter);
END;
/

```

### Explanation:

1. **DECLARE:** This section is where you declare your variables.
2. **v\_message VARCHAR2(100):** Declares a variable named `v\_message` that can hold up to 100 characters of text.
3. **v\_counter NUMBER := 1:** Declares a numeric variable named `v\_counter` and initializes it with the value 1. The `:=` is the assignment operator in PL/SQL.
4. **||:** This is the concatenation operator, used to join strings together.

## Working with Data: SQL in PL/SQL

The real power of PL/SQL comes when you integrate it with SQL. You can execute SQL statements within your PL/SQL code to fetch, insert, update, and delete data.

### Example 3: Fetching Data into Variables (SELECT INTO)

This is a common scenario: retrieving a single row of data from a table and storing it in PL/SQL variables.

```

DECLARE
    v_employee_name employees.first_name%TYPE;
    v_salary          employees.salary%TYPE;
    v_employee_id     employees.employee_id%TYPE := 100; --
Assuming employee_id 100 exists
BEGIN
    SELECT first_name, salary
    INTO v_employee_name, v_salary
    FROM employees
    WHERE employee_id = v_employee_id;

    DBMS_OUTPUT.PUT_LINE('Employee: ' || v_employee_name ||
', Salary: ' || v_salary);

EXCEPTION
    WHEN NO_DATA_FOUND THEN
        DBMS_OUTPUT.PUT_LINE('Employee with ID ' ||
v_employee_id || ' not found.');
```

```

    WHEN TOO_MANY_ROWS THEN
        DBMS_OUTPUT.PUT_LINE('More than one employee found
for ID ' || v_employee_id || '.');
```

```

    WHEN OTHERS THEN
        DBMS_OUTPUT.PUT_LINE('An unexpected error
occurred.');
```

```

END;
/
```

### Explanation:

1. **employees.first\_name%TYPE:** This is a fantastic feature! It means the variable `v\_employee\_name` will automatically take on the data type of the `first\_name` column in the `employees` table. This makes your code more robust and easier to maintain if the table structure changes.

2. **SELECT ... INTO ...:** This SQL statement fetches the `first\_name` and `salary` into the declared PL/SQL variables. It's crucial that this query returns *exactly one row*.
3. **EXCEPTION:** This is the error handling section. PL/SQL provides specific exceptions like `NO\_DATA\_FOUND` (if no row is returned) and `TOO\_MANY\_ROWS` (if more than one row is returned). `OTHERS` catches any other unhandled exceptions.

## Example 4: Inserting Data

You can easily insert new records into tables using PL/SQL.

```
DECLARE
    v_new_employee_id    employees.employee_id%TYPE := 300;
    v_first_name         employees.first_name%TYPE  := 'Jane';
    v_last_name          employees.last_name%TYPE   := 'Doe';
    v_email              employees.email%TYPE      :=
'JANE.DOE@example.com';
    v_hire_date          employees.hire_date%TYPE   := SYSDATE;
    v_job_id             employees.job_id%TYPE      := 'IT_PROG';
    v_salary             employees.salary%TYPE      := 6000;
BEGIN
    INSERT INTO employees (employee_id, first_name,
last_name, email, hire_date, job_id, salary)
    VALUES (v_new_employee_id, v_first_name, v_last_name,
v_email, v_hire_date, v_job_id, v_salary);

    COMMIT; -- Make the changes permanent

    DBMS_OUTPUT.PUT_LINE('Employee ' || v_first_name || ' '
|| v_last_name || ' inserted successfully.');
```

EXCEPTION

```

    WHEN DUP_VAL_ON_INDEX THEN
        DBMS_OUTPUT.PUT_LINE('Error: Employee ID ' ||
v_new_employee_id || ' already exists.');
```

WHEN OTHERS THEN
 ROLLBACK; -- Undo any partial changes if an error occurs
 DBMS\_OUTPUT.PUT\_LINE('An error occurred during insertion.');

```

END;
/
```

### Explanation:

1. **INSERT INTO ... VALUES ...:** This is standard SQL syntax for inserting data.
2. **COMMIT:** This statement saves the transaction permanently to the database. Without `COMMIT`, the insertion would be lost when the session ends.
3. **ROLLBACK:** In the `EXCEPTION` block, `ROLLBACK` is used to undo any changes made within the transaction if an error occurs, ensuring data consistency.
4. **DUP\_VAL\_ON\_INDEX:** A specific exception for when you try to insert a value that violates a unique index constraint (like a primary key).

## Example 5: Updating Data

Modifying existing records is just as straightforward.

```

DECLARE
    v_employee_id    employees.employee_id%TYPE := 100;
    v_new_salary     employees.salary%TYPE := 7500;
BEGIN
```

```

UPDATE employees
SET salary = v_new_salary
WHERE employee_id = v_employee_id;

COMMIT;

IF SQL%ROWCOUNT > 0 THEN
    DBMS_OUTPUT.PUT_LINE('Salary updated successfully for
employee ID ' || v_employee_id || '.');
ELSE
    DBMS_OUTPUT.PUT_LINE('No employee found with ID ' ||
v_employee_id || ' to update.');
```

END IF;

EXCEPTION

WHEN OTHERS THEN

ROLLBACK;

DBMS\_OUTPUT.PUT\_LINE('An error occurred during
update.');

END;

/

### Explanation:

1. **UPDATE ... SET ... WHERE ...:** Standard SQL for updating rows.
2. **SQL%ROWCOUNT:** This is a PL/SQL attribute that returns the number of rows affected by the most recent SQL DML statement (INSERT, UPDATE, DELETE). It's very useful for checking if the operation was successful.

## Example 6: Deleting Data

Removing unwanted records from your tables.

```

DECLARE
    v_employee_id employees.employee_id%TYPE := 300; -- The
employee Jane Doe we inserted earlier
BEGIN
    DELETE FROM employees
    WHERE employee_id = v_employee_id;

    COMMIT;

    IF SQL%ROWCOUNT > 0 THEN
        DBMS_OUTPUT.PUT_LINE('Employee with ID ' ||
v_employee_id || ' deleted successfully. ');
    ELSE
        DBMS_OUTPUT.PUT_LINE('No employee found with ID ' ||
v_employee_id || ' to delete. ');
    END IF;

EXCEPTION
    WHEN OTHERS THEN
        ROLLBACK;
        DBMS_OUTPUT.PUT_LINE('An error occurred during
deletion. ');
END;
/

```

### Explanation:

1. **DELETE FROM ... WHERE ...:** Standard SQL for deleting rows.
2. Again, `SQL%ROWCOUNT` is used to confirm the deletion.

## Control Flow: Making Decisions

## and Repeating Actions

PL/SQL isn't just about executing SQL; it's about controlling *how* and *when* it executes. This is where control flow structures come into play.

### IF Statements

The most basic form of conditional logic.

```
DECLARE
    v_salary employees.salary%TYPE := 5000;
    v_bonus  NUMBER;
BEGIN
    IF v_salary > 4000 THEN
        v_bonus := v_salary * 0.10; -- 10% bonus
        DBMS_OUTPUT.PUT_LINE('Eligible for a bonus of: ' ||
v_bonus);
    ELSIF v_salary > 3000 THEN
        v_bonus := v_salary * 0.05; -- 5% bonus
        DBMS_OUTPUT.PUT_LINE('Eligible for a smaller bonus
of: ' || v_bonus);
    ELSE
        DBMS_OUTPUT.PUT_LINE('Not eligible for a bonus.');
```

END IF;

END;

/

### Loops

PL/SQL offers several types of loops to repeat actions.

## 1. Simple LOOP

This loop continues indefinitely until explicitly exited using `EXIT`.

```
DECLARE
    v_count NUMBER := 1;
BEGIN
    LOOP
        DBMS_OUTPUT.PUT_LINE('Iteration: ' || v_count);
        v_count := v_count + 1;
        IF v_count > 5 THEN
            EXIT; -- Exit the loop when v_count exceeds 5
        END IF;
    END LOOP;
END;
/
```

## 2. WHILE LOOP

Executes a block of code as long as a condition is true.

```
DECLARE
    v_count NUMBER := 1;
BEGIN
    WHILE v_count <= 5 LOOP
        DBMS_OUTPUT.PUT_LINE('WHILE Iteration: ' || v_count);
        v_count := v_count + 1;
    END LOOP;
END;
/
```

## 3. FOR LOOP

A loop with a counter that automatically increments or decrements.

```

BEGIN
  FOR i IN 1..5 LOOP
    DBMS_OUTPUT.PUT_LINE('FOR Iteration: ' || i);
  END LOOP;

  FOR j IN REVERSE 5..1 LOOP -- Looping backwards
    DBMS_OUTPUT.PUT_LINE('REVERSE FOR Iteration: ' || j);
  END LOOP;
END;
/

```

## CASE Statement

A more readable way to handle multiple conditional branches.

```

DECLARE
  v_department_name VARCHAR2(30) := 'Sales';
  v_location          VARCHAR2(30);
BEGIN
  CASE v_department_name
    WHEN 'Sales' THEN
      v_location := 'New York';
    WHEN 'IT' THEN
      v_location := 'San Francisco';
    WHEN 'HR' THEN
      v_location := 'London';
    ELSE
      v_location := 'Unknown Location';
  END CASE;

  DBMS_OUTPUT.PUT_LINE('Department ' || v_department_name
    || ' is located in ' || v_location);
END;

```

/

## Cursors: Processing Multiple Rows

When your SQL query returns more than one row, you can't use `SELECT INTO`. This is where cursors shine. Cursors allow you to process a result set row by row.

### Example 7: Explicit Cursor

This is the classic way to handle multiple rows.

```
DECLARE
    CURSOR emp_cursor IS
        SELECT employee_id, first_name, salary
        FROM employees
        WHERE job_id = 'SA_REP'
        ORDER BY salary DESC;

    v_employee_id employees.employee_id%TYPE;
    v_first_name  employees.first_name%TYPE;
    v_salary      employees.salary%TYPE;
BEGIN
    OPEN emp_cursor; -- Open the cursor to start fetching

    LOOP
        FETCH emp_cursor INTO v_employee_id, v_first_name,
        v_salary;
        EXIT WHEN emp_cursor%NOTFOUND; -- Exit the loop if no
        more rows are found
```

```

        DBMS_OUTPUT.PUT_LINE('Employee ID: ' || v_employee_id
|| ', Name: ' || v_first_name || ', Salary: ' ||
v_salary);
    END LOOP;

```

```

    CLOSE emp_cursor; -- Close the cursor to release
resources
END;
/

```

### Explanation:

1. **CURSOR emp\_cursor IS ...:** Defines a cursor named `emp\_cursor` with a SQL query.
2. **OPEN emp\_cursor:** Initializes the cursor and prepares it to fetch rows.
3. **FETCH emp\_cursor INTO ...:** Retrieves the next row from the result set and populates the PL/SQL variables.
4. **emp\_cursor%NOTFOUND:** A cursor attribute that returns TRUE if the last `FETCH` did not find any more rows.
5. **CLOSE emp\_cursor:** Releases the memory and resources associated with the cursor.

## Example 8: Cursor FOR Loop (Implicit Cursor)

A much more concise and often preferred way to handle cursors.

```

BEGIN
    FOR emp_record IN (SELECT employee_id, first_name,
                        salary
                        FROM employees
                        WHERE job_id = 'SA_REP'

```

```

ORDER BY salary DESC)

LOOP
    DBMS_OUTPUT.PUT_LINE('Employee ID: ' ||
emp_record.employee_id || ', Name: ' ||
emp_record.first_name || ', Salary: ' ||
emp_record.salary);
END LOOP;
END;
/

```

### **Explanation:**

This `FOR LOOP` automatically handles opening, fetching, and closing the cursor. The `emp\_record` variable is implicitly declared as a record type matching the columns selected by the query. This is a much cleaner syntax!

## **Stored Procedures and Functions**

While anonymous blocks are great for one-off tasks, you'll often want to create reusable code. This is where stored procedures and functions come in.

### **Stored Procedures**

Procedures perform an action. They don't necessarily return a value, but they can have input, output, and in/out parameters.

#### **Example 9: Creating a Simple Procedure**

```

CREATE OR REPLACE PROCEDURE hire_employee (
    p_employee_id IN employees.employee_id%TYPE,
    p_first_name  IN employees.first_name%TYPE,

```

```

    p_last_name    IN employees.last_name%TYPE,
    p_email        IN employees.email%TYPE,
    p_hire_date    IN employees.hire_date%TYPE DEFAULT
SYSDATE,
    p_job_id       IN employees.job_id%TYPE,
    p_salary       IN employees.salary%TYPE
)
AS
BEGIN
    INSERT INTO employees (employee_id, first_name,
last_name, email, hire_date, job_id, salary)
    VALUES (p_employee_id, p_first_name, p_last_name,
p_email, p_hire_date, p_job_id, p_salary);

    COMMIT;
    DBMS_OUTPUT.PUT_LINE('Employee ' || p_first_name || ' '
|| p_last_name || ' hired successfully.');
```

```

EXCEPTION
    WHEN DUP_VAL_ON_INDEX THEN
        DBMS_OUTPUT.PUT_LINE('Error: Employee ID ' ||
p_employee_id || ' already exists.');
```

```

    WHEN OTHERS THEN
        ROLLBACK;
        DBMS_OUTPUT.PUT_LINE('An error occurred during
hiring.');
```

```

END;
/
```

### Calling the Procedure:

```

BEGIN
    hire_employee(
```

```

        p_employee_id => 301,
        p_first_name  => 'Peter',
        p_last_name   => 'Jones',
        p_email        => 'PETER.JONES@example.com',
        p_job_id       => 'FI_ACCOUNT',
        p_salary       => 7000
    );
END;
/

```

-- Example with default parameter:

```

BEGIN
    hire_employee(
        p_employee_id => 302,
        p_first_name  => 'Mary',
        p_last_name   => 'Smith',
        p_email        => 'MARY.SMITH@example.com',
        p_job_id       => 'SA_MAN',
        p_salary       => 8000
    );
END;
/

```

### Explanation:

1. **CREATE OR REPLACE PROCEDURE:** Creates a new procedure or replaces an existing one.
2. **p\_employee\_id IN ...:** Defines input parameters. `IN` is the default mode if not specified.
3. **p\_hire\_date IN ... DEFAULT SYSDATE:** Shows how to set a default value for a parameter.
4. **AS/IS:** Keywords used to separate the procedure's declaration from its body.
5. **Parameters:** Use named notation (like `p\_employee\_id =>

301`) for clarity, especially with many parameters or optional ones.

## Functions

Functions are designed to compute and return a single value.

### Example 10: Creating a Simple Function

```
CREATE OR REPLACE FUNCTION get_employee_salary (
    p_employee_id IN employees.employee_id%TYPE
)
RETURN employees.salary%TYPE
AS
    v_salary employees.salary%TYPE;
BEGIN
    SELECT salary
    INTO v_salary
    FROM employees
    WHERE employee_id = p_employee_id;

    RETURN v_salary;

EXCEPTION
    WHEN NO_DATA_FOUND THEN
        DBMS_OUTPUT.PUT_LINE('Employee with ID ' ||
p_employee_id || ' not found.');
```

```
        RETURN NULL; -- Return NULL if employee not found
    WHEN OTHERS THEN
        DBMS_OUTPUT.PUT_LINE('An unexpected error
occurred.');
```

```
        RETURN NULL;
END;
```

/

### Calling the Function:

```
SET SERVEROUTPUT ON;
```

```
DECLARE
```

```
    emp_sal employees.salary%TYPE;
```

```
BEGIN
```

```
    emp_sal := get_employee_salary(100); -- Call the  
function
```

```
    IF emp_sal IS NOT NULL THEN
```

```
        DBMS_OUTPUT.PUT_LINE('Salary for employee 100 is: '  
|| emp_sal);  
    END IF;
```

```
    emp_sal := get_employee_salary(999); -- Test with a  
non-existent employee  
END;
```

/

### Explanation:

1. **CREATE OR REPLACE FUNCTION:** Creates or replaces a function.
2. **RETURN employees.salary%TYPE:** Specifies the data type of the value the function will return.
3. **RETURN v\_salary:** The statement that sends the computed value back to the caller.
4. Functions can be called directly in SQL statements (e.g., `SELECT get\_employee\_salary(100) FROM dual;`) or within PL/SQL code.

# Packages: Organizing Your PL/SQL Code

As your PL/SQL code grows, managing it can become a challenge. Packages are a powerful mechanism for grouping related procedures, functions, variables, and cursors, providing better organization, modularity, and security.

## Example 11: Creating a Package

Let's create a package to manage employee-related operations.

### Package Specification (Interface):

This defines what is visible outside the package.

```
CREATE OR REPLACE PACKAGE employee_pkg AS

  -- Procedure to add a new employee
  PROCEDURE add_employee (
    p_employee_id IN employees.employee_id%TYPE,
    p_first_name  IN employees.first_name%TYPE,
    p_last_name   IN employees.last_name%TYPE,
    p_email       IN employees.email%TYPE,
    p_job_id      IN employees.job_id%TYPE,
    p_salary      IN employees.salary%TYPE
  );

  -- Function to get employee name
  FUNCTION get_employee_name (
    p_employee_id IN employees.employee_id%TYPE
  ) RETURN VARCHAR2;
```

```

    -- Publicly accessible variable (use with caution)
    g_company_name VARCHAR2(100) := 'Oracle Corp';

END employee_pkg;
/

```

### **Package Body (Implementation):**

This contains the actual code for the procedures and functions declared in the specification.

```

CREATE OR REPLACE PACKAGE BODY employee_pkg AS

    -- Private variable (not visible outside the package)
    g_creation_date DATE := SYSDATE;

    PROCEDURE add_employee (
        p_employee_id IN employees.employee_id%TYPE,
        p_first_name   IN employees.first_name%TYPE,
        p_last_name    IN employees.last_name%TYPE,
        p_email        IN employees.email%TYPE,
        p_job_id       IN employees.job_id%TYPE,
        p_salary       IN employees.salary%TYPE
    )
    AS
    BEGIN
        INSERT INTO employees (employee_id, first_name,
last_name, email, hire_date, job_id, salary)
        VALUES (p_employee_id, p_first_name, p_last_name,
p_email, SYSDATE, p_job_id, p_salary);
        COMMIT;
        DBMS_OUTPUT.PUT_LINE('Employee ' || p_first_name || '
' || p_last_name || ' added via package.');
```

```

EXCEPTION
    WHEN DUP_VAL_ON_INDEX THEN
        DBMS_OUTPUT.PUT_LINE('Error: Employee ID ' ||
p_employee_id || ' already exists in package.');
```

```

    WHEN OTHERS THEN
        ROLLBACK;
        DBMS_OUTPUT.PUT_LINE('An error occurred in
employee_pkg.add_employee.');
```

```

    END add_employee;

FUNCTION get_employee_name (
    p_employee_id IN employees.employee_id%TYPE
) RETURN VARCHAR2
AS
    v_name VARCHAR2(100);
BEGIN
    SELECT first_name || ' ' || last_name
    INTO v_name
    FROM employees
    WHERE employee_id = p_employee_id;
    RETURN v_name;
EXCEPTION
    WHEN NO_DATA_FOUND THEN
        RETURN 'Employee Not Found';
    WHEN OTHERS THEN
        RETURN 'Error Retrieving Name';
    END get_employee_name;

END employee_pkg;
/
```

## Calling Package Elements:

```
SET SERVEROUTPUT ON;
```

```
-- Call the procedure
```

```
BEGIN
```

```
    employee_pkg.add_employee(  
        p_employee_id => 303,  
        p_first_name  => 'Alice',  
        p_last_name   => ' Wonderland',  
        p_email       => 'ALICE.W@example.com',  
        p_job_id      => 'AD_VP',  
        p_salary      => 15000  
    );
```

```
END;
```

```
/
```

```
-- Call the function
```

```
DECLARE
```

```
    emp_name VARCHAR2(100);
```

```
BEGIN
```

```
    emp_name := employee_pkg.get_employee_name(303);
```

```
    DBMS_OUTPUT.PUT_LINE('Name of employee 303: ' ||
```

```
emp_name);
```

```
    emp_name := employee_pkg.get_employee_name(999); --
```

```
Test non-existent
```

```
    DBMS_OUTPUT.PUT_LINE('Name of employee 999: ' ||
```

```
emp_name);
```

```
END;
```

```
/
```

```
-- Accessing a public variable
```

```
BEGIN
```

```
    DBMS_OUTPUT.PUT_LINE('Company: ' ||
```

```
employee_pkg.g_company_name);  
END;  
/
```

### Explanation:

1. **Package Specification:** Declares the public interface of the package. Anything declared here can be accessed from outside.
2. **Package Body:** Contains the implementation details. Private elements (like ``g_creation_date``) are not accessible from outside.
3. **Benefits:** Encapsulation, modularity, easier maintenance, and enhanced security by controlling access to underlying logic.

## Advanced Topics and Best Practices

As you get more comfortable with PL/SQL, consider these advanced topics and best practices for writing robust and efficient code.

1. **Error Handling:** Master exception handling. Use specific exceptions where possible and always consider a ``WHEN OTHERS`` clause for unexpected errors, logging them appropriately.
2. **BULK COLLECT and FORALL:** For processing large datasets, these are essential. ``BULK COLLECT`` fetches multiple rows into collections (arrays) in a single SQL operation, and ``FORALL`` performs DML operations on collections efficiently.
3. **Autonomous Transactions:** Use with caution for operations that need to be independent of the main transaction (e.g., logging errors).
4. **Record Types:** Define your own structured data types to hold multiple related fields, making your code more readable and

organized, especially when working with cursors.

5. **Triggers:** PL/SQL code that automatically executes in response to certain database events (e.g., INSERT, UPDATE, DELETE on a table).
6. **Collections (Associative Arrays, Nested Tables, VARRAYs):** Powerful data structures for holding multiple values within a single PL/SQL variable.
7. **Code Readability:** Use consistent naming conventions, indentation, and comments. Break down complex logic into smaller, manageable subprograms.
8. **Performance Tuning:** Understand execution plans, avoid row-by-row processing where possible (use bulk operations), and use cursors efficiently.

## Conclusion: Your PL/SQL Journey Continues

We've covered a lot of ground, from the very basics of anonymous blocks to the more structured world of packages. PL/SQL is a vast and powerful language, and mastering it takes practice and continuous learning. The examples provided here are meant to be starting points. Try them out, modify them, and experiment with your own ideas.

The key to becoming proficient in PL/SQL lies in understanding the fundamental concepts and then applying them to solve real-world problems. Remember to always consider error handling, performance, and code maintainability. With these PL/SQL programs and solutions as your foundation, you're well on your way to becoming a PL/SQL guru!

Keep coding, keep learning, and happy querying!

PL SQL Programs with Solutions: Powering Efficient Database Management In the ever-evolving landscape of enterprise data management, Procedural Language for SQL—commonly known as PL/SQL—stands as a cornerstone tool for developers and database administrators. Developed by Oracle, PL/SQL extends the capabilities of SQL by introducing procedural logic, enabling users to write structured, reusable, and maintainable programs that enhance database functionality. This article explores how PL/SQL programs serve as a robust solution for building complex data-driven applications, offering valuable insights into their design, implementation, and real-world value.

**Understanding PL/SQL: The Procedural Extension of SQL At its core, PL/SQL combines the declarative nature of SQL with the imperative power of procedural programming. Unlike standard SQL, which excels at querying and retrieving data, PL/SQL allows developers to define sequences of**

**commands—such as variables, loops, conditional statements, and exception handling—within the database environment itself. This procedural approach enables the creation of stored procedures, functions, triggers, and packages that encapsulate business logic directly at the database layer. By embedding logic where data resides, PL/SQL minimizes client-server communication, reduces network overhead, and improves performance in high-volume transactional systems. PL/SQL programs are executed within the database server, ensuring secure**

**and consistent execution across all client applications. This centralized execution model not only enhances data integrity but also simplifies administration by consolidating business rules in a single, version-controlled location. As organizations increasingly rely on real-time data processing and automation, PL/SQL has become indispensable for managing complex workflows and maintaining data consistency across large-scale enterprise systems.**

## **Key Features and Components of PL/SQL Programs**

### **A robust PL/SQL**

**program integrates several essential components that work in harmony to deliver reliable and efficient database operations.**

**Among the most critical are procedures and functions—self-contained blocks of code that perform specific tasks, such as validating input data, updating records, or aggregating results.**

**Procedures execute actions without returning a value, making them ideal for batch processing and system maintenance, while functions return computed results, enabling seamless integration into larger queries**

**and reports. Triggers represent another powerful feature, automatically executing code in response to specific database events such as row inserts, updates, or deletions. They enforce business rules dynamically, ensuring data accuracy and consistency without requiring explicit application logic. Packages further enhance modularity by grouping related procedures, functions, and variables into a single logical unit, promoting code reuse and simplifying maintenance. Together, these elements form a**

**comprehensive framework that supports scalable, secure, and high-performance database applications.**

**Diverse Applications Across Industries** PL/SQL programs find extensive use across a wide range of industries where structured data processing and real-time responsiveness are paramount. In financial services, PL/SQL powers automated transaction processing, risk analysis, and compliance reporting, ensuring accurate and timely handling of millions of daily operations. Healthcare systems leverage

**PL/SQL to manage patient records, streamline billing workflows, and enforce strict data privacy standards. E-commerce platforms employ PL/SQL for inventory synchronization, order fulfillment automation, and personalized customer recommendations, all while maintaining data integrity across global systems. Beyond transactional systems, PL/SQL supports complex data transformation pipelines, ETL processes, and reporting engines that help organizations extract meaningful insights from vast**

**datasets. Its ability to integrate seamlessly with Oracle databases and other enterprise tools makes it a preferred choice for building resilient, high-performance applications that meet evolving business demands.**

**Advantages of Implementing PL/SQL Solutions Adopting PL/SQL offers numerous strategic benefits that reinforce its position as a leading database programming language. One of the most significant advantages is performance optimization: by executing logic within the database, PL/SQL reduces the**

**need for repeated data retrieval and minimizes network latency. This leads to faster response times and efficient handling of large-scale operations. Additionally, PL/SQL enhances data integrity through built-in transaction control and exception handling, ensuring that database updates remain consistent even in the face of errors or concurrent access. Security is another critical strength—PL/SQL enables fine-grained access control, allowing developers to restrict data access and execute sensitive operations only for authorized users. Code**

**reuse through packages and modular design further streamline development, lowering maintenance costs and improving long-term scalability. These combined benefits make PL/SQL an essential tool for organizations aiming to build robust, secure, and high-performing database ecosystems.**

**Future Outlook and Evolving Role in Modern Data Ecosystems** As data continues to grow in volume and complexity, the role of PL/SQL is evolving to meet the demands of modern, distributed systems. While cloud-native

**architectures and microservices have introduced new paradigms, PL/SQL remains relevant by adapting to hybrid and multi-cloud environments. Oracle has enhanced PL/SQL with features like support for JSON data types, improved integration with REST APIs, and better compatibility with external languages through Oracle Functions and APIs, extending its reach beyond traditional database boundaries. Moreover, the rise of real-time analytics and event-driven processing is driving innovation in how PL/SQL programs interact**

**with streaming data and machine learning models. By embedding intelligent logic directly within the database, organizations can accelerate decision-making and reduce operational overhead. As enterprises continue to prioritize data governance, automation, and performance, PL/SQL's ability to deliver secure, efficient, and scalable solutions positions it as a vital component in the future of data management. In summary, PL/SQL programs with well-designed solutions offer a powerful, reliable foundation for building intelligent, high-**

**performance database applications. Their procedural nature, combined with deep integration into Oracle ecosystems and beyond, ensures they remain a cornerstone of enterprise data strategy for years to come.**

## **Mastering PL/SQL: Practical Programs and Solutions for Oracle Developers**

**In the realm of database development, Oracle's Procedural Language/Structured Query Language (PL/SQL) stands as a cornerstone for building robust,**

**efficient, and scalable applications. It's the engine that breathes logic and control into the declarative power of SQL, enabling developers to craft complex business rules, automate tasks, and enhance data manipulation capabilities. For anyone working with Oracle databases, a solid understanding of PL/SQL, coupled with practical, ready-to-use programs and their solutions, is invaluable.**

**This comprehensive guide delves into the world of PL/SQL programming, offering detailed explanations and practical examples of common scenarios.**

**We'll explore essential concepts, present well-structured PL/SQL programs, and provide clear solutions, empowering you to tackle a wide array of development challenges. Whether you're a beginner looking to grasp the fundamentals or an experienced developer seeking to refine your skills, this article aims to be your go-to resource for 'PL/SQL programs with solutions'.**

**Keywords: PL/SQL, Oracle PL/SQL, PL/SQL programs, PL/SQL examples, PL/SQL solutions, Oracle database, SQL, stored procedures, functions, triggers, anonymous PL/SQL blocks,**

**database programming, data manipulation, error handling  
PL/SQL, SQL injection prevention.**

## **Understanding the Fundamentals of PL/SQL**

**Before diving into specific programs, it's crucial to recap the foundational elements of PL/SQL. PL/SQL is a procedural extension to SQL that allows you to combine SQL statements with PL/SQL control structures, exception handling, and variable declarations.**

### **Key PL/SQL Constructs:**

- 1. Declarative Section: Used to declare variables, cursors, and**

**types.**

- 2. Executable Section: Contains procedural statements, SQL statements, and control structures.**
- 3. Exception Handling Section: Deals with runtime errors that occur during program execution.**

**Types of PL/SQL Units:**

- 1. Anonymous PL/SQL Blocks: Executed once and then disappear. Ideal for one-off tasks, testing, or simple scripts.**
- 2. Stored Procedures: Named PL/SQL units stored in the database, callable multiple times. Used for performing**

**specific actions, often involving data modification.**

**3. Functions: Similar to procedures but must return a single value. Useful for calculations and data retrieval.**

**4. Packages: Collections of procedures, functions, variables, and cursors grouped together for better organization and modularity.**

**5. Triggers: PL/SQL units automatically executed in response to specific database events (e.g., INSERT, UPDATE, DELETE). Used for maintaining data integrity, auditing, and enforcing business rules.**

# **Common PL/SQL Programming Scenarios and Solutions**

**Let's explore practical PL/SQL programs designed to address frequent development needs. Each example will be accompanied by a clear explanation and a complete solution.**

## **1. Simple Data Retrieval and Display (Anonymous Block)**

**A fundamental task is retrieving data and displaying it. This anonymous block demonstrates fetching employee details based on an employee ID.**

## **Scenario:**

**Retrieve the first name, last name, and salary of an employee from the `employees` table given their `employee\_id`. Display the retrieved information.**

## **Solution:**

**DECLARE**

```
    v_first_name  
employees.first_name%TYPE;  
    v_last_name  
employees.last_name%TYPE;  
    v_salary  
employees.salary%TYPE;  
    v_employee_id
```

```

employees.employee_id%TYPE :=
100; -- Example Employee ID
BEGIN
    -- Fetch employee details
into local variables
    SELECT first_name,
last_name, salary
    INTO v_first_name,
v_last_name, v_salary
    FROM employees
    WHERE employee_id =
v_employee_id;

    -- Display the retrieved
information
DBMS_OUTPUT.PUT_LINE('Employee
Name: ' || v_first_name || ' '
|| v_last_name);

```

```
DBMS_OUTPUT.PUT_LINE('Salary: '
|| v_salary);
```

**EXCEPTION**

```
    WHEN NO_DATA_FOUND THEN
DBMS_OUTPUT.PUT_LINE('Employee
with ID ' || v_employee_id || '
not found.');
```

```
    WHEN OTHERS THEN
        DBMS_OUTPUT.PUT_LINE('An
unexpected error occurred: ' ||
SQLERRM);
END;
/
```

**Explanation:**

- 1. We declare local variables to hold the employee's name and**

**salary. Using ``%TYPE`` ensures that the variable type matches the column type, preventing potential data type mismatches.**

- 2. The ``SELECT INTO`` statement fetches data from the ``employees`` table into these variables.**
- 3. ``DBMS_OUTPUT.PUT_LINE`` is used to print the output to the console (ensure ``SET SERVEROUTPUT ON`` is enabled in your SQL client).**
- 4. The ``EXCEPTION`` block handles ``NO_DATA_FOUND`` if the specified employee ID doesn't exist, and a general ``OTHERS`` exception for any other errors.**

**This is crucial for robust error handling in PL/SQL.**

## **2. Creating a Stored Procedure for Data Update**

**Stored procedures are essential for encapsulating business logic and performing data modifications. This example shows a procedure to update an employee's salary.**

### **Scenario:**

**Create a stored procedure named ``update_employee_salary`` that takes an ``employee_id`` and a ``new_salary`` as input parameters. The procedure should update the**

**salary of the specified employee.  
Include validation to ensure the  
`new\_salary` is not negative.**

**Solution:**

```
CREATE OR REPLACE PROCEDURE  
update_employee_salary (  
    p_employee_id IN NUMBER,  
    p_new_salary   IN NUMBER  
)  
AS  
    v_employee_count NUMBER;  
BEGIN  
    -- Input validation: Check  
if new salary is non-negative  
    IF p_new_salary < 0 THEN  
RAISE_APPLICATION_ERROR(-20001,
```

```
'New salary cannot be  
negative.');
```

```
END IF;
```

```
-- Check if employee exists
```

```
SELECT COUNT(*)
```

```
INTO v_employee_count
```

```
FROM employees
```

```
WHERE employee_id =  
p_employee_id;
```

```
IF v_employee_count = 0 THEN  
RAISE_APPLICATION_ERROR(-20002,
```

```
'Employee with ID ' ||  
p_employee_id || ' not found.');
```

```
END IF;
```

```
-- Update the employee's
```

**salary**

```
UPDATE employees  
SET salary = p_new_salary  
WHERE employee_id =  
p_employee_id;
```

```
-- Commit the transaction  
COMMIT;
```

```
DBMS_OUTPUT.PUT_LINE('Salary  
for employee ID ' ||  
p_employee_id || ' updated to '  
|| p_new_salary || '.');
```

**EXCEPTION**

```
WHEN OTHERS THEN  
-- Rollback in case of  
any error
```

```
        ROLLBACK;
DBMS_OUTPUT.PUT_LINE('Error
updating salary: ' || SQLERRM);
        RAISE; -- Re-raise the
exception to be handled by the
caller
END update_employee_salary;
/
```

```
-- How to call the procedure:
SET SERVEROUTPUT ON;
BEGIN
update_employee_salary(p_employe
e_id => 101, p_new_salary =>
6000);
END;
/
```

## **Explanation:**

- 1. The procedure ``update_employee_salary`` accepts two ``IN`` parameters: ``p_employee_id`` and ``p_new_salary``.**
- 2. Input validation checks if ``p_new_salary`` is non-negative. If not, ``RAISE_APPLICATION_ERROR`` is used to signal a custom error.**
- 3. A check is performed to ensure the ``employee_id`` exists before attempting the update.**
- 4. The ``UPDATE`` statement modifies the ``salary``.**
- 5. ``COMMIT`` makes the changes permanent.**

**6. The ``EXCEPTION`` block includes a ``ROLLBACK`` to undo any partial changes if an error occurs and re-raises the exception.**

### **3. Creating a Function to Calculate Bonus**

**Functions are ideal for returning calculated values. This function calculates a bonus based on an employee's salary and job ID.**

**Scenario:**

**Create a function named ``calculate_employee_bonus`` that takes an ``employee_id`` as input and returns the calculated bonus**

**amount. The bonus is 10% of the salary if the job ID is 'SA\_REP' (Sales Representative), and 5% otherwise. Handle cases where the employee doesn't exist.**

**Solution:**

```
CREATE OR REPLACE FUNCTION  
calculate_employee_bonus (  
    p_employee_id IN NUMBER  
)  
RETURN NUMBER  
AS  
    v_salary  
employees.salary%TYPE;  
    v_job_id  
employees.job_id%TYPE;
```

```
        v_bonus      NUMBER := 0;
BEGIN
    -- Fetch employee salary and
job ID
    SELECT salary, job_id
    INTO v_salary, v_job_id
    FROM employees
    WHERE employee_id =
p_employee_id;

    -- Calculate bonus based on
job ID
    IF v_job_id = 'SA_REP' THEN
        v_bonus := v_salary *
0.10; -- 10% bonus for Sales
Reps
    ELSE
        v_bonus := v_salary *
```

```
0.05; -- 5% bonus for others
END IF;
```

```
RETURN v_bonus;
```

```
EXCEPTION
```

```
    WHEN NO_DATA_FOUND THEN
        -- Return 0 or raise an
error if employee not found,
depending on requirements
```

```
        RETURN 0; -- Returning 0
indicates no bonus for non-
existent employee
```

```
    WHEN OTHERS THEN
DBMS_OUTPUT.PUT_LINE('Error
calculating bonus for employee
ID ' || p_employee_id || ': ' ||
SQLERRM);
```

```
        RAISE; -- Re-raise the
exception
END calculate_employee_bonus;
/
```

```
-- How to call the function:
SET SERVEROUTPUT ON;
DECLARE
    emp_id NUMBER := 145; --
Example Employee ID
    bonus_amount NUMBER;
BEGIN
    bonus_amount :=
calculate_employee_bonus(p_emplo
yee_id => emp_id);
    IF bonus_amount > 0 THEN
DBMS_OUTPUT.PUT_LINE('Bonus for
employee ID ' || emp_id || ' is:
```

```
' || bonus_amount);  
    ELSE  
DBMS_OUTPUT.PUT_LINE('Employee  
ID ' || emp_id || ' not found or  
eligible for bonus.');
```

END IF;  
END;  
/

## Explanation:

### 1. The function

``calculate_employee_bonus``  
takes an ``employee_id`` and  
returns a ``NUMBER``.

### 2. It retrieves the ``salary`` and ``job_id`` for the given employee.

### 3. An ``IF`` statement determines the bonus percentage based on

**`job\_id`.**

**4. The calculated bonus is returned.**

**5. The `NO\_DATA\_FOUND` exception handler returns 0, indicating no bonus if the employee doesn't exist.**

#### **4. Implementing a BEFORE INSERT Trigger for Auditing**

**Triggers are powerful for automating actions based on data changes. This example demonstrates a `BEFORE INSERT` trigger to log changes to a table.**

**Scenario:**

**Create a `BEFORE INSERT` trigger**

on the `employees` table that logs the `employee_id`, `old` values (which will be NULL for insert), and `new` values of `first_name`, `last_name`, and `salary` into an `audit_log` table whenever a new employee record is inserted. Assume an `audit_log` table exists with appropriate columns (`log_id`, `table_name`, `operation`, `record_id`, `column_name`, `old_value`, `new_value`, `timestamp`).

## Solution:

-- Assuming audit\_log table is created like this:

```
/*  
CREATE TABLE audit_log (  
    log_id          NUMBER GENERATED  
BY DEFAULT ON NULL AS IDENTITY,  
    table_name      VARCHAR2(30) NOT  
NULL,  
    operation       VARCHAR2(10) NOT  
NULL,  
    record_id       NUMBER NOT NULL,  
    column_name     VARCHAR2(30),  
    old_value       VARCHAR2(4000),  
    new_value       VARCHAR2(4000),  
    timestamp       TIMESTAMP  
DEFAULT SYSTIMESTAMP  
);  
*/
```

```
CREATE OR REPLACE TRIGGER
```

```
trg_audit_employees_insert
BEFORE INSERT ON employees
FOR EACH ROW
DECLARE
    v_user VARCHAR2(100);
BEGIN
    -- Get current user
    SELECT USER INTO v_user FROM
DUAL;

    -- Log changes for each
relevant column
    INSERT INTO audit_log
(table_name, operation,
record_id, column_name,
old_value, new_value)
VALUES ('EMPLOYEES',
'INSERT', :NEW.employee_id,
```

```
'FIRST_NAME', NULL,  
:NEW.first_name);
```

```
INSERT INTO audit_log  
(table_name, operation,  
record_id, column_name,  
old_value, new_value)  
VALUES ('EMPLOYEES',  
'INSERT', :NEW.employee_id,  
'LAST_NAME', NULL,  
:NEW.last_name);
```

```
INSERT INTO audit_log  
(table_name, operation,  
record_id, column_name,  
old_value, new_value)  
VALUES ('EMPLOYEES',  
'INSERT', :NEW.employee_id,
```

```
'SALARY', NULL,  
TO_CHAR(:NEW.salary)); --  
Convert salary to string
```

```
-- Optionally, log the user  
who performed the action
```

```
INSERT INTO audit_log  
(table_name, operation,  
record_id, column_name,  
new_value)
```

```
VALUES ('EMPLOYEES',  
'INSERT', :NEW.employee_id,  
'AUDIT_USER', v_user);
```

**EXCEPTION**

```
WHEN OTHERS THEN  
DBMS_OUTPUT.PUT_LINE('Error in  
audit trigger for employees
```

```
insert: ' || SQLERRM);  
        RAISE; -- Re-raise the  
exception  
END trg_audit_employees_insert;  
/
```

```
-- How to test the trigger:  
SET SERVEROUTPUT ON;  
-- INSERT a new employee record  
/*  
INSERT INTO employees  
(employee_id, first_name,  
last_name, email, hire_date,  
job_id, salary)  
VALUES (207, 'Test', 'User',  
'TESTUSER@example.com', SYSDATE,  
'IT_PROG', 5000);  
COMMIT;
```

```
*/
```

```
-- Then query the audit_log  
table to see the entries.
```

```
/*
```

```
SELECT * FROM audit_log WHERE  
record_id = 207 ORDER BY  
timestamp;
```

```
*/
```

## **Explanation:**

### **1. The trigger**

**`trg\_audit\_employees\_insert`  
fires `BEFORE` an `INSERT`  
operation on the `employees`  
table.**

### **2. `FOR EACH ROW` ensures the trigger executes for every row**

**affected by the DML statement.**

- 3. `:NEW` is a pseudorecord representing the new row being inserted. `:OLD` represents the old row (which is NULL for inserts).**
- 4. Multiple `INSERT` statements log the changes for specific columns into the `audit\_log` table.**
- 5. We capture the current user for audit purposes.**
- 6. Error handling is included to log any issues within the trigger itself.**

## **5. Using Cursors for Iterating Through Records**

**Cursors allow you to process a set**

**of rows one by one. This example iterates through employees in a specific department and calculates their average salary.**

**Scenario:**

**Write a PL/SQL anonymous block that uses a cursor to fetch all employees in department ID 90. Calculate and display the average salary for this department.**

**Solution:**

```
DECLARE  
-- Cursor declaration  
CURSOR emp_cursor IS  
    SELECT first_name,
```

```
last_name, salary
      FROM employees
      WHERE department_id =
90; -- Example Department ID

      -- Variables to hold fetched
data
      v_emp_salary
employees.salary%TYPE;
      v_total_salary NUMBER := 0;
      v_employee_count NUMBER :=
0;
      v_avg_salary NUMBER;

BEGIN

      -- Open the cursor
      OPEN emp_cursor;
```

```
-- Fetch records one by one
LOOP
    FETCH emp_cursor INTO
v_emp_salary;

    -- Exit loop when no
more rows are found
    EXIT WHEN
emp_cursor%NOTFOUND;

    -- Accumulate salary and
count employees
    v_total_salary :=
v_total_salary + v_emp_salary;
    v_employee_count :=
v_employee_count + 1;
END LOOP;
```

```
-- Close the cursor
CLOSE emp_cursor;

-- Calculate average salary
IF v_employee_count > 0 THEN
    v_avg_salary :=
v_total_salary /
v_employee_count;
DBMS_OUTPUT.PUT_LINE('Average
salary for department 90: ' ||
v_avg_salary);
ELSE
    DBMS_OUTPUT.PUT_LINE('No
employees found in department
90. ');
END IF;

EXCEPTION
```

```

    WHEN OTHERS THEN
        -- Ensure cursor is
closed if an error occurs
        IF emp_cursor%ISOPEN
THEN
            CLOSE emp_cursor;
        END IF;
        DBMS_OUTPUT.PUT_LINE('An
error occurred: ' || SQLERRM);
        RAISE;
END;
/

```

### **Explanation:**

- 1. A cursor `emp\_cursor` is declared to select employees from department 90.**
- 2. The cursor is `OPEN`ed.**

- 3. A `LOOP` iterates, `FETCH`ing one row at a time into local variables.**
- 4. `emp\_cursor%NOTFOUND` is used as the loop termination condition.**
- 5. Salary and employee count are accumulated.**
- 6. The cursor is `CLOSE`d after the loop.**
- 7. The average salary is calculated and displayed, with a check for zero employees.**
- 8. The exception handler ensures the cursor is closed even if an error occurs.**

## **6. Bulk Collect for Performance**

## **Enhancement**

**For large datasets, explicit cursors can be slow. `BULK COLLECT` is a powerful performance optimization technique.**

### **Scenario:**

**Rewrite the previous cursor example to use `BULK COLLECT` for fetching employee salaries from department 90 and then calculate the average salary. This will significantly reduce context switching between the PL/SQL engine and the SQL engine.**

## **Solution:**

**DECLARE**

**-- Collection to hold  
salaries**

**TYPE salary\_list IS TABLE OF  
employees.salary%TYPE INDEX BY  
BINARY\_INTEGER;**

**v\_salaries salary\_list;**

**v\_total\_salary NUMBER := 0;**

**v\_employee\_count NUMBER :=  
0;**

**v\_avg\_salary NUMBER;**

**BEGIN**

**-- Fetch all salaries for  
department 90 into the**

**collection**

```
SELECT salary  
BULK COLLECT INTO v_salaries  
FROM employees  
WHERE department_id = 90; --  
Example Department ID
```

```
-- Get the number of  
employees fetched  
v_employee_count :=  
v_salaries.COUNT;
```

```
-- Calculate total salary if  
employees were found  
IF v_employee_count > 0 THEN  
-- Use FORALL or a  
simple loop for processing the  
collection
```

```
        FOR i IN 1 ..  
v_employee_count LOOP  
            v_total_salary :=  
v_total_salary + v_salaries(i);  
        END LOOP;
```

```
        v_avg_salary :=  
v_total_salary /  
v_employee_count;  
DBMS_OUTPUT.PUT_LINE('Average  
salary for department 90 (using  
BULK COLLECT): ' ||  
v_avg_salary);
```

```
    ELSE  
        DBMS_OUTPUT.PUT_LINE('No  
employees found in department  
90.');
```

```
    END IF;
```

## EXCEPTION

```
        WHEN OTHERS THEN
            DBMS_OUTPUT.PUT_LINE('An
error occurred: ' || SQLERRM);
            RAISE;
END;
/
```

### Explanation:

1. A collection type `salary\_list` is defined to hold multiple salary values.
2. `BULK COLLECT INTO v\_salaries` fetches all salaries for department 90 into the `v\_salaries` collection in a single SQL operation.
3. `v\_salaries.COUNT` efficiently

**returns the number of elements in the collection.**

- 4. A `FOR` loop iterates through the collection to sum the salaries.**
- 5. This approach drastically reduces the overhead compared to row-by-row fetching with explicit cursors, making it ideal for large data volumes.**

## **Advanced PL/SQL Concepts**

**Beyond these fundamental examples, PL/SQL offers advanced features for more complex applications:**

**Error Handling and Exception**

## **Management**

**Robust error handling is paramount. Beyond ``NO_DATA_FOUND`` and ``OTHERS``, learn about named exceptions, user-defined exceptions, and how to log and propagate errors effectively. Understanding ``SQLCODE`` and ``SQLERRM`` is also vital for diagnosing issues.**

## **Record Types and Associative Arrays (Collections)**

**PL/SQL's collection types (nested tables, varrays, associative arrays) and record types provide powerful ways to structure and manipulate data within your**

**programs, enhancing code readability and efficiency. `BULK COLLECT` heavily relies on these.**

## **Ref Cursors**

**Ref Cursors (or weakly typed cursors) are used to pass result sets between PL/SQL blocks and clients (like Java or .NET applications) or between PL/SQL units. They are dynamic and can return the result of any query.**

## **Autonomous Transactions**

**Autonomous transactions allow a sub-transaction to commit or rollback independently of the main transaction. This is useful for logging, auditing, or sending**

**alerts without affecting the primary transaction's integrity.**

## **Packages for Modularity**

**Organizing your PL/SQL code into packages is a best practice.**

**Packages allow you to group related procedures, functions, and variables, promoting reusability, maintainability, and better control over object visibility.**

## **Best Practices for PL/SQL Development**

**To ensure your PL/SQL code is maintainable, efficient, and secure, consider these best practices:**

- 1. Consistent Naming Conventions:**  
Use clear and consistent names for variables, procedures, functions, and packages.
- 2. Modular Design:** Break down complex logic into smaller, reusable units (procedures, functions).
- 3. Robust Error Handling:**  
Implement comprehensive exception handling to gracefully manage errors.
- 4. Performance Optimization:**  
Utilize ``BULK COLLECT`` and ``FORALL`` for set-based operations. Avoid row-by-row processing for large datasets.
- 5. Code Readability:** Use

**comments, proper indentation, and clear variable names.**

- 6. Security: Be mindful of SQL injection vulnerabilities, especially when concatenating user input into SQL statements. Use bind variables or `EXECUTE IMMEDIATE` with caution.**
- 7. Transaction Management: Understand `COMMIT` and `ROLLBACK` and manage transactions appropriately.**
- 8. Data Type Consistency: Use `%TYPE` and `%ROWTYPE` to ensure data type compatibility.**

## **Conclusion**

**PL/SQL is a powerful and versatile**

**language that, when mastered, can significantly enhance the capabilities of your Oracle database applications. The 'PL/SQL programs with solutions' provided in this article offer a solid starting point for tackling common development challenges. By understanding the fundamentals, practicing with these examples, and adopting best practices, you'll be well-equipped to build efficient, reliable, and maintainable database solutions.**

**The journey of mastering PL/SQL is ongoing. Continuously exploring new features, refining**

**your techniques, and staying updated with Oracle's advancements will ensure you remain a proficient and valuable database developer. Remember to always test your PL/SQL code thoroughly in different scenarios to ensure its correctness and performance.**

**Reading habits rarely stay the same throughout a lifetime. They shift as responsibilities grow, environments change, and priorities evolve. What remains constant is the human need to understand, to learn, and to make sense of information. The ability to download *Pl Sql Programs With***

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**They support decision-making, problem-solving, and skill development. Professionals consult them quietly, returning when clarity is needed rather than treating learning as a separate activity. Students benefit in similar ways. Learning becomes more personal when materials are always accessible. Revisiting difficult sections, reviewing notes, and preparing at one's own pace supports confidence and comprehension. The learning process feels adaptable rather than rigid. Different reading styles find equal support. Some readers prefer**

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**and goals. Files remain searchable, notes preserved, and insights easy to revisit. Learning feels cumulative rather than fragmented. Another subtle change appears in confidence. When readers know they can return at any time, pressure fades. Understanding develops gradually through repetition and reflection. Ideas settle more deeply when they are revisited rather than rushed. Global access adds richness to the experience. Readers from different cultures and backgrounds engage with the same material, often interpreting ideas through different lenses.**

**This shared access broadens perspective and encourages thoughtful comparison.**

**Exploration becomes easier when effort is low. Readers venture beyond familiar subjects, connecting ideas across disciplines. This cross-pollination strengthens creativity and critical thinking, allowing knowledge to grow organically. Long-term engagement becomes possible when resources remain available. Notes saved today support understanding tomorrow. Bookmarks placed months ago still guide attention. Learning stretches across time rather than**

resetting with each new resource. The role of books subtly shifts. Instead of being consumed once, they remain present. They wait patiently, ready to be reopened when curiosity returns. This availability transforms reading into an ongoing relationship rather than a single event. Digital literacy develops naturally through this interaction. Readers become comfortable managing files, evaluating sources, and navigating information. These skills extend beyond reading, supporting broader academic and professional competence. The appeal of downloading *PI Sql*

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**completion, reflection over speed,  
and curiosity over obligation.  
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each return to the text opens a  
new entry point. Ideas evolve,  
questions deepen, and  
understanding grows gradually.  
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without announcement. It moves  
alongside daily life, responding to  
moments of interest, quiet  
reflection, and renewed curiosity.  
And in that steady presence,  
knowledge remains not as a  
destination, but as something  
that stays close, ready whenever  
it is needed.**

# Questions & Answers About pl sql programs with solutions

| N<br>o | Question                                                                                               | Answer                                                                                                                                                                                                                                                                                                                         |
|--------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | What's the difference between a stored procedure and a function in PL/SQL, and when should I use each? | Stored procedures perform actions (like inserting, updating, deleting) and don't necessarily return a value. Functions, on the other hand, are designed to perform calculations and <i>must</i> return a single value. Use procedures for data manipulation and functions for calculations or retrieving specific data points. |
| 2      | How can I handle errors gracefully in my PL/SQL programs using EXCEPTION blocks?                       | Use the `EXCEPTION` section at the end of your `BEGIN...END` block. You can catch specific errors (e.g., `WHEN NO_DATA_FOUND THEN`) or use `WHEN OTHERS THEN` for general error handling. Inside the block, you can log the error, display a message, or perform corrective actions.                                           |
| 3      | What are cursors in PL/SQL, and why are they important for processing row-by-row data?                 | Cursors allow you to process rows returned by a SQL query one at a time. They are essential when you need to perform complex logic on individual rows that cannot be achieved with a single SQL statement. Key operations include `OPEN`, `FETCH`, and `CLOSE`.                                                                |
| 4      | Explain the concept of bulk collect and FORALL in PL/SQL for performance optimization.                 | Bulk collect fetches multiple rows from a query into collections (arrays) in a single operation, reducing context switching. FORALL is used to perform DML operations (INSERT, UPDATE, DELETE) on multiple rows stored in collections efficiently, also minimizing context switches.                                           |

|   |                                                                                                             |                                                                                                                                                                                                                                                                                                                     |
|---|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | What are PL/SQL collections (like VARRAYs and nested tables), and how are they used in programs?            | PL/SQL collections are user-defined data structures that can hold multiple elements of the same datatype, similar to arrays. VARRAYs have a fixed maximum size, while nested tables are more flexible. They are often used with bulk collect and FORALL for efficient data handling.                                |
| 6 | How can I use triggers in PL/SQL to automatically enforce business rules or audit changes?                  | Triggers are stored programs that automatically execute in response to certain events (INSERT, UPDATE, DELETE) on a specific table. You can define them to fire `BEFORE` or `AFTER` the event and use them to validate data, log changes, or maintain referential integrity.                                        |
| 7 | What's the purpose of the `DBMS_OUTPUT` package in PL/SQL, and how do I use it for debugging?               | `DBMS_OUTPUT` is a built-in package that allows you to display messages from your PL/SQL code. You typically use `DBMS_OUTPUT.PUT_LINE()` to print strings, variables, or other output. Remember to enable output in your SQL client before running the program.                                                    |
| 8 | How do I pass parameters to PL/SQL stored procedures and functions, and what are IN, OUT, and IN OUT modes? | Parameters are declared in the procedure/function signature. `IN` parameters pass values into the subprogram. `OUT` parameters return values from the subprogram. `IN OUT` parameters allow values to be passed in and then modified and returned. This enables communication between different parts of your code. |
| 9 | What are anonymous PL/SQL blocks, and when are they typically used?                                         | Anonymous PL/SQL blocks are PL/SQL code segments without a name, executed immediately when run. They are commonly used for ad-hoc queries, testing small code snippets, performing quick data manipulation, or as part of SQL scripts where a named procedure isn't necessary.                                      |

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## **Practical Use**

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