



PostgreSQL

Administration

Course Editorial Plan

17

MODULES

84

TOTAL LESSONS

~40h

TOTAL DURATION

3

LEVELS

Course Description

A comprehensive, standalone course covering the full spectrum of PostgreSQL database administration. From architecture internals and installation to advanced topics including backup and recovery, replication, high availability, query tuning, partitioning, connection pooling and upgrade strategies. Designed for DBA professionals and system administrators who need to deploy, operate and maintain PostgreSQL in production environments with confidence.

Target Audience

Junior and mid-level DBAs transitioning to PostgreSQL, system administrators managing PostgreSQL in production, developers moving into DBA or DevOps roles, and IT professionals responsible for database reliability, performance and security.

Prerequisites

Working knowledge of relational database concepts (tables, keys, basic SQL). Familiarity with Linux system administration. No prior PostgreSQL experience required — the course is fully self-contained.

Learning Outcomes

By the end of the course, students will be able to: install, configure and manage PostgreSQL clusters on Linux; implement comprehensive backup, recovery and PITR strategies; configure streaming replication and automated failover with Patroni; monitor and diagnose performance issues using system views and extensions; tune queries with EXPLAIN ANALYZE and advanced index strategies; design and manage partitioned tables; configure PgBouncer for connection pooling at scale; integrate external data sources via Foreign Data Wrappers; plan and execute major version upgrades safely.



Module Index

#	MODULE	LEVEL	LESSONS	DURATION
01	Introduction & System Architecture	Foundation	5	2h
02	Installation & Cluster Management	Foundation	5	2h
03	Configuration	Foundation	5	2h
04	Database Security & Compliance	Intermediate	6	2h 30min
05	Database Monitoring	Intermediate	5	2h
06	Monitoring Extensions	Intermediate	4	1h 30min
07	Routine Maintenance	Intermediate	5	2h
08	Backup, Recovery & Point-in-Time Recovery	Intermediate	6	2h 30min
09	SQL Tuning — Query Analysis	Intermediate	5	2h
10	SQL Tuning — Rewrite & Optimization	Advanced	5	2h
11	Performance Tuning	Advanced	5	2h
12	Performance Benchmarking	Advanced	4	1h 30min
13	Table Partitioning	Advanced	5	2h
14	Connection Pooling	Advanced	5	1h 30min
15	Foreign Data Wrappers	Advanced	4	1h 30min
16	Replication & High Availability	Advanced	5	2h 30min
17	Upgrading Best Practices	Advanced	5	1h 30min



Module Details

01 Introduction & System Architecture

FOUNDATION
2h

PostgreSQL in the DBMS landscape, deep dive into internal architecture: processes, memory management, storage engine, WAL and MVCC. Essential context for every DBA decision.

LESSONS

1. PostgreSQL positioning: open source ecosystem and enterprise use cases 20min
2. Core processes: postmaster, backend workers, autovacuum, WAL writer 25min
3. Memory architecture: shared_buffers, work_mem, WAL buffers, OS cache 25min
4. Storage engine: heap files, TOAST, FSM, visibility map 25min
5. Write-Ahead Log (WAL): purpose, structure and checkpoints 25min

Objectives: Process architecture • Memory management • Storage engine • WAL internals • MVCC overview

02 Installation & Cluster Management

FOUNDATION
2h

Installing PostgreSQL on Linux and other platforms, initializing and managing database clusters, tablespaces and multi-instance deployments.

LESSONS

1. Installation on Linux (Debian/Ubuntu, RHEL/Rocky) and Windows 25min
2. initdb: cluster initialization, encoding, locale options 20min
3. PGDATA layout: directories, configuration files, pg_wal 20min
4. Tablespaces: creation, management and operational use cases 20min
5. Managing multiple PostgreSQL instances on the same host 35min

Objectives: Cross-platform installation • Cluster initialization • PGDATA layout • Tablespace management • Multi-instance

03 Configuration

FOUNDATION
2h

In-depth walkthrough of postgresql.conf and pg_hba.conf. Understanding parameter categories, reload vs restart requirements, authentication methods and runtime changes.

LESSONS

1. postgresql.conf: parameter categories, units, context (postmaster/sighup/user) 30min
2. Memory parameters: shared_buffers, effective_cache_size, work_mem, maintenance_work_mem 25min
3. Connections and authentication: max_connections, pg_hba.conf methods 20min



4. Logging configuration: destinations, levels, duration thresholds, csvlog 20min
5. ALTER SYSTEM, SHOW, pg_reload_conf() and runtime configuration management 25min

Objectives: Configuration hierarchy • Memory tuning • pg_hba.conf • Logging • Runtime changes

04 Database Security & Compliance

INTERMEDIATE
2h 30min

Complete PostgreSQL security model for production environments: roles, privileges, Row Level Security, SSL/TLS, audit logging with pg_audit and data masking strategies.

LESSONS

1. Roles, users and privilege model: GRANT, REVOKE, role inheritance 25min
2. Object-level privileges: tables, schemas, functions, default privileges 20min
3. Row Level Security (RLS): policies, BYPASSRLS and multi-tenant patterns 25min
4. SSL/TLS: certificate setup, mutual TLS, sslmode configuration 20min
5. pg_audit: statement and object auditing, log format and analysis 30min
6. Data masking strategies: views, column-level security, anonymization 30min

Objectives: Role model • RLS • SSL/TLS • pg_audit • Compliance • Data masking

05 Database Monitoring

INTERMEDIATE
2h

Systematic monitoring of a running PostgreSQL instance: activity, wait events, replication lag, background processes and lock contention using system catalog views.

LESSONS

1. pg_stat_activity: session states, wait events, query duration 25min
2. pg_stat_bgwriter, pg_stat_checkpoint: I/O and checkpoint health 20min
3. Replication monitoring: pg_stat_replication, pg_replication_slots 20min
4. Lock monitoring: pg_locks, pg_blocking_pids(), deadlock detection 20min
5. Building a DBA monitoring dashboard: key metrics and alert thresholds 35min

Objectives: Session monitoring • Wait events • Checkpoint health • Replication lag • Lock contention

06 Monitoring Extensions

INTERMEDIATE
1h 30min

Extending PostgreSQL observability with dedicated extensions and external tools: pg_stat_statements for workload analysis, pgBadger for log mining and an introduction to Prometheus/Grafana integration.

LESSONS

1. pg_stat_statements: setup, workload analysis, top queries identification 30min



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| 2. pgBadger: log parsing, report generation, slow query trends | 25min |
| 3. Prometheus + postgres_exporter: metrics collection and alerting | 20min |
| 4. Grafana dashboards for PostgreSQL: key panels and practical setup | 15min |

Objectives: pg_stat_statements • pgBadger • Prometheus integration • Grafana dashboards

07 Routine Maintenance

INTERMEDIATE
2h

Keeping PostgreSQL healthy over time: VACUUM mechanics, autovacuum tuning, REINDEX strategies, statistics management and table bloat diagnosis and remediation.

LESSONS

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| 1. VACUUM mechanics: dead tuples, visibility map, freeze and wraparound | 25min |
| 2. ANALYZE and planner statistics: pg_statistic, inheritance, extended stats | 20min |
| 3. Autovacuum configuration: per-table settings, cost delay, worker tuning | 25min |
| 4. REINDEX: CONCURRENTLY, index bloat detection and scheduled rebuilds | 20min |
| 5. Table bloat: diagnosis with pgstattuple, pg_squeeze and CLUSTER strategies | 30min |

Objectives: VACUUM/ANALYZE • Autovacuum tuning • REINDEX • Bloat management • Freeze/wraparound

08 Backup, Recovery & Point-in-Time Recovery

INTERMEDIATE
2h 30min

Comprehensive backup strategy for production: logical and physical backups, WAL archiving, PITR procedures, pgBackRest for enterprise-grade backup management and recovery testing.

LESSONS

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| 1. Logical backup: pg_dump, pg_dumpall — formats, parallelism, advanced options | 25min |
| 2. Physical backup: pg_basebackup, file system snapshots, consistency requirements | 25min |
| 3. WAL archiving: archive_command, archive_status, restore_command | 25min |
| 4. Point-in-Time Recovery (PITR): full procedure, recovery.conf, target options | 35min |
| 5. pgBackRest: repository setup, stanza configuration, scheduling and retention | 20min |
| 6. Recovery testing: validation procedures, automation and RTO/RPO measurement | 20min |

Objectives: pg_dump advanced • pg_basebackup • WAL archiving • PITR • pgBackRest • Recovery testing

09 SQL Tuning — Query Analysis

INTERMEDIATE
2h



Deep dive into PostgreSQL query execution analysis: reading and interpreting execution plans, understanding planner statistics and cost model, identifying bottlenecks with `pg_stat_statements`.

LESSONS

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| 1. EXPLAIN anatomy: nodes, cost model, rows estimation, actual vs estimated | 30min |
| 2. EXPLAIN ANALYZE: buffers, timing, JIT compilation indicators | 25min |
| 3. Sequential vs index scans: when the planner chooses what and why | 20min |
| 4. Join strategies: nested loop, hash join, merge join — cost comparison | 20min |
| 5. Using <code>pg_stat_statements</code> for workload-driven tuning priorities | 25min |

Objectives: EXPLAIN anatomy • Cost model • Scan strategies • Join strategies • Workload analysis

10 SQL Tuning — Rewrite & Optimization

ADVANCED
2h

Practical query rewriting techniques and advanced index strategies to achieve optimal execution plans. Anti-pattern identification and planner hint workarounds.

LESSONS

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| 1. Partial indexes, covering indexes and expression indexes: design and use cases | 30min |
| 2. Query rewriting: eliminating implicit casts, rewriting correlated subqueries | 25min |
| 3. CTE optimization: MATERIALIZED vs inline, recursive CTE performance | 20min |
| 4. Planner configuration: <code>enable_*</code> parameters, <code>planner_cost</code> settings | 20min |
| 5. Common anti-patterns: N+1, functions in WHERE, unnecessary DISTINCT | 25min |

Objectives: Advanced indexes • Query rewriting • CTE optimization • Planner config • Anti-patterns

11 Performance Tuning

ADVANCED
2h

System-level and PostgreSQL-level performance tuning: OS configuration, I/O subsystem, checkpoint and WAL tuning, connection overhead and hardware considerations for production deployments.

LESSONS

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| 1. OS tuning: huge pages, swappiness, I/O scheduler, transparent hugepages | 25min |
| 2. Checkpoint tuning: <code>checkpoint_completion_target</code> , <code>max_wal_size</code> , <code>wal_buffers</code> | 25min |
| 3. I/O performance: <code>random_page_cost</code> , <code>effective_io_concurrency</code> , tablespace placement | 20min |
| 4. Parallel query: <code>max_parallel_workers</code> , <code>parallel_setup_cost</code> , practical limits | 20min |
| 5. Connection overhead and its impact: why pooling is not optional at scale | 30min |

Objectives: OS-level tuning • Checkpoint config • I/O tuning • Parallel query • Connection management



12 Performance Benchmarking

ADVANCED
1h 30min

Establishing performance baselines and running meaningful benchmarks with pgbench. Methodology for interpreting results, avoiding common pitfalls and tracking regressions over time.

LESSONS

1. pgbench: initialization, built-in scripts, custom transaction scripts 30min
2. Benchmark methodology: warm-up, steady state, statistical significance 20min
3. Interpreting results: TPS, latency percentiles, throughput vs concurrency curves 20min
4. Regression testing: establishing baselines and detecting performance changes 20min

Objectives: pgbench • Benchmark methodology • Result interpretation • Regression testing

13 Table Partitioning

ADVANCED
2h

Designing and managing partitioned tables in PostgreSQL: declarative partitioning strategies, partition pruning, index design on partitions and operational lifecycle management.

LESSONS

1. Declarative partitioning: RANGE, LIST and HASH strategies — when to use each 25min
2. Partition pruning: constraint exclusion, runtime pruning, EXPLAIN validation 25min
3. Index design on partitions: local vs global indexes, unique constraints 20min
4. Partition management: adding, detaching, attaching and archiving partitions 25min
5. Sub-partitioning and practical patterns: time-series, tenant isolation 25min

Objectives: Partitioning strategies • Partition pruning • Index design • Lifecycle management • Patterns

14 Connection Pooling

ADVANCED
1h 30min

Managing database connections at scale with PgBouncer: pooling modes, configuration, sizing and monitoring. Architectural comparison with pgpool-II and decision criteria.

LESSONS

1. Why connection pooling: PostgreSQL process model and connection cost 15min
2. PgBouncer architecture: session, transaction and statement pooling modes 30min
3. PgBouncer configuration: pool sizing, authentication, TLS, admin interface 25min
4. Monitoring PgBouncer: SHOW POOLS, SHOW STATS, key metrics 20min
5. pgpool-II overview: feature comparison and when to consider it instead 20min

Objectives: Connection cost model • PgBouncer modes • Configuration & sizing • Monitoring • pgpool-II comparison



15 Foreign Data Wrappers

ADVANCED
1h 30min

Integrating external data sources into PostgreSQL using Foreign Data Wrappers: `postgres_fdw` for remote PostgreSQL, `file_fdw` for flat files, and `oracle_fdw` for Oracle database integration.

LESSONS

1. FDW architecture: CREATE SERVER, USER MAPPING, IMPORT FOREIGN SCHEMA 20min
2. `postgres_fdw`: remote query pushdown, join pushdown, performance considerations 25min
3. `file_fdw`: CSV and log file access, format options and use cases 20min
4. `oracle_fdw`: prerequisites, Oracle client setup, connection configuration 25min

Objectives: FDW architecture • `postgres_fdw` • `file_fdw` • `oracle_fdw` • Query pushdown

16 Replication & High Availability

ADVANCED
2h 30min

Building highly available PostgreSQL clusters: streaming replication, synchronous vs asynchronous standby, replication slots and automated failover with Patroni.

LESSONS

1. Streaming replication: primary and standby configuration, replication user 30min
2. Synchronous vs asynchronous replication: trade-offs and `synchronous_commit` modes 20min
3. Replication slots: physical and logical slots, risks and monitoring 20min
4. Patroni: architecture, etcd/Consul integration, automatic failover 35min
5. HA operational runbook: failover, switchover, replica re-sync procedures 25min

Objectives: Streaming replication • Sync/async standby • Replication slots • Patroni • Failover runbook

17 Upgrading Best Practices

ADVANCED
1h 30min

Safely upgrading PostgreSQL major and minor versions: `pg_upgrade` methodology, logical replication upgrade strategy, pre/post checks and rollback planning.

LESSONS

1. Minor vs major version upgrades: risks, compatibility and planning 20min
2. `pg_upgrade`: pre-checks, link mode vs copy mode, post-upgrade steps 30min
3. Logical replication upgrade: zero-downtime strategy and validation 25min
4. Pre-upgrade checklist: extension compatibility, deprecated features, `pg_dump` validation 15min



5. Rollback strategy and go/no-go criteria for production upgrades

20min

Objectives: Version upgrade planning • pg_upgrade • Zero-downtime upgrade • Pre/post checks • Rollback strategy