sql path

1. Fundamentals of SQL

- **Topics to Learn:**
  - What is SQL Server? Overview of RDBMS.
  - SQL Server installation and tools (SSMS).
  - Database and table concepts.
- **Tasks:**
  - Install SQL Server and configure it.
  - Create a sample database with tables (e.g., `Employees`, `Departments`).

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2. Data Querying

- **Topics to Learn:**
  - `SELECT` statements and filtering data with `WHERE`.
  - Sorting data (`ORDER BY`).
  - Aggregate functions (`SUM`, `AVG`, `COUNT`, `MAX`, `MIN`).
  - Grouping data (`GROUP BY`, `HAVING`).
  - Joins (`INNER`, `LEFT`, `RIGHT`, `FULL`).
- **Tasks:**
  - Write queries to fetch data from tables.
  - Practice joining `Employees` and `Departments` tables.
  - Group employees by department and calculate total salaries.

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3. Data Manipulation

- **Topics to Learn:**

- `INSERT`, `UPDATE`, `DELETE`.
- Transactions (`BEGIN`, `COMMIT`, `ROLLBACK`).

- **Tasks:**
  - Insert sample data into tables.
  - Update employee records.
  - Practice using transactions to prevent accidental data loss.

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4. Database Design

- **Topics to Learn:**
  - Normalization (1NF, 2NF, 3NF).
  - Primary keys, foreign keys, and constraints.
  - Indexes (clustered and non-clustered).
- **Tasks:**
  - Design a normalized database for an e-commerce application.
  - Add primary and foreign key constraints.
  - Create indexes to optimize queries.

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5. Advanced Querying

- **Topics to Learn:**
  - Subqueries and Common Table Expressions (CTEs).
  - Window functions (`ROW_NUMBER`, `RANK`, `OVER`).
  - Case statements and conditional logic.
- **Tasks:**
  - Write a query using a CTE to find the top 3 highest-paid employees.
  - Use window functions to calculate running totals.

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6. Stored Procedures and Functions

- **Topics to Learn:**
  - Creating and using stored procedures.
  - User-defined functions (scalar and table-valued).
  - Parameters and error handling in stored procedures.
- **Tasks:**
  - Write a stored procedure to retrieve employee details by department.
  - Create a function to calculate employee bonuses.

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7. Triggers

- **Topics to Learn:**
  - Types of triggers (AFTER, INSTEAD OF).
  - Use cases for triggers.
- **Tasks:**
  - Create a trigger to log changes made to the `Employees` table.

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8. Performance Tuning

- **Topics to Learn:**
  - Query execution plans.
  - Index optimization.
  - Identifying and resolving performance bottlenecks.
- **Tasks:**
  - Analyze query execution plans for expensive queries.
  - Add missing indexes to improve query performance.

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9. Security

- **Topics to Learn:**
  - User authentication and roles.
  - Granting and revoking permissions.
  - Data encryption (TDE, Always Encrypted).
- **Tasks:**
  - Create a read-only user for your database.
  - Encrypt sensitive columns like `Salary` using `Always Encrypted`.

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10. Backup and Recovery

- **Topics to Learn:**
  - Database backup types (Full, Differential, Transaction Log).
  - Restoring databases.
  - Automating backups using SQL Server Agent.
- **Tasks:**
  - Set up a backup schedule for your database.
  - Restore the database from a backup.

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11. Working with Large Datasets

- **Topics to Learn:**
  - Partitioning tables.
  - Bulk data import/export (BCP, SSIS).
  - Handling deadlocks and isolation levels.
- **Tasks:**
  - Partition a large sales table by year.
  - Import data from a CSV file into the `Sales` table.

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12. Advanced Topics

- **Topics to Learn:**
  - Dynamic SQL.
  - Temporary tables vs. table variables.
  - Common database design patterns (e.g., Audit Log).
- **Tasks:**
  - Write dynamic SQL to fetch data from different tables based on user input.
  - Implement an audit log for tracking changes to key tables.

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13. Real-World Applications

- **Tasks:**
  - Design and implement a database for an online booking system.
  - Optimize a poorly performing report query.
  - Create a data pipeline for importing monthly revenue data from an external file.

Mastery Roadmap

1. Deep Dive into Database Architecture

- **What to Learn:**
  - SQL Server storage architecture (pages, extents, data files, and transaction logs).
  - Query processing and optimization pipeline.
  - Locking and blocking mechanisms.
  - Concurrency and isolation levels.
- **How to Master:**

    - Study SQL Server internals through books like *"SQL Server 2019 Internals"* by Kalen Delaney.
    - Use the `sys.dm_exec_requests` and `sys.dm_tran_locks` views to analyze locking and blocking in real time.
- **Practice:**
    - Simulate deadlock scenarios and resolve them using techniques like deadlock priority or query hints.

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2. Advanced Query Optimization

- **What to Learn:**
    - Execution plans (Graphical and Text-based).
    - Indexing strategies for complex queries (filtered, covering, columnstore indexes).
    - Statistics and their impact on performance.
    - Dynamic Management Views (DMVs) for performance tuning.
- **How to Master:**
    - Use the **Query Store** to analyze slow queries and improve them.
    - Optimize queries with billions of rows using partitioning and proper indexing.
- **Practice:**
    - Rewrite poorly performing queries and analyze the performance improvements.
    - Identify and fix index fragmentation using `sys.dm_db_index_physical_stats`.

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3. Automation and Scripting

- **What to Learn:**
    - Automating tasks with SQL Server Agent.

    - Writing and scheduling custom scripts for maintenance (backups, index rebuilds).
    - PowerShell integration with SQL Server.
- **How to Master:**
    - Automate daily tasks like backups, data imports, and index maintenance.
    - Write a PowerShell script to monitor server health and send email alerts.
- **Practice:**
    - Schedule a nightly full backup and weekly index rebuild.
    - Create a script to check database sizes and log growth.

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4. Data Modeling and ETL

- **What to Learn:**
    - Advanced normalization and denormalization techniques.
    - Data Warehousing concepts (star schema, snowflake schema).
    - Master SQL Server Integration Services (SSIS) for ETL.
- **How to Master:**
    - Design a robust data warehouse with slowly changing dimensions (SCD).
    - Create SSIS packages to extract, transform, and load data between systems.
- **Practice:**
    - Build a data warehouse for a retail business with historical sales data.
    - Automate data imports from multiple sources like Excel and CSV files using SSIS.

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5. Security and Auditing

- **What to Learn:**

    - Advanced encryption techniques (Always Encrypted, TDE, Dynamic Data Masking).
    - Auditing changes with SQL Server Audit.
    - Row-level security and permissions hierarchy.
- **How to Master:**
    - Set up auditing for sensitive tables and track all changes.
    - Use Row-Level Security (RLS) to restrict access to specific data subsets.
- **Practice:**
    - Implement column-level encryption for sensitive columns like credit card numbers.
    - Write triggers or use SQL Audit to log changes in high-importance tables.

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6. High Availability and Disaster Recovery

- **What to Learn:**
    - Always On Availability Groups.
    - Log shipping and database mirroring.
    - Backup strategies for minimal data loss (RPO/RTO considerations).
- **How to Master:**
    - Configure and manage an Always On Availability Group.
    - Perform failover and restore operations in a simulated disaster scenario.
- **Practice:**
    - Set up a DR plan with log shipping between primary and secondary servers.
    - Simulate a failover to ensure recovery works as expected.

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7. Big Data and Advanced Analytics

- **What to Learn:**

    - Working with PolyBase for external data integration.
    - Data analysis with R and Python in SQL Server.
    - Columnstore indexes and in-memory tables.
- **How to Master:**
    - Use PolyBase to query external data sources like Hadoop or Azure Blob Storage.
    - Perform advanced analytics using R/Python scripts in stored procedures.
- **Practice:**
    - Query and analyze large datasets stored in Azure Blob using PolyBase.
    - Use R in SQL Server to run predictive analytics on sales data.

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8. Mastering Reporting and BI

- **What to Learn:**
    - SQL Server Reporting Services (SSRS).
    - Power BI integration with SQL Server.
    - Real-time reporting with DirectQuery.
- **How to Master:**
    - Design visually appealing dashboards in Power BI using SQL Server data.
    - Build parameterized and interactive reports in SSRS.
- **Practice:**
    - Create an SSRS report for monthly revenue and customer trends.
    - Design a Power BI dashboard for real-time analytics on product performance.

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9. Working with Cloud Databases

- **What to Learn:**

- Azure SQL Database vs. on-premise SQL Server.
- Hybrid solutions and migrations to the cloud.
- Scaling and performance tuning in cloud environments.

- **How to Master:**
  - Set up and configure an Azure SQL Database.
  - Use Azure Data Factory for cloud-based ETL workflows.
- **Practice:**
  - Migrate an on-premise database to Azure SQL Database using DMA.
  - Set up automated scaling for high-traffic periods.

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10. Continuous Learning and Real-World Scenarios

- **What to Learn:**
  - Common design patterns (CQRS, Event Sourcing).
  - Advanced monitoring with tools like SQL Sentry and SolarWinds.
  - Participate in SQL Server communities (e.g., SQLServerCentral, Stack Overflow).
- **How to Master:**
  - Work on real-world scenarios like building financial systems, CRM databases, or IoT data pipelines.
  - Attend SQL Server conferences and user groups.
- **Practice:**
  - Optimize a production-level reporting database.
  - Build a robust system that handles high concurrency without performance degradation.

Key Tools and Resources

- **Certifications:**

- Microsoft Certified: Azure Database Administrator Associate.