

# PostgreSQL Developer – 100+ Lab Exercises (Basic, Intermediate, Advanced)

## □ Basic Level (30+ Exercises)

**Goal:** Build foundational knowledge of PostgreSQL database management, SQL syntax, and data manipulation.

### Installation & Setup

- Install PostgreSQL on Windows/Linux/macOS.
- Configure pgAdmin for database management.
- Create and connect to a PostgreSQL database.
- Understand PostgreSQL architecture overview.

### Basic SQL Queries

- Write SELECT statements with filtering (WHERE).
- Use ORDER BY and LIMIT clauses.
- Insert, update, and delete data.
- Use DISTINCT and aggregate functions (COUNT, SUM, AVG).
- Basic string and date/time functions.

### Table Design & Data Types

- Create tables with appropriate data types.
- Use constraints: NOT NULL, UNIQUE, PRIMARY KEY.
- Define default values and check constraints.
- Understand and use SERIAL and UUID types.
- Alter tables to add/drop columns and constraints.

### Basic Joins & Subqueries

- Implement INNER JOIN, LEFT JOIN, RIGHT JOIN.
- Write simple correlated and non-correlated subqueries.
- Use EXISTS and IN predicates.
- Practice UNION and UNION ALL.



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## □ Intermediate Level (40+ Exercises)

**Goal:** Develop advanced querying skills, indexing, and data integrity enforcement.

### Advanced SQL Queries

- Use window functions: ROW\_NUMBER(), RANK(), LEAD(), LAG().
- Advanced filtering with CASE expressions.
- Recursive queries with CTEs (WITH clause).
- Complex joins and multi-table queries.
- Perform data pivoting and aggregation.

### Indexing & Performance Tuning

- Create and analyze B-tree, GIN, GiST, and BRIN indexes.
- Understand EXPLAIN and EXPLAIN ANALYZE outputs.
- Optimize query performance with indexes.
- Use VACUUM and ANALYZE for maintenance.
- Partition tables for performance and management.

### Transactions & Concurrency

- Implement transactions with BEGIN, COMMIT, ROLLBACK.
- Set transaction isolation levels.
- Manage locks and deadlocks.
- Use advisory locks.
- Practice multi-version concurrency control (MVCC).

### Functions & Stored Procedures

- Create user-defined functions in PL/pgSQL.
- Use triggers to automate data actions.
- Write stored procedures and control flow structures.
- Handle exceptions in functions.
- Implement security definer functions.

## □ Advanced Level (40+ Exercises)



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**Goal:** Master PostgreSQL administration, replication, security, and complex data types.

## Advanced Data Types & Extensions

- Use JSON and JSONB for semi-structured data.
- Query and index JSONB data.
- Work with arrays and hstore.
- Use PostGIS for geospatial data.
- Implement full-text search capabilities.

## Replication & High Availability

- Setup streaming replication (primary & standby).
- Configure synchronous and asynchronous replication.
- Perform failover and switchover.
- Use pg\_stat\_replication for monitoring.
- Understand logical replication and publication/subscription.

## Backup, Restore & Security

- Perform pg\_dump and pg\_restore operations.
- Use continuous archiving and point-in-time recovery.
- Manage roles, permissions, and row-level security.
- Encrypt data at rest and in transit.
- Audit database activities.

## Advanced Administration

- Automate maintenance tasks with cron and pgAgent.
- Configure connection pooling with PgBouncer.
- Tune PostgreSQL configuration parameters.
- Use monitoring tools (pgAdmin, pgBadger, Prometheus).
- Manage large datasets with table partitioning and clustering.

## Capstone Projects

- Design a multi-tenant SaaS database schema.
  - Implement a full-text search engine for product catalogs.
  - Build a geospatial application using PostGIS.
  - Setup a PostgreSQL cluster with replication and failover.
  - Create a real-time analytics dashboard with continuous aggregation.
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## □ Tools & Platforms

- PostgreSQL CLI, pgAdmin, DBeaver
- pgBouncer, pgBadger, PostGIS
- Linux/Unix shell scripting
- Monitoring tools: Prometheus, Grafana