IT6863 Database Security and Auditing (summer 2018)

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IT Department

Kennesaw State University

Contents

Catalog Description

Course Outcomes

Module 1 SQL Review

- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 2 Security Architecture

- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 3 Securing Database Environment

- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 4 SQL Procedures and Functions

- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 5 Triggers
- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 6 User Administration: Oracle
- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 7 User Administration: SQL Server
- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 8 Profiles, Passwords, Privileges, and
- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 9 Database Application Security Models
- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading

Module 10 Database Auditing: Oracle
- Introduction and Module Summary
- Objectives and Outcomes
- Assigned Reading
- Optional Reading
Catalog Description

Prerequisites: IT 5433 Databases: Design and Applications.

This course provides students with an understanding of security concepts and practices in general and those specific to database security in a highly detailed implementation. Students will learn fundamental principles of database security and how to develop database applications embedding from simple to sophisticated security and auditing models using advanced database systems and software tools.

Course Outcomes

Students who complete this course successfully will be able to

- Evaluate vulnerabilities of Database Management Systems.
- Describe the methods for controlling database security.
- Explain principles of database auditing.
- Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

Module 1 SQL 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.

Objectives and Outcomes

This module directly supports highlighted course outcome(s)
Students who complete this course successfully will be able to

1. **Evaluate vulnerabilities of Database Management Systems.**

2. Describe the methods for controlling database security.

3. Explain principles of database auditing.

4. Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

### Module outcomes and activities:

<table>
<thead>
<tr>
<th>After completing this module, students will be able:</th>
<th>to develop conceptual, logical and physical data models</th>
<th>to use SQL for data manipulation and data extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Readings</td>
<td>introduced</td>
<td>introduced</td>
</tr>
<tr>
<td>Practice exercise</td>
<td>reinforced</td>
<td>reinforced</td>
</tr>
<tr>
<td>SQL quiz</td>
<td>reinforced</td>
<td>reinforced</td>
</tr>
<tr>
<td>Lab 1</td>
<td>mastered</td>
<td>mastered</td>
</tr>
</tbody>
</table>

### Assigned Reading

1. SQL [http://docs.oracle.com/database/121/CNCPT/sqliangu.htm#CNCPT015](http://docs.oracle.com/database/121/CNCPT/sqliangu.htm#CNCPT015)

2. Readings linked through the module

3. Intro to SQL 1-10 [http://sqlcourse.com/intro.html](http://sqlcourse.com/intro.html)

4. Intro 2 to SQL 1-10 [http://sqlcourse.com/](http://sqlcourse.com/)

### Optional Reading

1. Oracle Relational Data Structures [https://docs.oracle.com/cd/E11882_01/server.112/e40540/part_datstr.htm](https://docs.oracle.com/cd/E11882_01/server.112/e40540/part_datstr.htm)

2. Oracle 12c [https://docs.oracle.com/database/121/nav/portal_4.htm](https://docs.oracle.com/database/121/nav/portal_4.htm)


### Module 2 Security Architecture

#### Introduction and Module Summary

This module introduces basic concepts of database security. First, we will discuss basic definitions of database management systems. Then we will discuss information security and information security architecture followed by description of database security methods.

#### Objectives and Outcomes

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

Students who complete this course successfully will be able to

- **Evaluate vulnerabilities of Database Management Systems.**

- Describe the methods for controlling database security.

- Explain principles of database auditing.

- Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

### Module outcomes and activities:
### Module 3 Securing Database Environment

#### Introduction and Module Summary

In this module, you will learn how to protect the database environment. You will also learn about Oracle multitenant architecture and continue SQL review.

#### Objectives and Outcomes

This module directly supports highlighted course outcome(s) for:

Students who complete this course successfully will be able to:

- Evaluate vulnerabilities of Database Management Systems.

- **Describe the methods for controlling database security.**

- Explain principles of database auditing.

- Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

#### Module outcomes and activities:

<table>
<thead>
<tr>
<th>After completing this module, students will be able:</th>
<th>Describe database environment</th>
<th>Outline several server administration best practices</th>
<th>Explain the differences between authentication methods</th>
<th>Use SQL for data manipulation and data extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Readings</td>
<td>reinforced</td>
<td>Introduced/ reinforced</td>
<td>introduced/ reinforced</td>
<td>Reinforced/ mastered</td>
</tr>
<tr>
<td>Lab 1</td>
<td>reinforced/ mastered</td>
<td>reinforced/ mastered</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Assigned Reading


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After completing this module, students will be able:

- Describe an information system and its components
- Define database management system functionalities
- Outline the concept of information security
- Protect database driven applications from SQL Injections

<table>
<thead>
<tr>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>introduced</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQLi quiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>introduced</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lab 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>reinforced/mastered</td>
</tr>
</tbody>
</table>
Module 4 SQL Procedures and Functions

Introduction and Module Summary

In this module, you will learn 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 execution of any named block 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 statement.

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

- Evaluate vulnerabilities of Database Management Systems.
- Describe the methods for controlling database security.
- Explain principles of database auditing.
- Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

Module outcomes and activities:

<table>
<thead>
<tr>
<th>After completing this module, students will be able:</th>
<th>to list benefits of procedural SQL</th>
<th>differentiate when to use function and when to use procedures</th>
<th>develop procedural SQL code</th>
<th>test and execute procedural SQL code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read PL/SQL Language Fundamentals and the module (2 hours)</td>
<td>introduced</td>
<td>introduced</td>
<td>introduced</td>
<td></td>
</tr>
<tr>
<td>Execute PL/SQL code from the module (2 hour)</td>
<td>reinforced</td>
<td>reinforced</td>
<td>introduced</td>
<td>introduced</td>
</tr>
<tr>
<td>Complete Module Lab (1 hour 40 min)</td>
<td></td>
<td></td>
<td>mastered</td>
<td>mastered</td>
</tr>
</tbody>
</table>
Module 5 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

- Evaluate vulnerabilities of Database Management Systems.
- Describe the methods for controlling database security.
- Explain principles of database auditing.

- Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

Module outcomes and activities:

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

Assigned Reading

1. Oracle Triggers http://docs.oracle.com/database/121/CNCPT/srvrside.htm#CNCPT218

Optional Reading

1. Date functions examples http://psoug.org/reference/date_func.html
Module 6 User Administration: Oracle

Introduction and Module Summary
In this module, you will learn how to create/remove users using Oracle. How to modify an existing user and the difference between common and local users in Oracle pluggable database. You will take the first look at object permissions in Oracle and use data dictionary to report quota usage by users.

Objectives and Outcomes
This module directly supports highlighted course outcome(s)

Students who complete this course successfully will be able to

- Evaluate vulnerabilities of Database Management Systems.
- Describe the methods for controlling database security.
- Explain principles of database auditing.
- Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

Module outcomes and activities:

<table>
<thead>
<tr>
<th>After completing this module, students will be able:</th>
<th>Create/remove/modify users accounts using Oracle</th>
<th>List best practices for user administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read assigned materials</td>
<td>introduced</td>
<td>introduced</td>
</tr>
<tr>
<td>Read and execute code from the module</td>
<td>reinforced</td>
<td>reinforced</td>
</tr>
<tr>
<td>Complete Module Lab</td>
<td>mastered</td>
<td>mastered</td>
</tr>
</tbody>
</table>

Assigned Reading
1. Multitenant Architecture
   https://docs.oracle.com/database/121/CNCPT/cdbovrvw.htm#CNCPT89234
2. Managing Security for Oracle Database Users
   https://docs.oracle.com/database/121/DBSEG/users.htm
3. SYS vs SYSTEM
   https://docs.oracle.com/database/121/ADMQS/GUID-CF1CD853-AF15-41EC-BC80-61918C73FDB5.htm
4. SYSDBA and SYSOOPER System Privileges
   https://docs.oracle.com/database/121/ADMQS/GUID-2033E766-8FE6-4FBA-97E0-2607B083FA2C.htm

Optional Reading
1. Documentation library Release 2 (11.2) http://www.oracle.com/pls/db112/homepage

Module 7 User Administration: SQL Server

Introduction and Module Summary
In this module, you will learn how to create/remove users and logins using SQL Server. You will also learn...
how to modify an existing user and how to list all default users using SQL servers.

**Objectives and Outcomes**

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

Students who complete this course successfully will be able to

- Evaluate vulnerabilities of Database Management Systems.
- Describe the methods for controlling database security.
- Explain principles of database auditing.
- **Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).**

**Module outcomes and activities:**

<table>
<thead>
<tr>
<th>After completing this module, students will be able:</th>
<th>Create/remove/modify users accounts using MS SQL Server</th>
<th>List elements of password policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read assigned materials</td>
<td>introduced</td>
<td>introduced</td>
</tr>
<tr>
<td>Read and execute code from the module</td>
<td>reinforced</td>
<td>reinforced</td>
</tr>
<tr>
<td>Complete Module Lab</td>
<td>mastered</td>
<td>mastered</td>
</tr>
</tbody>
</table>

**Assigned Reading**


**Optional Reading**


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**Module 8 Profiles, Passwords, Privileges, and Roles**

**Introduction and Module Summary**

In this module, you will learn about four aspects of user administration and user security. These aspects are profiles, passwords, privileges, and roles.

**Objectives and Outcomes**

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

Students who complete this course successfully will be able to

- Evaluate vulnerabilities of Database Management Systems.
• Describe the methods for controlling database security.

• Explain principles of database auditing.

• **Develop and implement a security plan for an enterprise level database** (password policies, auditing policies, user privileges, profile, and roles).

**Module outcomes and activities:**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Password Policies</th>
<th>User Privileges</th>
<th>User Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read assigned materials</td>
<td>introduced</td>
<td>introduced</td>
<td>introduced</td>
</tr>
<tr>
<td>Read and execute code from the module</td>
<td>reinforced</td>
<td>reinforced</td>
<td>reinforced</td>
</tr>
<tr>
<td>Prepare for discussion topic and post your answer</td>
<td>reinforced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Module Lab</td>
<td>mastered</td>
<td>mastered</td>
<td>mastered</td>
</tr>
</tbody>
</table>

**Assigned Reading**

1. Principal of least Privilege [https://www.us-cert.gov/bsi/articles/knowledge/principles/least-privilege](https://www.us-cert.gov/bsi/articles/knowledge/principles/least-privilege)

2. Oracle Profiles [https://docs.oracle.com/database/121/SQLRF/statements_6012.htm](https://docs.oracle.com/database/121/SQLRF/statements_6012.htm)

3. Oracle roles [http://docs.oracle.com/database/121/SQLRF/statements_6014.htm](http://docs.oracle.com/database/121/SQLRF/statements_6014.htm)


**Optional Reading**

1. Oracle Data Dictionary [https://docs.oracle.com/database/121/CNCPT/datadict.htm](https://docs.oracle.com/database/121/CNCPT/datadict.htm)


3. Documentation library Release 2 (11.2) [http://www.oracle.com/pls/db112/homepage](http://www.oracle.com/pls/db112/homepage)

**Module 9 Database Application Security Models**

**Introduction and Module Summary**

In this module, you will learn about different types of users in a database environment and the related security model concepts. It also lists and describes the most commonly used application types.

**Objectives and Outcomes**

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

Students who complete this course successfully will be able to

• Evaluate vulnerabilities of Database Management Systems.

• Describe the methods for controlling database security.
Explain principles of database auditing.

Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

Module outcomes and activities:

<table>
<thead>
<tr>
<th>Activity</th>
<th>After completing this module, students will be able:</th>
<th>Describe the different types of users in a database environment and the distinct purpose of each</th>
<th>Explain the use of data encryption within database applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read assigned materials</td>
<td>introduced</td>
<td>introduced</td>
<td>introduced</td>
</tr>
<tr>
<td>Read and execute code from the module</td>
<td>reinforced</td>
<td>reinforced</td>
<td>reinforced</td>
</tr>
<tr>
<td>Complete Module Lab</td>
<td>mastered</td>
<td>mastered</td>
<td>mastered</td>
</tr>
</tbody>
</table>

**Assigned Reading**


3. Oracle Data Redaction [https://docs.oracle.com/cloud/latest/db121/ASOAG/redaction.htm#ASOAG594](https://docs.oracle.com/cloud/latest/db121/ASOAG/redaction.htm#ASOAG594)


**Optional Reading**


2. Oracle application users and roles [https://docs.oracle.com/en/database/oracle/oracle-database/12.2/dbfsg/configuring-application-sessions.html#GUID-BF0AACF5-D06C-47E1-B83C-1D354C2CF2F3](https://docs.oracle.com/en/database/oracle/oracle-database/12.2/dbfsg/configuring-application-sessions.html#GUID-BF0AACF5-D06C-47E1-B83C-1D354C2CF2F3)

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**Module 10 Database Auditing: Oracle**

**Introduction and Module Summary**

This module discusses the role of audit in cybersecurity and explains database auditing, which together with database security ensures that your data is protected. You guard your data by enforcing database security, and you ensure that data is well guarded through database auditing.

**Objectives and Outcomes**

This module directly supports highlighted course outcome(s)

Students who complete this course successfully will be able to

- Evaluate vulnerabilities of Database Management Systems.
- Describe the methods for controlling database security.
- Explain principles of database auditing.
- Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

**Module outcomes and activities:**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Explain role of auditing in cybersecurity</th>
<th>Select appropriate auditing model and differences between auditing</th>
<th>Define the differences between auditing</th>
<th>Describe Audit Vault and Unified</th>
</tr>
</thead>
<tbody>
<tr>
<td>After completing this module, students will be able:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module 11 Database Auditing Models MS SQL Server

Introduction and Module Summary
This module discusses how to use SQL Server audit to create server audits that include server audit specifications for server level events, and database audit specifications for database level events.

Objectives and Outcomes
This module directly supports highlighted course outcome(s)

Students who complete this course successfully will be able to

- Evaluate vulnerabilities of Database Management Systems.
- Describe the methods for controlling database security.
- **Explain principles of database auditing.**
- Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).

Module outcomes and activities:

<table>
<thead>
<tr>
<th>After completing this module, students will be able:</th>
<th>Describe anatomy of SQL Server audit</th>
<th>Configure auditing in SQL Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read assigned materials</td>
<td>introduced</td>
<td>introduced</td>
</tr>
<tr>
<td>Watch assigned videos</td>
<td>reinforced</td>
<td>reinforced</td>
</tr>
</tbody>
</table>
Assigned Reading


4. (video) SQL Server 2016 [https://www.youtube.com/watch?v=Xh3WRDGWpq0](https://www.youtube.com/watch?v=Xh3WRDGWpq0)

5. (video) SQL Server 2014 [https://www.youtube.com/watch?v=EefIHhT78I0](https://www.youtube.com/watch?v=EefIHhT78I0)

Optional Reading


Module 12 Virtual Private Databases

**Introduction and Module Summary**

This module illustrates the concept of a virtual private database—a shared database schema containing data that belongs to many different users and each user can view or update only the data he or she owns. Three ways of implementing a virtual private database in Oracle: using the VIEW database object, using Oracle’s application context and using Oracle’s virtual private database feature. Two ways of implementing a virtual private database in MS SQL Server: using the VIEW database object and using MS SQL Server Row-Level. You will also learn how to mask data in MS SQL Server tables.

**Objectives and Outcomes**

This module directly supports highlighted course outcome(s)

Students who complete this course successfully will be able to

- Evaluate vulnerabilities of Database Management Systems.
- Describe the methods for controlling database security.
- Explain principles of database auditing.
- **Develop and implement a security plan for an enterprise level database (password policies, auditing policies, user privileges, profile, and roles).**

**Module outcomes and activities:**

<table>
<thead>
<tr>
<th>After completing this module, students will be able:</th>
<th>Define the term “virtual private database” and explain its importance</th>
<th>Implement a virtual private database in Oracle</th>
<th>Implement a virtual private database in MS SQL Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read assigned materials</td>
<td>introduced</td>
<td>introduced</td>
<td>introduced</td>
</tr>
<tr>
<td>Read and execute code from the module</td>
<td>reinforced</td>
<td>reinforced</td>
<td>reinforced</td>
</tr>
<tr>
<td>Prepare for discussion topic and post your answer.</td>
<td>Reinforced, mastered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Module Lab</td>
<td></td>
<td></td>
<td>reinforced</td>
</tr>
<tr>
<td>Assigned Reading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. VPD Oracle: Using Oracle Virtual Private Database to Control Data Access</td>
<td><a href="https://docs.oracle.com/database/121/DBSEG/vpd.htm">https://docs.oracle.com/database/121/DBSEG/vpd.htm</a></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Optional Reading</th>
<th></th>
</tr>
</thead>
</table>