PostgreSQL Database Fundamentals with Performance & Tuning

Duration: 15 days
Prerequisites: Knowledge of Database Systems

Day 1 – Introduction to Databases & PostgreSQL

- What is data, information, and database
- File system vs database system
- Introduction to RDBMS
- Overview of popular RDBMS (MySQL, Oracle, SQL Server, PostgreSQL)
- Why PostgreSQL for enterprise applications
- PostgreSQL features and advantages
- PostgreSQL architecture overview
- Introduction to SQL
- **Lab:** Exploring PostgreSQL tools and documentation

Day 2 – PostgreSQL Installation & Environment Setup

- PostgreSQL installation overview (Windows/Linux)
- PostgreSQL directory structure
- PostgreSQL service and startup
- Introduction to psql
- pgAdmin overview
- Connecting to PostgreSQL server
- PostgreSQL configuration files overview
- **Lab:** Install PostgreSQL and connect using psql & pgAdmin

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Day 3 – Database Objects, Schemas & Data Types

- Databases and schemas
- Creating and dropping databases
- Schema usage and best practices
- PostgreSQL data types:
    - Numeric
    - Character
    - Date & Time
    - Boolean
- Choosing optimal data types (performance awareness)
- Naming conventions
- **Lab:** Create database objects with proper data types

Day 4 – SQL DDL & Table Design Best Practices

- SQL syntax fundamentals
- CREATE, ALTER, DROP, TRUNCATE

- Constraints and data integrity
- Primary keys and foreign keys
- Table normalization (basic level)
- Table design impact on performance
- **Lab:** Design well-structured relational tables

Day 5 – SQL DML & Data Manipulation

- INSERT, UPDATE, DELETE
- SELECT statement fundamentals
- WHERE clause
- Handling NULL values
- DISTINCT and ORDER BY
- Efficient data insertion practices
- **Lab:** CRUD operations on sample datasets

Day 6 – Filtering, Expressions & Query Optimization Basics

- Comparison and logical operators
- LIKE, IN, BETWEEN
- Pattern matching
- Expressions and column aliases
- LIMIT and OFFSET
- Writing readable and efficient queries
- **Lab:** Query filtering with performance awareness

Day 7 – Functions, Aggregations & Performance Considerations

- Built-in PostgreSQL functions
- Aggregate functions (COUNT, SUM, AVG, MIN, MAX)
- GROUP BY and HAVING
- String and date functions
- Avoiding common performance mistakes in aggregations
- **Lab:** Analytical and summary queries

Day 8 – Joins & Query Performance

- Table relationships
- INNER, LEFT, RIGHT, FULL joins
- Self joins
- Join order and performance basics
- Cartesian joins and how to avoid them
- **Lab:** Optimized multi-table queries

Day 9 – Subqueries, Views & Performance Impact

- Subqueries (single and multi-row)
- Correlated subqueries (intro level)
- Views vs tables
- Performance considerations of views
- When to use subqueries vs joins
- **Lab:** Views and nested queries

Day 10 – Indexing for Performance Tuning

- What is an index and why it matters
- How indexes work internally (conceptual)
- Types of indexes:
    - B-tree
    - Unique indexes
    - Composite indexes
- When to create indexes
- Index overhead and maintenance
- **Lab:** Creating and testing indexes for query speed

Day 11 – Query Performance Analysis & Optimization

- Introduction to query execution
- Understanding EXPLAIN
- Understanding EXPLAIN ANALYZE
- Sequential scan vs index scan
- Identifying slow queries
- Basic query optimization techniques
- **Lab:** Analyze and optimize slow SQL queries

Day 12 – Transactions, Locks & Concurrency Performance

- Transactions and ACID properties
- COMMIT, ROLLBACK, SAVEPOINT
- Transaction isolation levels (conceptual)
- Locks and blocking
- Deadlock basics
- Performance impact of long transactions
- **Lab:** Transaction handling and concurrency scenarios

Day 13 – PostgreSQL Configuration & Performance Parameters

- PostgreSQL server architecture
- Memory concepts:
    - shared_buffers
    - work_mem
    - maintenance_work_mem
- Connection handling basics
- Autovacuum overview
- Logging for performance troubleshooting
- **Lab:** Review and tune basic configuration parameters

Day 14 – Maintenance, Backup & Performance Health

- Importance of regular maintenance
- VACUUM and ANALYZE
- Index maintenance
- Backup strategies overview
- pg_dump and pg_restore
- Monitoring database health
- **Lab:** Perform maintenance and backup tasks

Day 15 – Real-World Performance Use Cases & Assessment

- Common PostgreSQL performance issues
- Best practices for SQL performance
- Application-side performance considerations
- Case study: slow query troubleshooting
- End-to-end performance review