Microsoft SQL Server 2025: Enterprise Database Performance Optimization

Microsoft SQL Server 2025: Enterprise Performance & Query Optimization (40 Hours)

Maximize the performance and efficiency of your SQL Server 2025 environments with this **advanced 40-hour program** tailored for enterprise DBAs, database engineers, and performance specialists. Participants gain **deep insights into SQL Server 2025 engine internals, query processing, indexing, and workload optimization**, enabling them to troubleshoot and prevent performance bottlenecks in real-world scenarios.

The curriculum covers **core architectural concepts, query execution and plan stability, Intelligent Query Processing (IQP), batch mode, vector indexing, columnstore enhancements, and tempdb governance**. Advanced modules focus on **plan cache management, deadlock analysis, resource governance, and continuous optimization strategies**.

Hands-on labs simulate **enterprise-level performance challenges**, from slow queries and blocking to mixed OLTP-analytics workloads, ensuring participants acquire **practical, actionable skills** that can be immediately applied in production environments.

Day 1: SQL Server 2025 Architecture, Query Processing & Waits Framework

Module 1: SQL Server 2025 Internal Architecture

- SQL Server core architectural components
- Storage Engine internals: pages, extents, buffer pool, checkpoints
- Query Processing Engine and execution pipeline
- Memory internals: workspace memory, cache stores
- Scheduling (SOS), workers, tasks
- Transaction Log architecture and log flow

Module 2: Waits & Queues Methodology

- Scheduling, workers, tasks, worker lifecycle
- Key wait types for CPU, IO, memory, blocking
- Using waits to isolate systemic bottlenecks

Labs

- Slow query diagnosis using waits and engine internals

Day 2: Indexing, Columnstore, Vector Indexing & Batch Mode Optimization

Module 3: Indexing Strategy in SQL Server 2025

- Rowstore vs columnstore vs hybrid indexing
- Covering, filtered, composite index patterns
- SQL 2025 engine-driven indexing changes

Module 4: Columnstore Enhancements & Memory Optimize container

- Ordered Nonclustered Columnstore Indexes (NCCS)
- Online columnstore maintenance improvements
- Advanced segment elimination
- Columnstore use cases for analytics and hybrid workloads
- Memory-optimized container and filegroup removal
-

Module 5: Vector Indexing

- CREATE VECTOR INDEX
- Embedding-based search patterns
- Querying vector-augmented datasets

Module 6: Batch Mode & Hybrid Workload Optimization

- Batch mode performance improvements in SQL 2025
- Batch mode on rowstore
- Performance characteristics for JSON, vector, and relational workloads

Labs

- Build NCCS and evaluate analytics performance
- Run hybrid OLTP + reporting workloads; observe batch mode behavior

Business Problems Addressed

- Index bloat
- Slow analytics
- High rebuild overhead
- Mixed workload contention

Day 3: Engine Enhancements, Plan Stability, Query Store, Plan Cache & Concurrency

Module 7: SQL Server 2025 Engine Performance Improvement

- Storage engine and memory improvements
- Buffer pool and memory subsystem optimizations

- Optimized Locking: Transaction ID Locking, Lock After Qualification
- Columnstore engine enhancements
- OLTP vs OLAP performance considerations
- ZSTD compression algorithm introduced in SQL Server 2025

Module 8: Execution Plan Concepts

- Estimated, actual and live plans
- Operators, cardinality, and cost model fundamentals
- Detecting plan regressions and anti-patterns

Module 9: Intelligent Query Processing (IQP) in SQL 2025

- IQP evolution
- CE Feedback for expressions
- Optional Parameter Plan Optimization (OPPO)
- Parameter Sensitive Plan Optimization (PSP)
- Adaptive Query Processing enhancements

Module 10: Query Store & Automatic Tuning

- Query Store improvements in SQL 2025
- Automatic tuning and plan correction
- Detecting and preventing plan regression

Module 11: Plan Cache Internals

- Plan cache architecture, cache stores
- Identifying cache bloat
- Troubleshooting using cache metadata
- Forced parameterization and reuse strategies

Module 12: Compilation Storm Prevention & Dynamic SQL Optimization

- SQL 2025 enhancements for compilation efficiency
- Parameterization best practices (sp_executesql)
- Avoiding unnecessary recompilation

Module 13: Locking, Blocking & Isolation Levels

- SQL 2025 optimized locking model
- Lock After Qualification, Transaction ID Locking
- RCSI, Snapshot, Serializable, Repeatable Read, Read Uncommitted

- Advanced blocking chain diagnostics

Labs

- Mixed workload simulation: DOP feedback, memory grants, plan cache
- Locking and blocking analysis

Business Problems Addressed

- Compilation storms
- Excessive parallelism
- Memory grant instability
- Blocking and lock contention

Day 4: Deadlocks, Tempdb Optimization & Resource Governance

Module 14: Deadlocks , Extended Events & Monitoring

- Deadlock detection and capture
- Deadlock graph interpretation
- Extended Events for locks, waits, deadlocks
- Automation and alerting
- Time-bound event sessions

Module 15: Tempdb Performance & Governance

- Tempdb space governance (SQL 2025)
- ADR improvements
- Tempdb file layout and configuration
- Managing spills, sorts, and hash joins

Module 16: Resource Governance & Workload Management

- CPU, IO, and memory governance
- Resource Governor workload groups
- Monitoring memory grants, IO stalls, and system waits

Labs

- Concurrency simulation using optimized locking
- Tempdb high-load stress test

Business Problems Addressed

- Deadlocks
- Tempdb exhaustion

- Memory starvation
- Runaway workloads

Day 5: Monitoring, Troubleshooting & Continuous Optimization

Module 17: Monitoring & Baseline Establishment

- Performance Dashboard
- DMVs for CPU, memory, IO, locks, tempdb, waits
- Extended Events for diagnostics
- Building actionable baselines

Module 18: Troubleshooting SQL Server Performance

- Identifying slow queries
- Root-cause analysis of regressions
- Statistics health and lifecycle
- Index usage, missing and dormant index analysis

Module 19: Performance Governance & Automation

- Automated health checks
- Alerts and performance reporting
- QA-to-production performance validation
- Using SLAs for performance governance

Module 20: Continuous Optimization with SQL Server 2025

- IQP adoption strategy
- Rolling out optimized locking and resource governance
- Index and statistics lifecycle management
- Designing for mixed OLTP + analytics workloads
- Tips & Tricks to Improve Database Server & Query Performance

Labs

- Baseline creation and workload drift detection
- Automated weekly health report generation

Business Problems Addressed

- Performance regression after deployments
- CPU/IO/memory spikes

- Workload drift
- Maintenance gaps causing slowdowns
