IT 6733 Database Administration

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IT 6733 Database Administration course covers data administration and management, backup/recovery, security, access control, performance monitoring and tuning, data warehousing, data mining, online analytical processing, centralized versus distributed environments, client server and world-wide-web database integration.

Students who complete this course successfully will be able to

* Describe tasks commonly performed by DBAs.
* Analyze performance characteristics of a DB system and justify necessary changes.
* Write programs to perform maintenance and user support operations.
* Explain the concept of database security and backup/recovery

In this course, we will use Oracle 18c and SQL server 2019. We will start with SQL review, and then learn how to write triggers, administer users, and make configuration changes, you will also learn about database security, performance tuning, data mining and analytical processing.

Table of Contents

[Module 1: Review](#_Toc67926403)

[Module 2: Introduction to SQL Procedures and Functions](#_Toc67926404)

[Module 3: SQL Procedures & Functions Part II](#_Toc67926405)

[Module 4: Triggers](#_Toc67926406)

[Module 5: Overview of Database Administration](#_Toc67926407)

[Module 6: Database and Application Performance](#_Toc67926408)

[Module 7: Security](#_Toc67926409)

[Module 8: Data Warehousing and ETL](#_Toc67926410)

[Module 9: Database Backup and Recovery](#_Toc67926411)

[Module 10: MongoDB](#_Toc67926412)

[Module 11: Data Dictionaries](#_Toc67926413)

[Module 12: Implementing ETL with SQL Server Integration Services](#_Toc67926414)

# Module 1: Review

## Introduction and Module Summary

In this module, you will review database design and Structured Query Language (SQL). SQL is the standard language for relational database management systems. SQL knowledge is the prerequisite to this course. Depending on when you took an introduction to databases course, this module will take you anywhere from 4 to 12 hours of work. Spending enough time on this review will help you to complete other modules in this course.

Bookmark two resources that you will use throughout this course

1. [Oracle 18c](https://docs.oracle.com/en/database/oracle/oracle-database/18/books.html)
2. [MS SQL 2019](https://docs.microsoft.com/en-us/sql/sql-server/sql-server-technical-documentation?toc=..%2Ftoc%2Ftoc.json&view=sql-server-ver15)

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

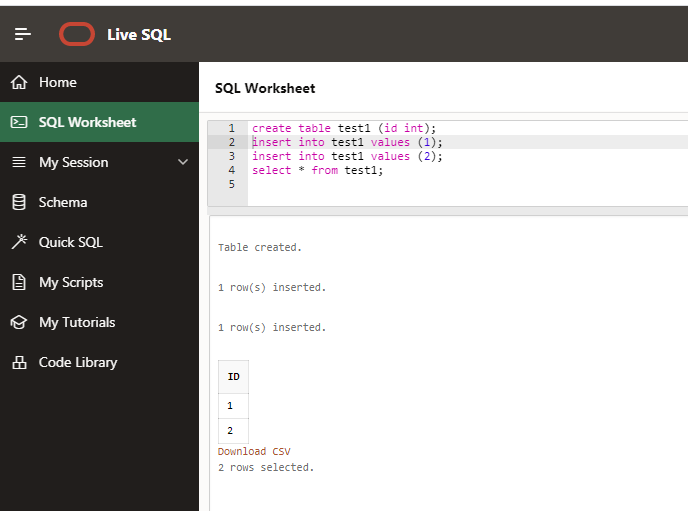
1. Describe tasks commonly performed by DBAs.
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. **Write programs to perform maintenance and user support operations.**
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | to develop conceptual, logical and physical data models | to use SQL for data manipulation and data extraction |
| --- | --- | --- |
| Readings | introduced | introduced |
| Practice exercise | reinforced | reinforced |
| Lab 0 |  | reinforced |
| SQL quiz | reinforced | reinforced |
| Lab 1 | mastered | mastered |

## Assigned Reading

1. [Environment to exercise](https://livesql.oracle.com/) (create an account, login, use Live SQL)



1. [SQL](https://docs.oracle.com/en/database/oracle/oracle-database/18/cncpt/sql.html#GUID-DA48618A-A6BB-421A-A10A-02859D8ED9AD)
2. Readings linked throughout the module
3. [Intro to SQL 1-10](http://sqlcourse.com/intro.html)
4. [Intro 2 to SQL 1-10](http://sqlcourse2.com/)

## Optional Reading

1. [Oracle Relational Data Structures](https://docs.oracle.com/en/database/oracle/oracle-database/18/cncpt/oracle-relational-structures.html#GUID-54C48ABE-E589-428A-849F-B8746C9D276A)

# Module 2: Introduction to SQL Procedures and Functions

## Introduction and Module Summary

In this module, you will learn the benefits of using procedural SQL and how to write, execute, and test SQL procedures and functions.

SQL has limitations: it can execute one statement at a time. PL/SQL is executed as a block of code. Moreover, you can repeat the execution of any named black as many times as you wish.

PL/SQL is used to write triggers, functions, procedures, and packages. You can call PL/SQL functions from SQL statements.

Why use PL/SQL?

[By Bryn.Llewellyn](https://blogs.oracle.com/plsql-and-ebr/entry/why_use_pl_sql)

"Large software systems must be built from modules. A module hides its implementation behind an interface that exposes its functionality. This is computer science's most famous principle. For applications that use an Oracle Database, the database is, of course, one of the modules. The implementation details are the tables and the SQL statements that manipulate them. These are hidden behind a PL/SQL interface. This is the Thick Database paradigm: select, insert, update, delete, merge, commit, and rollback are issued only from database PL/SQL. Developers and end-users of applications built this way are happy with their correctness, maintainability, security, and performance."

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. Describe tasks commonly performed by DBAs.
2. Analyze the performance characteristics of a DB system and justify necessary changes.
3. **Write programs to perform maintenance and user support operations.**
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | to list benefits of procedural SQL | differentiate when to use function and when to use procedures | develop procedural SQL code | test and execute procedural SQL code |
| --- | --- | --- | --- | --- |
| Read PL/SQL Language Fundamentals (2 hours) | introduced | introduced | introduced |  |
| Read PL/SQL Subprograms (1 hour) | reinforced | reinforced | introduced | introduced |
| Module Discussion preparation and posting (1 hour) | mastered | mastered |  |  |
| Complete Module Lab (1 hour 40 min) |  |  | mastered | mastered |
| Self-assessment quiz (20 min**)** |  |  | reinforced | reinforced |

## Assigned Reading

1. [Introduction to PL/SQL part I and II](http://w2.syronex.com/jmr/edu/db/introduction-to-plsql/) (except cursors)

## Optional Reading

1. [Date functions examples](http://psoug.org/reference/date_func.html)
2. [PL/SQL Language Fundamentals](https://docs.oracle.com/en/database/oracle/oracle-database/18/lnpls/overview.html)
3. [Variables and Types](http://infolab.stanford.edu/~ullman/fcdb/oracle/or-plsql.html#variables%20and%20types)
4. [Oracle Procedures](http://www.psoug.org/reference/procedures.html)
5. [Oracle Functions](http://www.psoug.org/reference/functions.html)
6. [PL/SQL FAQ](http://www.orafaq.com/wiki/PL/SQL_FAQ)

# Module 3: SQL Procedures & Functions Part II

## Introduction and Module Summary

In this module, you will learn how to use IF, CASE, COMMIT, and LOOPs. SQL does not support all of the traditional language constructs, so achieve branching and looping the procedural SQL will be used. Transact SQL and its difference with Procedural SQL will be discussed.

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. Describe tasks commonly performed by DBAs.
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. **Write programs to perform maintenance and user support operations.**
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | explain the use of transactions | use looping and branching control structures | declare variables  develop Transact SQL code | test and execute Transact SQL code |
| --- | --- | --- | --- | --- |
| Read assigned materials | introduced | introduced | introduced | introduced |
| Read and execute code from the module | reinforced | reinforced | reinforced | reinforced |
| Complete the lab |  | mastered | mastered | mastered |

## Assigned Reading

1. [PL/SQL Control Structures](https://docs.oracle.com/en/database/oracle/oracle-database/18/lnpls/plsql-control-statements.html)
2. [What is a Stored Procedures in SQL server with examples](https://www.youtube.com/watch?v=Qu3E-oncF3g)
3. [Creating and executing stored procedures with output parameters](1.%09https:/www.youtube.com/watch?v=bldBshxuhMk)
4. [What are return values for stored procedures, difference between stored procedure return values and output parameters, when to use output parameters over return values](https://www.youtube.com/watch?v=st8RnNg_LLA)
5. [Transact SQL](http://www.tsql.info/stored-procedures/stored-procedures.php)
6. [A Comparison of PL/SQL and Transact SQL](http://psoug.org/reference/sqlserver.html)

## Optional Materials

1. [Oracle control structures](http://psoug.org/reference/control_struct.html)
2. [T-SQL Reference](https://docs.microsoft.com/en-us/sql/t-sql/language-reference?view=sql-server-ver15)

# Module 4: Triggers

## Introduction and Module Summary

In this module, you will learn how to write PL/SQL and T-SQL triggers. A trigger is a named structural SQL block (PL/SQL or T-SQL) that is stored in the database and executed (fired) in response to a specified event that occurs in the database.

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. Describe tasks commonly performed by DBAs.
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. **Write programs to perform maintenance and user support operations.**
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | to develop, test and debug Oracle PL/SQL triggers | to develop, test and debug MS SQL Server T-SQL triggers |
| --- | --- | --- |
| Read assigned materials | introduced | introduced |
| Read and execute code from the module | reinforced | reinforced |
| Complete Module Lab | mastered | mastered |

## Assigned Reading

1. [Oracle Triggers](https://docs.oracle.com/en/database/oracle/oracle-database/18/lnpls/plsql-triggers.html)
2. [T-SQL Triggers](https://docs.microsoft.com/en-us/sql/t-sql/statements/create-trigger-transact-sql?view=sql-server-ver15)

## Optional Materials

1. [Oracle triggers reference](http://psoug.org/reference/table_trigger.html)
2. [Triggers in PL/SQL includes: definition, trigger event, main parts of a trigger, types of trigger, syntax with example of creating triggers](https://www.youtube.com/watch?v=aCOkOkfhmA0)
3. [DML triggers in SQL server](https://www.youtube.com/watch?v=JNb54seLzZY)

# Module 5: Overview of Database Administration

## Introduction and Module Summary

In this module, you will become familiar with database administration tasks and learn how to ensure the ongoing operational functionality and efficiency of an organizations database.

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. **Describe tasks commonly performed by DBAs.**
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. Write programs to perform maintenance and user support operations.
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | to distinguish between data and database administration | list responsibilities of a database administrator |
| --- | --- | --- |
| Read the module and watch recorded lecture | introduced | introduced |
| Read assigned materials | reinforced | reinforced |
| Module Discussion preparation and posting | mastered | mastered |

## Assigned Reading

1. [DBA Roles and Responsibilities](https://docs.oracle.com/en/database/oracle/oracle-database/18/admin/getting-started-with-database-administration.html) (1.1 & 1.2)

## Optional Materials

1. [Indeed DBA job description](https://www.indeed.com/hire/job-description/database-administrator)

# Module 6: Database and Application Performance

## Introduction and Module Summary

In this module, you will learn how to choose DBMS based on data availability requirements and how to design the database and configure the database instance to achieve the best performance by designing indexes for an application, using denormalization and views, avoiding deadlocks

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. Describe tasks commonly performed by DBAs.
2. **Analyze performance characteristics of a DB system and justify necessary changes.**
3. Write programs to perform maintenance and user support operations.
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | explain how to achieve good database performance | list activities performed during database performance tuning | to optimize performance of MS SQL databases | to optimize performance of Oracle databases |
| --- | --- | --- | --- | --- |
| Assigned reading | introduced | introduced | introduced | introduced |
| Lab | Reinforced and mastered | Reinforced and mastered | Reinforced and mastered | Reinforced and mastered |

## Assigned Reading

1. [Execution Plan Basics](https://www.simple-talk.com/sql/performance/execution-plan-basics/)
2. Database Indexes [1 (Microsoft)](https://docs.microsoft.com/en-us/sql/2014-toc/sql-server-index-design-guide?view=sql-server-2014&viewFallbackFrom=sql-server-ver15) and [2 (Oracle)](https://docs.oracle.com/en/database/oracle/oracle-database/18/cncpt/indexes-and-index-organized-tables.html) (if you need more details than provided in the module)
3. [Indexing in Oracle (25 min)](https://www.youtube.com/watch?v=0X9bbtwTnuE)
4. [Query optimization techniques in SQL Server: Database Design and Architecture](https://www.sqlshack.com/query-optimization-techniques-in-sql-server-database-design-and-architecture/)

## Optional Materials

1. [Isolation](http://en.wikipedia.org/wiki/Isolation_%28database_systems%29)
2. [Understanding how SQL Server executes a query](https://docs.microsoft.com/en-us/sql/relational-databases/query-processing-architecture-guide?view=sql-server-ver15)
3. [Database Performance Analyzer](http://www.solarwinds.com/database-performance-analyzer-oracle.aspx)(Interactive Demo)
4. [Oracle Database High Availability](https://docs.oracle.com/en/database/oracle/oracle-database/18/high-availability.html)
5. [MS SQL Server High Availability](https://docs.microsoft.com/en-us/sql/database-engine/sql-server-business-continuity-dr?view=sql-server-ver15)

# Module 7: Security

## Introduction and Module Summary

In this module, you will learn about Operating System Security, DBMS Security and Database Application Security. Database Administrators responsibility is to implement and manage Database Security. These include defining and determining the following:

* Who is allowed access to the database
* How a user will be authenticated
* The authority level a user is granted
* The data that a user is allowed to read and/or modify
* The database objects a user is allowed to create, alter, and/or drop

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. Describe tasks commonly performed by DBAs.
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. Write programs to perform maintenance and user support operations.
4. **Explain the concept of database security and backup/recovery**

## Module Outcomes and Activities

| After completing this module, students will be able: | use Virtual Private Database feature (Oracle) | create and remove database user | create Profiles (Oracle) and Roles | GRANT, REVOKE , DENY Permissions to users and roles | Use Views and Stored Procedures for Security |
| --- | --- | --- | --- | --- | --- |
| Read the module and run all code | introduced | introduced | introduced |  | introduced |
| Read assigned materials | reinforced | reinforced | introduced | introduced |  |
| Complete Module Lab 1 |  | mastered |  | reinforced | reinforced |
| Complete Module Lab 2 |  |  | mastered | mastered | mastered |

## Assigned Reading

1. [Keeping Your Oracle Database Secure](https://docs.oracle.com/en/database/oracle/oracle-database/18/dbseg/keeping-your-oracle-database-secure.html)
2. [Database application security](https://github.com/OWASP/CheatSheetSeries/blob/master/cheatsheets/SQL_Injection_Prevention_Cheat_Sheet.md)
3. SQL Server
   1. [USERS](https://docs.microsoft.com/en-us/sql/t-sql/statements/create-user-transact-sql?view=sql-server-ver15)
   2. [LOGINS](https://docs.microsoft.com/en-us/sql/t-sql/statements/create-login-transact-sql?view=sql-server-ver15)
   3. [Permissions](https://docs.microsoft.com/en-us/sql/relational-databases/security/authentication-access/getting-started-with-database-engine-permissions?view=sql-server-ver15)
4. [Difference Between SQL Server Logins and Database Users](https://www.top-password.com/blog/difference-between-sql-server-logins-and-database-users/)

## Optional Materials

1. [Security check lists](http://web.nvd.nist.gov/view/ncp/repository?keyword=oracle&startIndex=0)

# Module 8: Data Warehousing and ETL

## Introduction and Module Summary

In this module, you will learn about Data Warehousing. The term Data Warehouse was coined by Bill Inmon in 1990, which he defined in the following way: "A warehouse is a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision making process". ETL is short for extract, transform, load, three database functions that to pull data out of different data sources in on database.

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. **Describe tasks commonly performed by DBAs.**
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. Write programs to perform maintenance and user support operations.
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | list major reasons why most organizations today need data warehousing. | to design, create, and manage cubes from data warehouse |
| --- | --- | --- |
| Read the module and watch lecture recording | introduced | introduced |
| Read assigned materials | reinforced | reinforced |
| Complete Module Lab | mastered | mastered |

## Assigned Reading

1. [Oracle Database/ Data Warehousing Guide/ 18c](https://docs.oracle.com/en/database/oracle/oracle-database/18/dwhsg/index.html) (Part I chapters 1 & 2)
2. [Design a multidimensional business intelligence (BI) semantic model](https://www.microsoftpressstore.com/articles/article.aspx?p=2812063)
3. [Data Warehouse Schema Design](https://www.guru99.com/star-snowflake-data-warehousing.html)

## Optional Materials

1. [Big Data Trends](https://financesonline.com/big-data-trends/)
2. [Azure Synapse Analytics (formerly SQL Server Data Warehousing)](https://docs.microsoft.com/en-us/azure/synapse-analytics/sql-data-warehouse/sql-data-warehouse-overview-what-is)

# Module 9: Database Backup and Recovery

## Introduction and Module Summary

In this module, you will learn structures and processes for backup and recovery. Introduce the different methods for backup and recovery Diagnose and troubleshoot database problems.

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. Describe tasks commonly performed by DBAs.
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. Write programs to perform maintenance and user support operations.
4. **Explain the concept of database security and backup/recovery**

## Module Outcomes and Activities

| After completing this module, students will be able: | To create / schedule backups for the databases | Choose the correct type of database recovery |
| --- | --- | --- |
| Read assigned materials, watch recorded lecture | introduced | introduced |
| Read assigned materials | reinforced | reinforced |
| Watch Oracle Recovery Management Tutorial | reinforced |  |
| Complete Module Lab | mastered | mastered |

## Assigned Reading

1. [Oracle Backup and Recovery](https://docs.oracle.com/en/database/oracle/oracle-database/18/bradv/database-backup-and-recovery-users-guide.pdf) ch 1 & 2 (34 pages)
2. [High Availability with SQL Server 2019](https://docs.microsoft.com/en-us/sql/database-engine/availability-groups/windows/always-on-availability-groups-sql-server?view=sql-server-ver15)
3. [Required tutorial](https://www.youtube.com/watch?v=tYwCzNiJD6w)

## Optional Materials

1. [How to: Restore a Database Backup](https://docs.microsoft.com/en-us/sql/relational-databases/backup-restore/restore-a-database-backup-using-ssms?view=sql-server-ver15) (SQL Server Management Studio)
2. [Managing Backups (part IV)](https://docs.oracle.com/en/database/oracle/oracle-database/18/bradv/database-backup-and-recovery-users-guide.pdf) pp 33-37

# Module 10: MongoDB

## Introduction and Module Summary

In this module, you will learn about NoSQL (Not Only SQL) Databases and how real time web applications deal with massive amount of data. NoSQL databases use the concept of a key/value store, and it is designed for distributed data stores where very large scale of data storing needs. These type of data storing may not require fixed schema, avoid join operations and typically scale horizontally.

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. Describe tasks commonly performed by DBAs.
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. **Write programs to perform maintenance and user support operations.**
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | Write and run MongoDB shell commands | List major differences between RDBMS and NoSQL databases. |
| --- | --- | --- |
| Read | introduced | introduced |
| Module Discussion preparation and posting |  | Reinforced & mastered |
| Complete Module Lab | Reinforced & mastered |  |

## Assigned Reading

1. [SQL vs NoSQL](https://www.youtube.com/watch?v=ZS_kXvOeQ5Y) 21 min
2. [The best NoSQL databases 2020](https://www.improgrammer.net/most-popular-nosql-database/)
3. [NoSQL](http://www.w3resource.com/mongodb/nosql.php)
4. [MongoDB](https://docs.mongodb.org/manual/introduction/)
5. [MongoDB Tutorial](https://www.youtube.com/watch?v=pWbMrx5rVBE) 32 min

## Optional Materials

1. [Mongo Shell Quick Reference Guide](https://docs.mongodb.com/manual/reference/mongo-shell/#command-line-options)
2. [NoSQL](http://nosql-database.org/)
3. [Sharding Concepts](http://docs.mongodb.org/manual/core/sharded-clusters/)

# Module 11: Data Dictionaries

## Introduction and Module Summary

In this module, you will learn about metadata and about metadata in both SQL Server and Oracle. Database metadata provides technical information about a database object, such as, field structures of a table, the owner of a table, the tablespace, constraints.

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. Describe tasks commonly performed by DBAs.
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. **Write programs to perform maintenance and user support operations.**
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | to identify sources of metadata in Oracle and SQL Server | to query system catalog to extract metadata |
| --- | --- | --- |
| Assigned reading | introduced | introduced |
| Module Discussion preparation and posting | reinforced | reinforced |
| Lab | mastered | mastered |

## Assigned Reading

1. [Data Dictionary](1.%09https:/docs.oracle.com/en/database/oracle/oracle-database/18/cncpt/data-dictionary-and-dynamic-performance-views.html)
2. [SQL Server Catalog Views](https://docs.microsoft.com/en-us/sql/relational-databases/system-catalog-views/catalog-views-transact-sql?view=sql-server-ver15)

## Optional Materials

1. [Oracle Catalog Views](https://docs.oracle.com/en/database/oracle/oracle-database/18/rcmrf/summary-of-rman-recovery-catalog-views.html)

# Module 12: Implementing ETL with SQL Server Integration Services

## Introduction and Module Summary

In this module, you will use Microsoft SQL Server Integration Services (SSIS) features you'll extract data from many different data sources to provide a unified view of the data.

## Objectives and Outcomes

This module directly supports **highlighted** course outcome(s)

Students who complete this course successfully will be able to

1. **Describe tasks commonly performed by DBAs.**
2. Analyze performance characteristics of a DB system and justify necessary changes.
3. **Write programs to perform maintenance and user support operations.**
4. Explain the concept of database security and backup/recovery

## Module Outcomes and Activities

| After completing this module, students will be able: | Set data sources and destinations for extracting and loading data | Use transformations for cleaning, aggregating, merging, and copying data |
| --- | --- | --- |
| Read the module and watch lecture recording | introduced | introduced |
| Read assigned materials | reinforced | reinforced |
| Complete the Project | mastered | mastered |

## Assigned Reading

1. N/A

## Optional Materials

1. [Merge Two Data in ETL project of SSIS](http://www.jitendrazaa.com/blog/sql/sqlserverintegrationservices/merge-two-data-in-etl-project-of-ssis/)