



RQF LEVEL 4



GENDD401

**NETWORKING
AND INTERNET
TECHNOLOGIES**

Database Development

TRAINER'S MANUAL

October, 2024



DATABASE DEVELOPMENT

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ACRONYMS

B-tree: Balanced tree

CODASYL: Conference on Data Systems Languages.

CPU Power: Central Processing Unit Power

DBMS: Database Management System

DCL: Data Control Language

DDL: Data Definition Language

DML: Data Manipulation Language

DQL: Data Query Language

ERD: Entity Relationship Diagram

I/O: Input/Out put

MD5: Message Digest Algorithm 5

NFRs: Non-Functional Requirements

OODBMS: Object-Oriented Database Management Systems

RTB: Rwanda TVET Board

SHA: Secure Hash Algorithm

SQL: Structured Query Language

SSMS: SQL Server Management Studio

TCL: Transaction Control Language

TQUM Project: TVET Quality Management Project

INTRODUCTION

This trainer's manual includes all the methodologies required to effectively deliver the module titled "**Database Development.**" Trainees enrolled in this module will engage in practical activities designed to develop and enhance their competencies.

The development of this training manual followed the Competency-Based Training and Assessment (CBT/A) approach, offering ample practical opportunities that mirror real-life situations.

The trainer's manual is organized into Learning Outcomes, which is broken down into indicative content that includes both theoretical and practical activities. It provides detailed information on the key competencies required for each learning outcome, along with the objectives to be achieved.

As a trainer, you will begin by asking questions related to the activities to encourage critical thinking and guide trainees toward real-world applications in the labor market. The manual also outlines essential information such as learning hours, didactic materials, and suggested methodologies.

This manual outlines the procedures and methodologies for guiding trainees through various activities as detailed in their respective trainee manuals. The activities included in this training manual are designed to offer students opportunities for both individual and group work. Upon completing all activities, you will assist trainees in conducting a formative assessment known as the end learning outcome assessment. Ensure that trainees review the key reading and the points to remember section.

MODULE CODE AND TITLE: GENDD401 DATABASE DEVELOPMENT

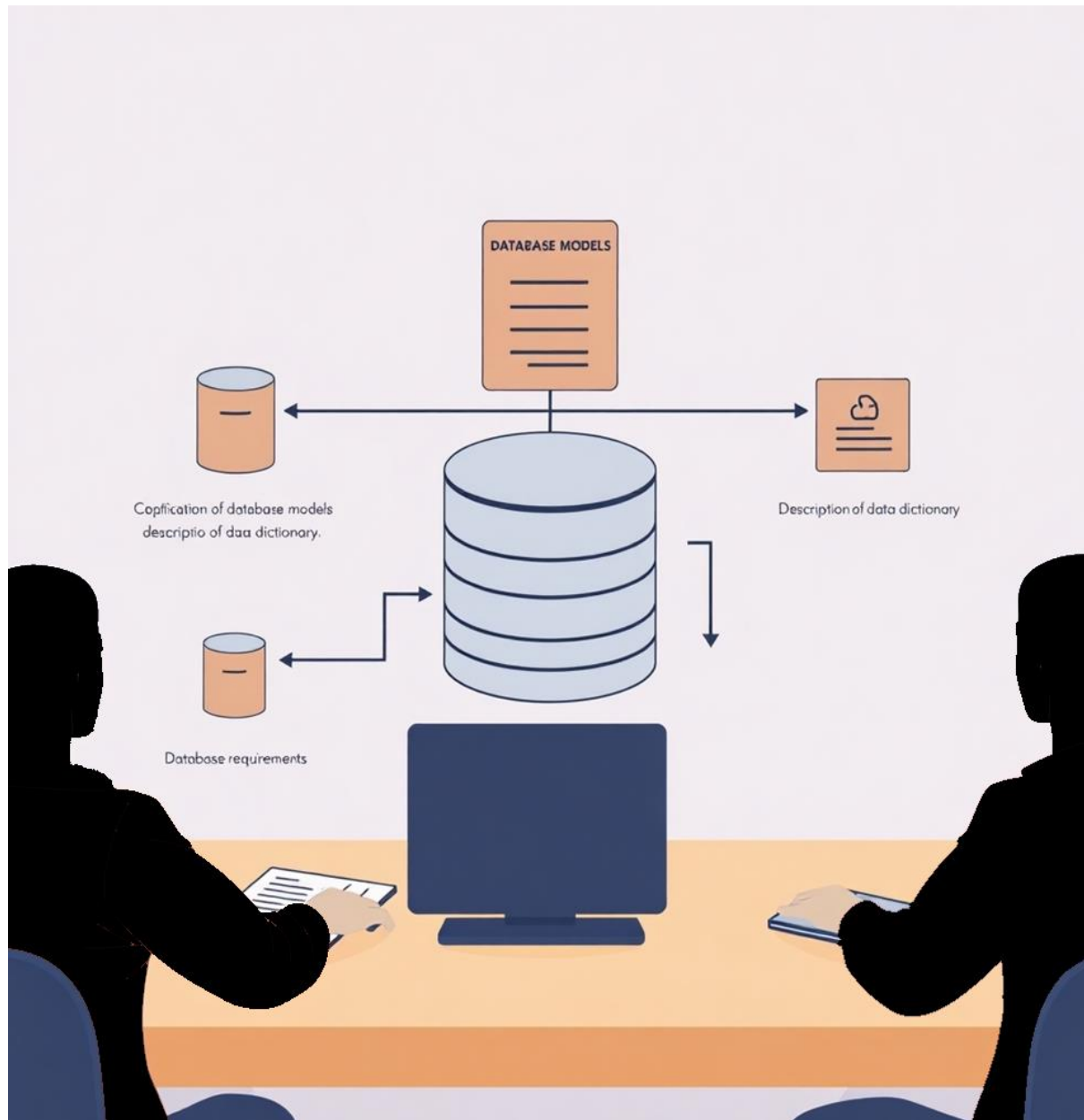
Learning Outcome 1: Analyse Database

Learning Outcome 2: Design Database

Learning Outcome 3: Implement Database

Learning Outcome 4: Secure Database

Learning Outcome 1: Analyse Database



Indicative contents

1.1 Description of database fundamental

1.2 Description of data dictionary

1.3 Identification of database requirements

Key Competencies for Learning Outcome 1: Analyse Database

Knowledge	Skills	Attitudes
• Description of database Concepts • Identification of database models • Identification of database relationships • Description of determination for database datatypes • Description of data dictionary • Identification database requirements • Identification of data collection methods	• Gathering data based on user requirement • Analysing database requirements	• Having self-confidence while gathering data • Being Organizer while analysing collected data • Having attention to details



Duration: 15 hrs

Learning outcome 1 objectives:



By the end of the learning outcome, the trainees will be able to:

1. Describe properly Database concepts based on database standards.
2. Identify properly Database models based on database standards
3. Identify properly Database relationship based on database standards
4. Determine correctly Datatypes based on database standards
5. Describe clearly Data dictionary based on database models.
6. Prepare correctly data dictionary according to the user requirements
7. Identify properly database requirements based on user requirements
8. Gather properly correctly data based on customer needs
9. Analyse effectively database requirements based on user requirement.



Resources

Equipment	Tools	Materials
• Computer • Digital voice recorders (audio or video)	• Video conferencing tools:(Zoom, Microsoft Teams, Skype)	• Internet • Papers • pens



Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail computers with installed Ms office and internet accessibility.



Indicative content 1.1: Description of Database Fundamental.



Duration: 7 hrs



Theoretical Activity 1.1.1: Introduction to database Concepts



Notes to the trainer:

- Trainer may use small groups for introducing database.
- Use images as didactic materials differentiate database elements



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and request trainees to answer to the following questions:

I. Define the following terms:

- a. Database
- b. Data
- c. Information
- d. Entities
- e. Attributes/Field
- f. Records
- g. Table
- h. Database schema
- i. DBMS
- j. SQL

II. Where a database can be applied?

Step 2: Ask trainees to write answers on paper, flipchart, blackboard or white board

Step 3: Provide expert view and clarifies ideas by using didactic materials.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read key reading 1.1.1.in the trainee manual.



Points to Remember

- Database always used to store structured data for easy access, management, and updating.

- You should Apply databases in various fields like business, e-commerce, banking, healthcare, and education to ensure organized data handling.
- To ensure the safety Store and process of information in a relational database you are recommended to use SQL (Structured Query Language).
- Processed data turns into useful information.
- While interacting with database, Database Management System (DBMS) is always used to create and manage data efficiently.



Theoretical Activity 1.1.2: Identification of database Models



Notes to the trainer:

- Trainer may use small group for describing database models.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What do you mean by database model?
- II. Explain types of database model

Step 2: Ask trainees to present their answers

Step 3: Asks trainees to participate in grouping and agreeing on correct answers.

Step 4: Provide expert view for more clarification.

Step 5: Address any questions or concerns.

Step 6: Ask trainees to read the key reading 1.1.2 in the trainee manual.



Points to Remember

- Database model always determine how data is stored, organized, and accessed.
- You are recommended to use different types of database model: Relational, Hierarchical, Network, and Object-Oriented.



Theoretical Activity 1.1.3: Identification of database Relationships



Notes to the trainer:

- Trainer may use small groups for describing database relationships.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Involve trainees in group formulation

Step 2: Introduce the activity and request trainees to answer to the following questions:

- I. What do you understand by relationship in database
- II. Identify types of database relationship

Step 3: Involve trainees in presentation of their answers.

Step 4: Provide expert view and clarifies ideas by using didactic materials.

Step 5: Address any questions or concerns.

Step 6: Ask trainees to read key reading 1.1.3 in the trainee manual.



Points to Remember

- You should define associate related entities using relationships in relational databases
- Always identify clearly the type of relationship between entities to determine whether it is one-to-one, one-to-many, many-to-one or many-to-many.



Theoretical Activity 1.1.4: Description of determination data types



Notes to the trainer:

- Trainer may use small group for describing datatype concepts.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What do you understand by datatype?
- II. What are main categories of datatype?

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

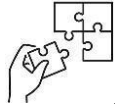
Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 1.1.4 in the trainee manual.



Points to Remember

- Data type must be assigned to each column to specify what kind of data it will store.
- The main categories of datatypes in database should focus on numeric, character, date and time



Application of learning 1.1.

XYZ University is a large institution with thousands of students, faculty members, and administrative staff. To efficiently manage the records of students, faculty, and courses, the university decided to implement a student information management system (SIMS). The goal of the system is to store, organize, and retrieve relevant data related to student enrolment, faculty assignments, and course offerings. you are asked to analyse the above case study and find out elements that will be stored in database.

Checklist:

Criteria	Indicators	Observation	
Database fundamentals are well described	1.Entities are identified	Yes	No
	2.Relationships are specified		
	3.Attributes are provided		
	4.Datatypes are provided		
Decision			



Indicative content 1.2: Description of Data Dictionary



Duration: 3 hrs



Theoretical Activity 1.2.1: Description of data dictionary



Notes to the trainer:

- Trainer may use small groups for describing data dictionary



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What do you mean by data dictionary?
- II. what are elements of data dictionary?

Step 2: Asks any trainee to write answers provided on flipchart

Step 3: Collect the feedback from trainees about the above discussed Activity.

Step 4: Ask trainee to discuss the provided answer and choose correct answers.

Step 5: Provide expert view and address any questions or concerns

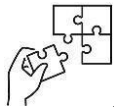
Step 6: Address any questions or concerns.

Step 7: Ask trainees to read key reading 1.2.1.in the trainee manual.



Points to Remember

- A data dictionary is a structured collection of metadata that provide detailed information about data stored in database
- While displaying data dictionary ensure that it contains its essential elements, including table names, attribute names, data types (with their sizes), and constraints.



Application of learning 1.2.

The data dictionary below is generated by the MySQL DBMS from the database of A&U Trading Company, which is located in Gasabo district, Giti sector, Muhuro village. As a newly hired database analyst for the company, you are asked to identify and analyse the key elements within this data dictionary produced by the DBMS."

a&u_trading_company_database

customer_table

Column	Type	Null	Default	Links to
Customerid (<i>Primary</i>)	int(7)	No		
CustomerFname	varchar(35)	No		
CustomerLname	varchar(25)	No		
CustomerPhone	varchar(14)	No		
CustomerSex	varchar(1)	No		

employee_table

Column	Type	Null	Default	Links to
Employeeid (<i>Primary</i>)	int(7)	No		
EmployeeFname	varchar(25)	No		
EmployeeLname	varchar(35)	No		
EmployeeEmail	varchar(18)	No		
EmployeeSex	varchar(1)	No		
EmployeeUserName	varchar(38)	No		
EmployeePassword	varchar(34)	No		
EmployeePhone	varchar(13)	No		

orders_table

Column	Type	Null	Default	Links to
OrdersId (<i>Primary</i>)	int(7)	No		
OrdersDate	date	Yes	NULL	
Customerid	int(5)	Yes	NULL	customer_table -> Customerid
Employeeid	int(6)	Yes	NULL	employee_table -> Employeeid

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Data dictionary is properly Described	1.Entities are Identified		
	2.Attributes for Each Entity are identified		
	3.Datatypes are identified		
	4.Datatypes size is identified		
	5.Constraints are identified		
Decision			



Indicative content 1.3: Identification of Database Requirements



Duration: 5 hrs



Theoretical Activity 1.3.1: Identification of data collection methods



Notes to the trainer:

- Trainer may use small groups for describing methodologies for data collection.
- Avail the sample of data collection tools as didactic materials.
- Have the images/video as didactic materials.



Key steps:

While delivering this activity, pass through the following steps:

- Step 1:** Introduce activity and ask learners to answer the following questions:
- I. How does data collection contribute to the successful development of a database?
 - II. What are the primary methodologies for data collection in database design?
- Step 2:** Ask learners to share their findings in groups.
- Step 3:** Provide the expert view.
- Step 4:** Address any questions or any concern
- Step 5:** Ask trainees to read key reading 1.3.1. In the trainee manual.



Points to Remember

- Always use interviews as the primary method of data collection to obtain efficient data for the database system.
- To ensure the accurate information You should conduct interview with key users of the current system or future users who will manage the information in the new application/system.
- Ensure that the analyst conducts interviews with both main users and those responsible for managing the database system.
- You are recommending to use questionnaires to collect data from a large number of people who will use the services provided by the database system.



Practical Activity 1.3.2: Collecting data



Notes to the trainer

- This activity should take place on field out of the class Trainer may use small group for performing data collection.
- Avail the research topic as Activity and own methods to be used for each group created.
- Avail the tools and Equipment needed to perform data collection for each method.



Key steps:

While delivering this activity, pass through the following steps:

- Step 1:** Introduce the Activity and ask trainees to read the task described below: your school need to enhance the technology that will help to manage internet accessibility in different trades. To implements that technology school needs an application that will store and executes the user information. As database analyst, you are requested to collect data that will guide in database development by using interview, observation, documentation and Questionnaire.
- Step 2:** Demonstrate how to gather data using different methods. While demonstrating, explain the steps to collect data
- Step 3:** Ask trainees to collect data by using interview, observation, documentation and Questionnaire.
- Step 4:** Ask trainees to read key reading 1.3.2.



Points to Remember

- Prepare clear questions that will guide interviewer.
- It is mandatory to organize tools and materials that relate with the methods to be used in data collection.



Theoretical Activity 1.3.3: Identification of database requirements



Notes to the trainer:

- Trainer may use small groups to identify database requirements



Key steps:

While delivering this activity, pass through the following steps:

- Step 1:** Introduce activity and ask learners to answer the following questions:
- I. What do you understand by database requirement?
 - II. What are the types of database requirement?
- Step 2:** Ask learners to share their findings in groups.
- Step 3:** Provide the expert view.
- Step 4:** Address any questions or any concern
- Step 5:** Ask trainees to read key reading 1.3.3 in the trainee manual.



Points to Remember

- Clearly define the database requirements to ensure that the system meets the necessary specifications for the intended application.
- All Specified Database requirements must be classified into functional and non-functional categories.
- to guide the design and implementation process requires to Identify and classify the database requirements into functional (what the system should do) and non-functional (performance, scalability, etc.)



Practical Activity 1.3.4: Analysing database requirements



Notes to the trainer

- Trainer may use black/whiteboard.
- Trainees may use their notebooks



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity by explaining set operations.

Step 2: Ask trainees to answer the questions below:

A university is planning to develop a new Student Information System (SIS) to manage student records, academic performance, and enrolment. The system will be used by students, faculty, and administrative staff.

You are tasked to:

Identify the potential database requirements for this SIS. Consider both functional and non-functional requirements. Think about the data that needs to be stored, the operations that need to be performed, and the system's overall performance and security needs.

Step 3: Ask trainees to present their findings.

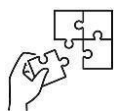
Step 4: Based on presentation of trainees, give expert view on application of set operations.

Step 5: Ask trainees to read key readings 1.3.4 in their manuals.



Points to Remember

- Ensure that all requirements are clear, complete, and consistent before proceeding with the design and implementation.
- Express clearly the goals and objectives of the database system before implementation to check if it meets with requirement.
- Always Determine who will use the system (the users of the system) to identify the target users and their roles.
- Analyze the data collected during the research phase to understand the needs.
- Before designing database, you should Specify the actions and operations the system will perform.



Application of learning 1.3.

A new online clothing store XYZ is launching and requires a robust database to manage its operations. The clothing store XYZ needs to store information about products, customers, orders, and inventory.

Task:

You are tasked with designing the database structure for the online clothing store. Identify the **critical data elements** to be stored, the **essential database operations** required, and the **performance and security requirements** necessary to ensure a successful online shopping experience.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Data are properly collected	Collecting data using interview		
	1.Conversation is Introduced		
	2.Interview Script is followed		
	3.Responses are Recorded		
	4.Participant Questions Addressed		
	5.Interview is closed		
	Collecting data using Questionnaire		
	1.Questionnaire is well distributed		
	2.Responses is monitored		
	3.Responses was collected		
	Collecting data by using documentation		
	1.Determine Relevant Documents		
	2.Obtain Access to Documents		
	3.Review and Analyse the Documents		
	4.Extract and Organize Data		
	5.Cross-Verify Data		
	6.Document Findings		
	7.Determine Relevant Documents		
	Collecting data by using observation		
	1.Conduct the Observation		
	2.Maintain Objectivity		
	3.Record data		
Database requirements are properly analyzed	1.Define the System's Purpose		
	2.Identify Stakeholders		
	3.Gather Information		
	4.Define Functional Requirements		

	5. Define Non-Functional Requirements:		
	6. Prioritize Requirements		
	7. Validate Requirements		
Decision			



Learning outcome 1 end assessment

Written assessment

1) Match the terms in column A with their description in column B.

Answers	Column A	Column B
1=B	1. Database	A) A person, place, thing, or event.
2=J	2. Data	B) A structured collection of related data.
3=E	3. Information	C) The logical structure of a database, defining entities, attributes, and relationships
4=A	4. Entity	D) A characteristic or property of an entity.
5=D	5. Attribute/Field	E) A collection of related data organized in a structured format
6=F	6. Record	F) A row in a table, representing an instance of an entity.
7=I	7. Table	G) Software used to manage databases.
8=C	8. Database schema	H) A language used to interact with databases.
9=G	9. DBMS	I) A collection of related records.
10=H	10. SQL	J) Raw facts and figures.

2) Read the following statements and circle the letter with the correct answers:

- I. Which database model is based on a hierarchical structure?
 - a. Relational database
 - b. Hierarchical database
 - c. Network database
 - d. Object-oriented database

Answer: b. Hierarchical database

II. What is the relationship between a department and its employees?

- a. One-to-one
- b. One-to-many
- c. Many-to-one
- d. Many-to-many

Answer: b. One-to-many

III. Which data type would be suitable for storing a person's age?

- a. Character
- b. Number
- c. Date
- d. None

Answer: b. Number

3) Determine the type of data base relationship below:

- a) A table of employees and a table of their corresponding addresses.
- b) A table of customers and a table of their orders.
- c) A table of books and a table of their authors.

Answers:

- a) **One-to-one relationship:** Each employee has one corresponding address, and each address corresponds to only one employee.
- b) **One-to-many relationship:** One customer can place many orders, but each order is associated with only one customer.
- c) **Many-to-many relationship:** A book can have multiple authors, and an author can write multiple books.

4) What are the different methods used to collect data for database design?

Answers:

- **Interviews:** Conducting one-on-one or group interviews with stakeholders to gather insights about data requirements, workflows, and relationships.
- **Observation:** Observing how data is handled and used in real-time within the organization or system to understand workflows and identify data requirements.
- **Questionnaires:** Distributing structured questionnaires to users and stakeholders to gather information about data usage, needs, and expectations.
- **Documentation:** It involves reviewing and analyzing existing written materials to gather detailed information about data requirements and processes.

5) What are the key elements of a data dictionary?

Answers:

Field Name

Data Type

Length

Constraints

Description

- 6) Identify the two types of database requirements and explain how they differ. Provide examples of each type.

Answers:

Types of database requirements

Functional requirement

Non-Functional Requirement

Functional requirement: define the specific actions and operations the database system must perform. They outline the system's capabilities and functionalities.

Examples: Data storage, Data retrieval, Data update, Data deletion, Data processing, Reporting

Non-Functional Requirements: describe the qualities and characteristics of a database system, rather than its specific functions. They focus on how well the system performs its functions.

Examples: Performance, Security, Reliability, Maintainability, Usability, Compatibility, Portability, Scalability.

Practical assessment

A hospital ADB is planning to develop a new Hospital Information System (HIS) to manage patient records, appointments, treatments, and billing. The system will be used by doctors, nurses, administrative staff, and patients.

Task:

1. **Database Fundamentals Analysis** (Identify the key database terms involved in this scenario, Determine the applications of the HIS database, Analyze the solution gained from using a HIS database, Identify the most suitable database model for this scenario, what are the relationships between key entities in the HIS, Identify the data types required for storing various information in HIS database.)
2. **Identify and categorize the functional and non-functional requirements** for the HIS.
3. **Identify a data dictionary** for the HIS, defining the entities, attributes, and data types to be used in the database.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Entities are well specified	Entities are identified		
	Attributes for Each Entity are Defined		
	Attributes are provided		
data dictionary is well described	Datatypes are assigned		
	Datatypes size is specified		
	Constraints are Specify		
	Data Dictionary is defined		
	Element of data dictionary is specified		
Data are properly collected	Collecting data using interview		
	1. Conversation is Introduced		
	2. Interview Script is followed		
	3. Responses are Recorded		
	4. Participant Questions Addressed		
	5. Interview is closed		
	Collecting data using Questionnaire		
	1. Questionnaire is well distributed		
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	3. Responses was collected		
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	1. Determine Relevant Documents		
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	1. Conduct the Observation		
	2. Maintain Objectivity		
	3. Record data		
Database requirements are properly analysed	1. Define the System's Purpose		
	2. Identify Stakeholders		

	3.Gather Information		
	4.Define Functional Requirements		
	5.Define Non-Functional Requirements:		
	6.Prioritize Requirements		
	7.Validate Requirements		
Decision			



Further information to the trainer

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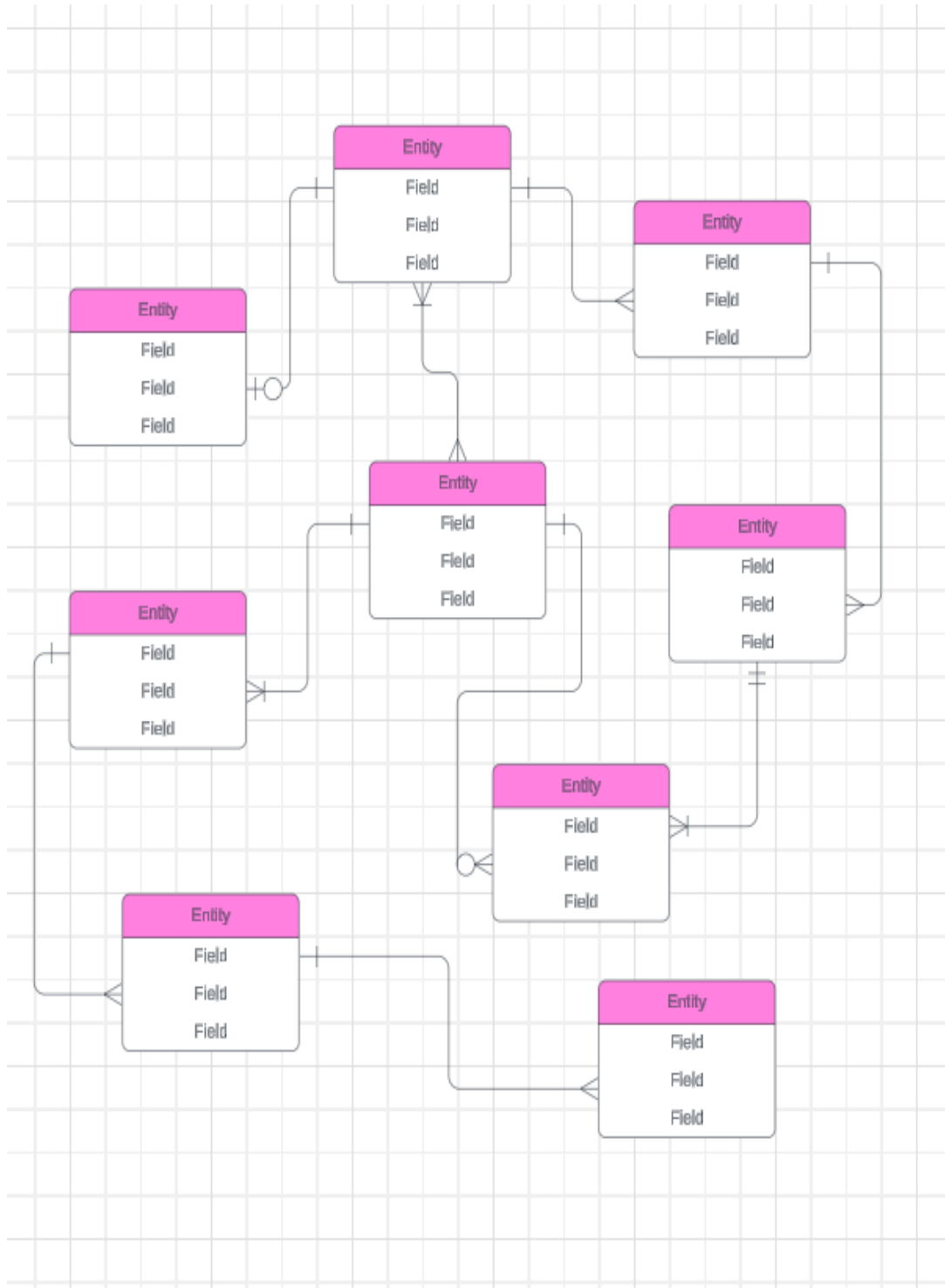
<https://study.com/academy/lesson/what-is-an-entity-in-a-database.html>

Ramez Elmasri, S. B. (2015). Fundamentals of Database Systems. Boston: Pearson.

Sciore, E. (2008). Database Design and Implementation. Hoboken, New Jersey, USA: Wiley.

Watt,A. (2014). Database Design – 2nd Edition. Victoria, British Columbia, Canada: BCcampus Open Education

Learning Outcome 2: Design Database



Indicative contents

- 2.1 Description of database schema**
- 2.2 Design of conceptual database schema**
- 2.3 Design of logical database schema**
- 2.4 Optimization of database**
- 2.5 Design of Physical database schema**

Key Competencies for Learning Outcome 2 : Design Database

Knowledge	Skills	Attitudes
• Description of database schema • Description of conceptual database schema • Description of logical database schema • Description of physical database schema	• Designing conceptual database schema • Designing logical database schema • Optimizing database • Designing Physical database schema	• Having creativity skills in designing database schemas • Being Innovative in designing database schemas • Having adaptability skills in designing database schemas • Being Organizer while designing database schemas • Being Flexible while optimizing database • Having self-confidence while optimizing database



Duration: 25hrs

Learning outcome 2 objectives:



By the end of the learning outcome, the trainees will be able to:

1. Describe properly database schema based on DBMS
2. Describe properly conceptual database schema based on DBMS
3. Design correctly ERD based on system requirements
4. Design properly logical database schema based on system requirements
5. Implement effectively Database optimization based on database schema
6. Create appropriately Physical Database Schema based on the Physical Data Model



Resources

Equipment	Tools	Materials
• Computer	• E-Draw max • MySQL set up	• Internet



Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail computers with installed E-Draw max
- Avail internet connection
- Avail MySQL set up



Indicative content 2.1: Description of Database Schema



Duration: 2hrs



Theoretical Activity 2.1.1: Description of database schema



Notes to the trainer:

- Trainer may use groups, to describe database schema



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- i. What do you understand with database schema?
- ii. Identify types of database schema
- iii. What are three levels of database abstraction
- iv. Identify types of data independence

Step 2: Ask trainees to present their findings to the whole classroom

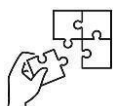
Step 3: Provide expert view and address any questions or concerns

Step 4: Ask trainees to read the key reading 2.1.1 in the trainee manual, for more clarification.



Points to Remember

- Define database schemas by identifying and analyzing their key elements.
- Simplify the complexity of databases and operations by breaking them down into three levels of abstraction: Physical, Logical, and View.
- Emphasize that data in a database is independent at both the logical and physical levels.



Application of learning 2.1.

Bright Future University is developing a new **Student Information System (SIS)** to manage student records, academic performance, and enrolment. The university wish to hire a database designer who will helps it to take a decision about a database structure

to be by identifying elements of each structure, as technician suggest database structure of this system.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Database schemas are properly identified	Conceptual database schema elements		
	1.Entities are indicated		
	2.Relationship is indicated		
	Logical database schema elements		
	1.Entities are indicated		
	2.Relationship is indicated		
	3.Attributes are indicated		
	4.Primary key is indicated		
	5.Foreign key is indicated		
	Physical database Schema		
	1.Table name is indicated		
	2.Column name is indicated		
	3.Primary key is indicated		
	4.Foreign key is indicated		
	5.Datatypes are indicated		
Database abstraction levels are correctly identified	1.Physical abstraction level is identified		
	2.Logica abstraction level is identified		
	3.View level is identified		
Data independence is properly explained	1.Logical data independence is explained		
	2. Physical data independence is explained		
Decision			



Indicative content 2.2: Design of conceptual database schema



Duration: 6hrs



Theoretical Activity 2.2.1: Description of conceptual database schema



Notes to the trainer:

- Trainer may use groups to describe conceptual database schema



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. Explain why conceptual database schema is required in database design?
- II. What is an Entity Relationship Diagram (ERD)
- III. Describe ERD by explaining its components

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 2.2.1 in the trainee manual.



Points to Remember

- To describe the ERD you should focus on Entities, Attributes, Relationships, and Cardinality symbols



Practical Activity 2.2.2: Designing ERD



Notes to the trainer

- This activity should be individual
- Avail drawing materials
- Avail images as didactic materials



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

The management team of "Book Nook," a small independent bookstore, is seeking to develop a simple database system to manage its core operations. They require a database that can efficiently handle the essential aspects of their business with a focus on simplicity. The system should manage customer information, including basic contact details and a record of their past purchases. It should also track the inventory of books, including details such as the title, author, genre, and stock levels. As a database designer you are requested to create an ERD that includes up to four tables, representing customers, books, sales transactions, and transaction details.

Step 2: Demonstrate how design ERD. While demonstrating, explain each step

Step 3: Ask trainees to design ERD

Step 4: Verify whether the ERD is well designed

Step 5: Ask trainees to read key reading 2.2.2.



Points to Remember

- Arrange entities and connect them using relationship before assigning the attributes to make a diagram clear
- End by add attributes and defining the type of relationship between entities to avoid confusion to the database developers
- Use an appropriate symbol for each element of ERD to avoid confusion in the diagram.



Practical Activity 2.2.3: Draw an ERD using Draw-max



Notes to the trainer

- This activity should take place in computer lab and it is individual
- Avail computers connected to the internet
- Use video as didactic material
- Avail an ERD

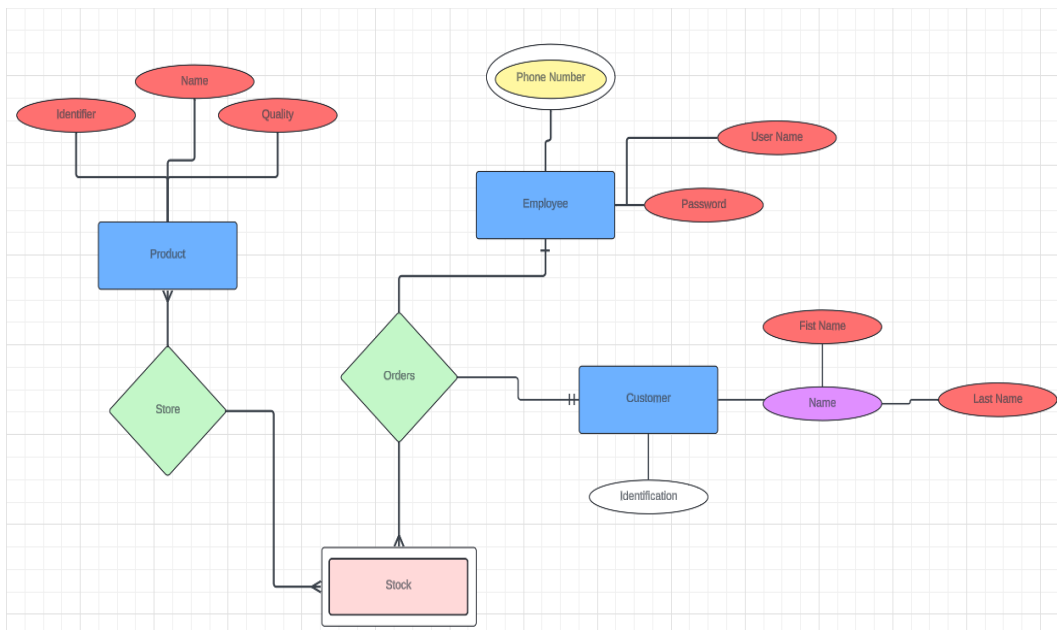


Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As a database designer you are requested to go in computer lab to draw ERD by using E-draw max, use a provided ERD



Step 2: Demonstrate how to draw ERD. While demonstrating, explain each step

Step 3: Ask trainees to draw ERD using E-Draw max

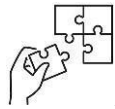
Step 4: Verify whether the ERD is well drawn

Step 5: Ask trainees to read key reading 2.2.3.



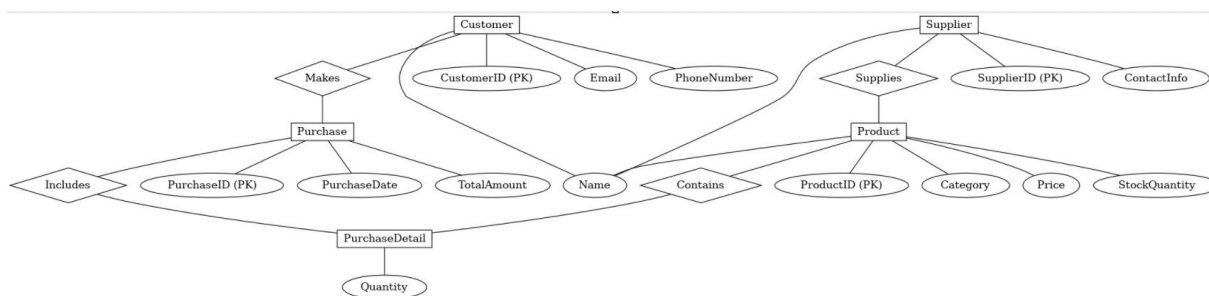
Points to Remember

- Use E-draw Max either online or by downloading and installing it on your computer to draw ERD.
- Select the appropriate ERD format to optimize drawing time.
- Begin by arranging entities and connecting them with relationships to maintain clarity in the diagram, then add attributes afterward.



Application of learning 2.2.

The owner of "Fresh Harvest Market," a local grocery store, wants to implement a new database system to streamline the store's inventory and sales operations. The system should manage product information, including product name, category, price, and stock quantity. It should also handle supplier details, such as supplier name, contact information, and the products they supply. The store needs to keep track of customer purchases, including the date of purchase, items bought, and the total amount spent. Additionally, the database should support inventory management, enabling the store to monitor stock levels and automatically reorder products when they fall below a certain threshold. As a database designer, design ERD and draw it by using Edraw max



Checklist:

Criteria	Indicators	Observation	
		Yes	No
ERD is well created	1.Entities are defined		
	2. Entities types are specified		
	3.Relationships are established		
	4. Attributes for each are defined		
	5. Types of attributes are specified		
	6.Relationships are defined by using cardinality symbol		
ERD is well drawn	7. E-draw Max is opened		
	8. ERD is drawn		
	9. ERD is clearly drawn		
	10. The File is saved		



Indicative content 2.3: Design of Logical Database Schema



Duration: 6hrs



Theoretical Activity 2.3.1: Description of logical database schema



Notes to the trainer:

- Trainer may use groups to deliver this content



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer to the following questions:

- i. What do you understand with logical database schema?
- ii. List and explain constraints in SQL

Step 2: Ask trainees to present their answers.

Step 3: Provide expert view and address any questions or concerns

Step 4: Ask trainees to read the key reading 2.3.1 in the trainee manual, for more clarification.



Points to Remember

- You should describe table rules through NOT NULL, UNIQUE, DEFAULT, CHECK, PRIMARY KEY and FOREIGN KEY constraints.



Practical Activity 2.3.2: Converting conceptual database schema into logical database schema



Notes to the trainer

- This activity should be individual
- Avail conceptual database schema
- Avail images as didactic material
- Avail computers with installed software to draw logical database schema

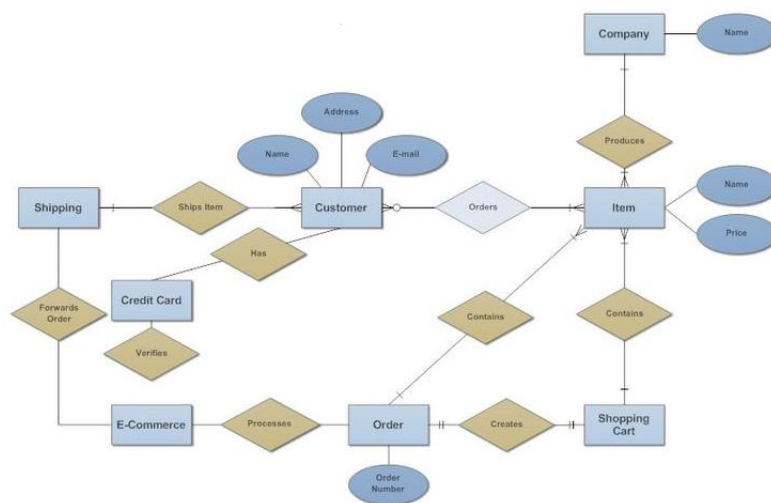


Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As a database designer you are requested to go in computer lab to transform the provided ERD into logical database schema



Step 2: Demonstrate how draw logical database schema. While demonstrating, explain each step

Step 3: Ask trainees to transform conceptual database schema into logical database schema

Step 4: Verify whether the logical database schema is well drawn

Step 5: Ask Clarification if any

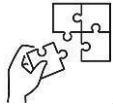
Step 6: Ask trainees to read key reading 2.3.2.



Points to Remember

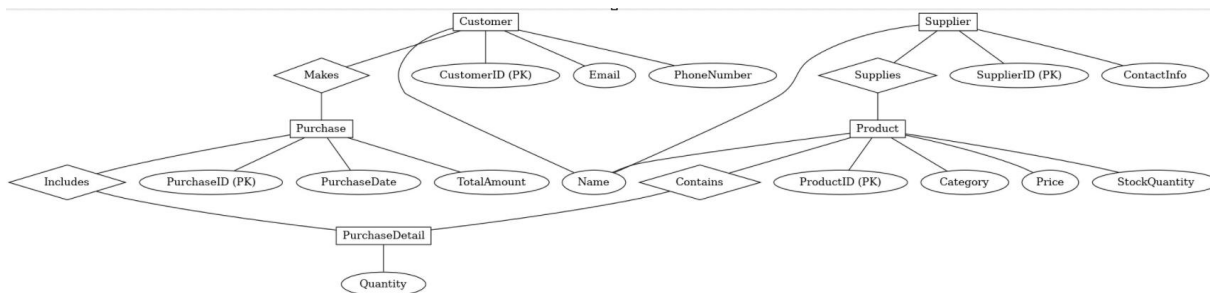
- "In a logical database design, if a relationship in the ERD involves a many-to-many connection between two entities, it should typically be represented as a separate table.
- Select a primary key for each entity
- Create a relationship between entities by migrating a primary key of a parent entity in the child entity

- Arrange entities properly to maintain clarity of a schema.
- Incorporate Entities, relationships between entities, Attributes and constraints in the logical database schema.



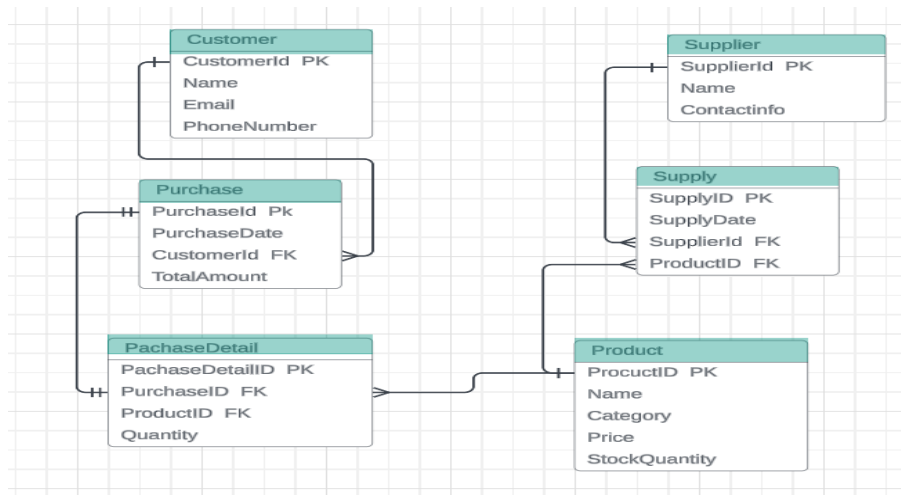
Application of learning 2.3.

The owner of "Fresh Harvest Market," provide the below ERD and he is seeking for a database developer to develop to transform it into Logical database schema.



You as a database designer you are requested to transform it in Logical database schema.

Solution



Checklist:

Criteria	Indicators	Observation	
		Yes	No
Logical database schema is elaborated	1.Entities are defined		
	2.Relationships are established		
	3.Attributes are specified		
	4.Primary key is selected		
	5.Foreign key provided		
Decision			



Indicative content 2.4: Optimization of Database



Duration: 6hrs



Theoretical Activity 2.4.1: Description of database optimisation



Notes to the trainer:

- Trainer may use groups to describe database optimisation.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What do you understand by database optimisation?
- II. Explain the ways that can be used to optimise database

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 2.4.1 in the trainee manual.



Points to Remember

- For better understanding database optimization, use Normalization and indexing descriptions



Practical Activity 2.4.2: Normalising database



Notes to the trainer

- Facilitation of this activity may be individual
- Avail sample abnormal tables



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to do the task described below:

As a database designer you are requested to perform the task described below:
A small retail company, "KIGALITechs," maintains a database to keep track of its inventory and sales. The current database structure stores information in a single table, which includes the following attributes: OrderID, CustomerName, CustomerAddress, ProductID, ProductName, Quantity, UnitPrice, and OrderDate. Over time, the company has experienced several issues, such as redundant data, difficulty in maintaining accurate customer information, and inconsistencies in product pricing. As a database designer you are tasked with normalizing this table to improve its efficiency and integrity. Check 1NF, 2NF, and 3NF

Step 2: Demonstrate how to normalise a table. While demonstrating, explain each step

Step 3: Ask trainees to Normalise table

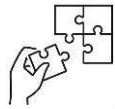
Step 4: Verify whether table is correctly normalised

Step 5: Ask trainees to read key reading 2.4.2.



Points to Remember

- Check if the column values are atomic. If they are, proceed to the next step; if not, ensure the column values are made atomic.
- Verify if each non-key column depends on a single prime attribute. If it does, move to the next step; if not, separate the columns based on their dependency on different prime attributes by splitting the table into additional tables.
- Ensure that non-key attributes are mutually independent. If they are not, the process is complete; if they are, separate the non-key columns that depend on one another.
- If you split a table into more tables, establish relationships between the newly created tables.



Application of learning 2.4.

Isange restaurant located at Kicukiro Distring, Mukingi, Sector , Mutovu village, has a restaurant management application that is used to store data about the company's employees it is annoyed by the information in that table because of duplications of data. It needs to hire a database designer to help it to change the structure of employee table to remove data duplication. As a database designer normalize the below table:

employee_id	name	job_code	job	state_code	home_state
E001	Alice	J01	Chef	26	Michigan
E001	Alice	J02	Waiter	26	Michigan
E002	Bob	J02	Waiter	56	Wyoming
E002	Bob	J03	Bartender	56	Wyoming
E003	Alice	J01	Chef	56	Wyoming

Solution:

All the entries are atomic and there is a composite primary key (employee_id, job_code) so the table is in the first normal form (1NF).

2NF

even if you only know someone's employee_id, then you can determine their name, home_state, and state_code (because they should be the same person). This means name, home_state, and state_code are dependent on employee_id (a part of primary composite key). So, the table is not in 2NF. We should separate them to a different table to make it 2NF.

employee_roles Table

employee_id	job_code
E001	J01
E001	J02
E002	J02
E002	J03
E003	J01

Employees Table

employee_id	name	state code	home state
E001	Alice	26	Michigan
E002	Bob	56	Wyoming
E003	Alice	56	Wyoming

jobs table

job code	job
J01	Chef
J02	Waiter
J03	Bartender

home state is now dependent on state code. So, if you know the state code, then you can find the home state value.

To take this a step further, we should separate them again to a different table to make it 3NF.

employee roles Table

employee_id	job code
E001	J01
E001	J02
E002	J02
E002	J03
E003	J01

employees Table

employee_id	name	state code
E001	Alice	26
E002	Bob	56
E003	Alice	56

jobs Table

job code	job
J01	Chef
J02	Waiter
J03	Bartender

states Table

state code	home state
26	Michigan
56	Wyoming

Now our database is in 3NF.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Data are correctly normalised	1.1NF is respected		
	2.2NF is respected		
	3.3NF is respected		
Decision			



Indicative content 2.5: Design of Physical Database Schema



Duration: 5 hrs



Theoretical Activity 2.5.1: Description of DBMS



Notes to the trainer:

- Trainer may use groups to facilitate this activity



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What do you understand by DBMS?
- II. What are the components of DBMS?

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 2.5.1 in the trainee manual.



Points to Remember

- A Database Management System (DBMS) is a software system that is designed to manage and organize data in a structured manner.
- Components of DBMS: Hardware, Software, Data, Procedures, Database Access Language, People.



Practical Activity 2.5.2: Preparing DBMS Environment (MySQL)



Notes to the trainer

- The activity is individual
- Avail computers and MYSQL DBMS set up



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As a database designer you are requested to prepare MySQL environment

Step 2: Demonstrate how to prepare MySQL environment. While demonstrating, explain each step

Step 3: Ask trainees to prepare MySQL environment

Step 4: Verify whether environment is well prepared

Step 5: Ask trainees to read key reading 2.5.2.



Points to Remember

- During XAMPP installation, select all necessary components required for your DBMS to ensure optimal functionality



Practical Activity 2.5.3: Converting logic database schema to physical database schema



Notes to the trainer

- This activity should be individual
- Avail logical database schema

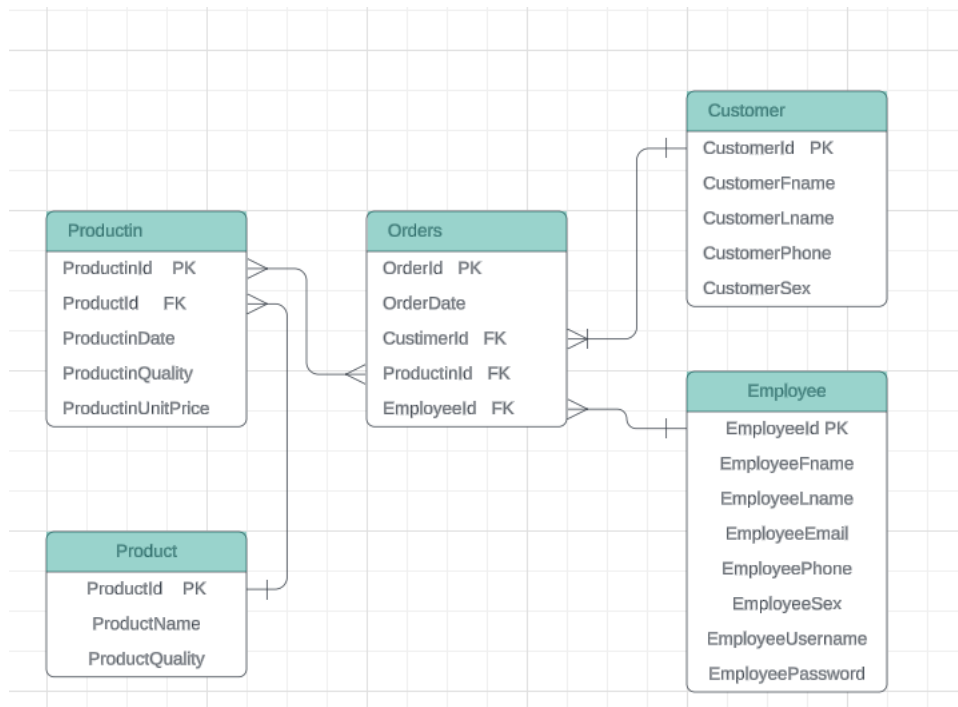


Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As a database designer you are requested to transform logical database schema into physical database schema



Step 2: Demonstrate how convert logical database schema into physical database schema. While demonstrating, explain each step

Step 3: Ask trainees to convert logical database schema into physical database schema

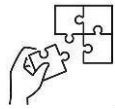
Step 4: Verify whether physical database schema is well designed

Step 5: Ask trainees to read key reading 2.5.3.



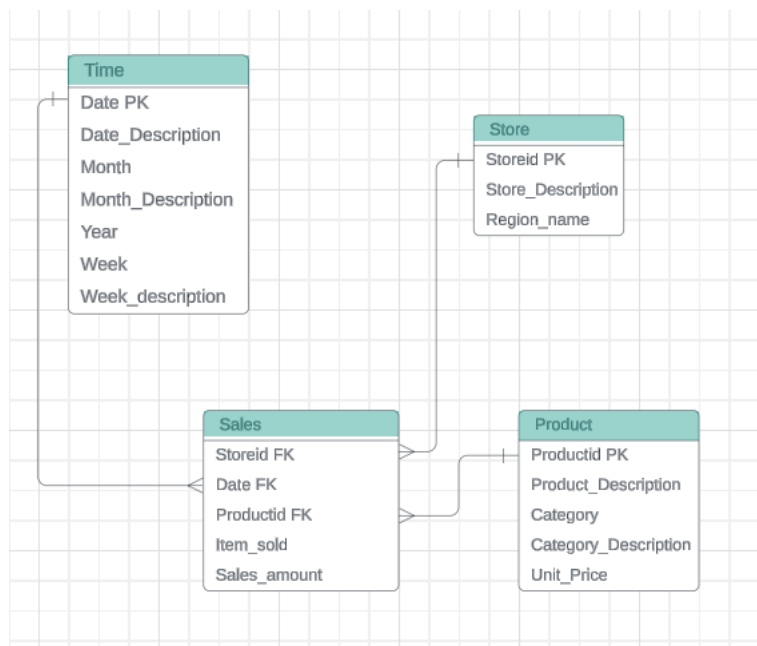
Points to Remember

- Understand that the physical database schema does not support many-to-many relationships.
- Use the physical database schema to guide how the database will be created and stored.
- Always organize the table structure to ensure a clear and comprehensible database structure.
- Link the primary key field to its foreign key to provide guidance for database developers.



Application of learning 2.5.

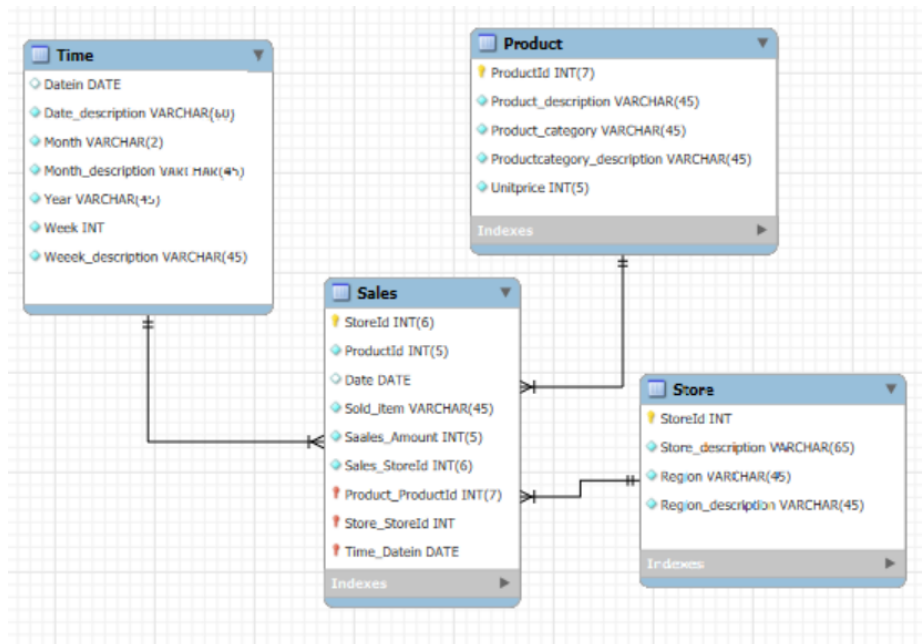
RAHABU is a company that sales its product online, it is located near your school. It is in the process of designing a database that will helps their employees to manage online sales the previous database designer lost the job after designing logical database schema shown below



you are hired as a database designer to prepare MySQL environment, then convert the above logical database schema into physical database schema

Solution:

Physical database schema



Checklist:

Criteria	Indicators	Observation	
		Yes	No
MySQL environment is well prepared	1.MySQL is installed		
	2.MySQL is Configured		
	3.MySQL Server is Started		
	4.MySQL is Connected		
Physical database schema is elaborated	5.Table names are provided		
	6.Column names are provided		
	7.Primary key is selected		
	8.Foreign key is provided		
	9.Datatypes are indicated		
Decision			



Learning outcome 2 end assessment

Written assessment

Question1: Match the following terms in column A with their correct definitions in column

B

Answers	Terms (Column A)	Definitions(Column B)
1..	1. Database Schema	A. A big-picture view of what the system will contain, how it will be organized, and which business rules are involved.
2..	2. Conceptual Schema	B. Clearly defines schema objects with table names, field names, relationships, and integrity constraints but lacks technical requirements.
3..	3. Logical Schema	C. is the lowest level of data abstraction, which deals with the physical storage and representation of data.
4..	4. Physical Schema	D. Provides a high-level representation of the data, defining tables, columns, and relationships without concerning physical storage details.
5...	5. Physical Level of Data Abstraction	E. Is a process of simplifying the structure of database by removing data duplication
		F. Defines the structure, organization, and relationships of a database, including tables, columns, data types, and constraints.

Question2: Read careful the below statements and encircle the correct answer from the provided options

1) The following features are included in a database schema Except:

- A) Tables and columns
- B) Primary key constraints
- C) User interface designs
- D) Data types and lengths

2) A conceptual schema provides:

- A) The syntax for creating data structures on disk storage
- B) A high-level view of the system's organization and business rules
- C) Detailed technical requirements for database implementation
- D) A specific view for different database users

3) The following are table constraints Except.....

- A) Primary Key
- B) Foreign Key
- C) Data Type
- D) Unique

4) PRIMARY KEY constraint ensures that.....

- A) All values in the column(s) are unique.
- B) The column(s) cannot contain NULL values.
- C) The column(s) uniquely identify each row in the table.
- D) All of the above.

5) A constraint ensures that a column must have a value (i.e., it cannot be NULL) is

- A) PRIMARY KEY
- B) FOREIGN KEY
- C) CHECK
- D) NOT NULL

- 6) A constraint that is used to enforce a relationship between two entities is known as a.....
- A) PRIMARY KEY
 - B) FOREIGN KEY
 - C) UNIQUE
 - D) CHECK
- 7) The role of a UNIQUE constraint is to....
- A) Ensures that all values in the column(s) are different.
 - B) Ensures that no two rows have the same values in the specified column(s).
 - C) Allows only one NULL value in the column.
 - D) All of the above.
- 8) The constraint used to limit the range of values that a column can store is known as.....
- A) PRIMARY KEY
 - B) CHECK
 - C) UNIQUE
 - D) FOREIGN KEY

Question3: write True to the correct statement and False to the wrong statement

- a) A strong entity is an entity that does not depend on any other entity for its existence.
- b) A weak entity can exist independently without being associated with a strong entity.
- c) In a one-to-one relationship, each entity in one entity set can be associated with multiple entities in the other entity set.
- d) A one-to-many relationship means that one entity in an entity set is associated with many entities in another entity set.
- e) In a many-to-many relationship, each entity in one entity set can be associated with multiple entities in another entity set, and vice versa.
- f) Attributes are properties or characteristics of entities that help to describe the entity.
- g) A composite attribute is an attribute that can be divided into smaller sub-attributes.

Question 4: Match Normal forms to their descriptions

Answers	Forms of Normalisation	Description
1..	1.1NF	A. Ensures that a table has no repeating groups and that each column contains atomic (indivisible) values.
2..	2.2NF	B. Requires that a table be in 2NF and that all transitive dependencies are eliminated, ensuring that non-key attributes are only dependent on the primary key.
3..	3.3NF	C. Requires that a table be in 1NF and that all non-key attributes be fully functionally dependent on the primary key.

Answers

Question1:

1..f

2..a

3..b

4..d

5..c

Question2:

1: C

2: B

3: C

4: D

5: D

6: B

7: D

8: B

Question3:

a) T

b) F

c) F

d) T

e) T

f) T

g) T

Practical assessment

KTG is a secondary school located in your village, it needs a database designer to redesign a database for its system that cover all key aspects of the school's operations, including student information, teacher details, class schedules, subjects, and grades. The current database it uses it turn errors in the weekly report because of the gaps in database design. You as a database design you are hired by that school and your tasks are:

- To create an Entity-Relationship Diagram (ERD) and draw it using E-draw Max.
- Design a logical database schema
- Design physical database schema
- Prepare MySQL environment

Checklist:

Criteria	Indicators	Observation	
		Yes	No
ERD is well created	1.Entities are defined		
	2.Entities types are specified		
	3.Relationships are established		
	4.Attributes are defined		
	5.Types of attributes are specified		
	6.Relationships are defined by using cardinality symbol		
ERD is well drawn	7. Edraw Max is Opened		
	8. ERD is created		
	10.Customize Your ER Diagram		
	11.Save File		
Logical database schema is elaborated	12.Entities Defined		
	13.Relationships are established		
	14.Attributes are specified		
	15.Primary key is selected		
	16.Foreign key provided		
MySQL environment is well prepared	17.MySQL is installed		
	18.MySQL is Configured		

	19.MySQL Server is Started		
	20.MySQL is Connected		
Physical database schema is elaborated	21.Table names are provided		
	22.Column names are provided		
	23.Primary key is selected		
	24.Foreign key is provided		
	25.datatypes are indicated		
Decision			

END



Further information to the trainer

<https://miro.com/diagramming/how-to-draw-an-er-diagram/> diagram.

<https://www.edrawsoft.com/entity-relationship-diagrams.html>

<https://www.ibm.com/topics/database-schema>

Ramez Elmasri, S. B. (2015). Fundamentals of Database Systems. Boston: Pearson.

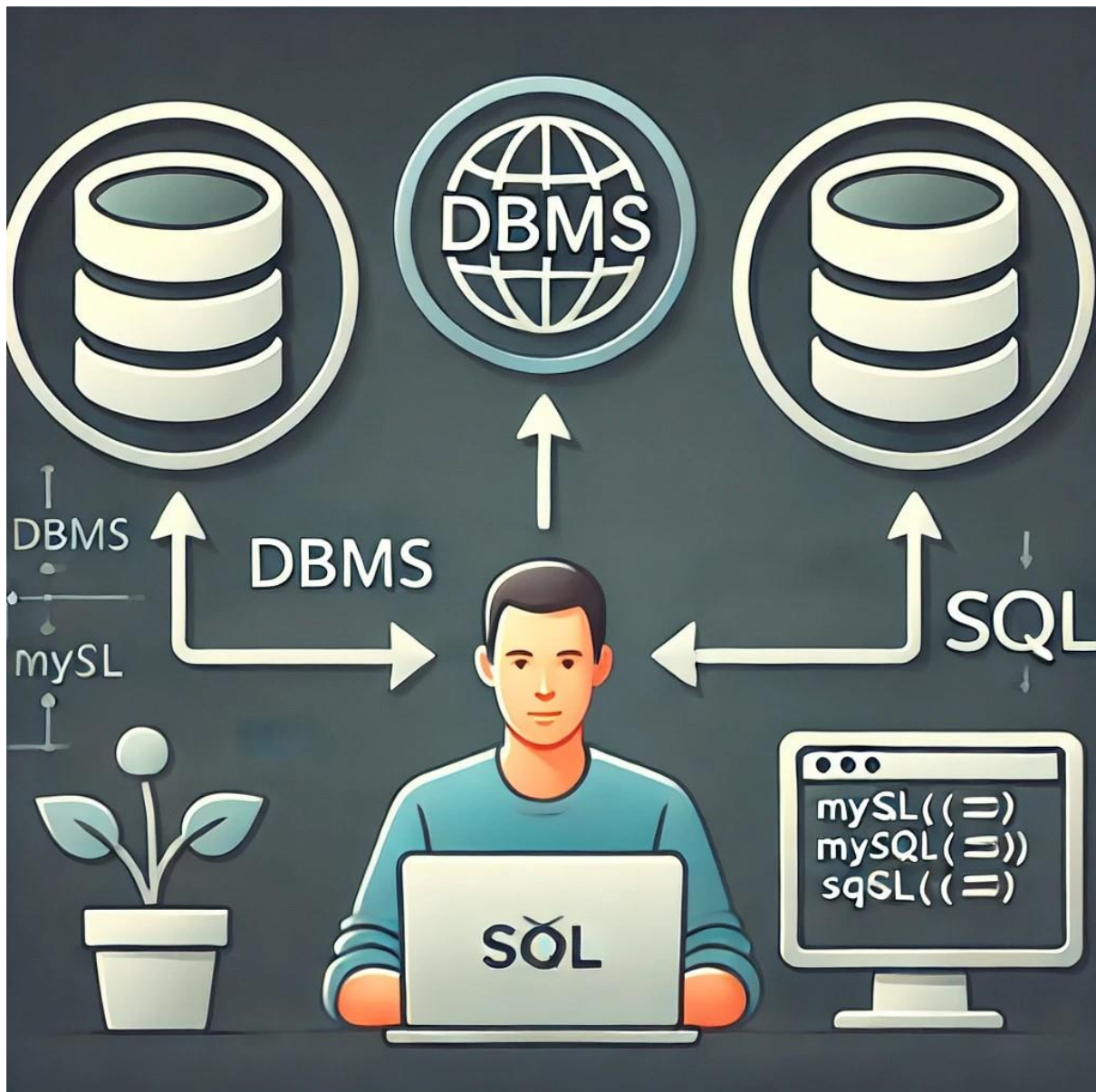
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www.geeksforgeeks.org/database-schemas/

Learning Outcome 3: Implement Database



Indicative contents

- 3.1 Description to SQL**
- 3.2 Application of DDL commands**
- 3.3 Application of DML commands**
- 3.4 Application of DQL Command**
- 3.5 Application of DCL commands**
- 3.6 Application of TCL commands**

Key Competencies for Learning Outcome 3 : Implement Database

Knowledge	Skills	Attitudes
• Description of SQL • Description of DDL Command • Description of DML Commands • Description of DQL Commands • Description of DCL Commands • Description of TCL Commands	• Writing SQL queries • Applying DDL Commands • Applying DML Commands • Applying DQL Commands • Applying DCL Commands • Applying TCL Commands	• Being Flexible in command Query debugging • Having Teamwork error handling • Having self Confidence while executing SQL command. • Being rapid during work execution



Duration: 20 hrs

Learning outcome 3 objectives:



By the end of the learning outcome, the trainees will be able to:

1. Describe properly SQL as used in database
2. Describe properly SQL Queries in Database
3. Apply effectively DDL Queries based on database schema
4. Apply effectively DML Queries based on database schema
5. Apply effectively DQL Queries based on database schema
6. Apply effectively DCL Queries based on database schema
7. Apply effectively TCL Queries based on database schema

Resources

Equipment	Tools	Materials
• Computer	• MySQL • Apache • XAMPP • WAMP • LAMP	• Pen • Papers



Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail computer lab with installed XAMPP and web browser.



Indicative content 3.1: Description to SQL



Duration: 4 hrs



Theoretical Activity 3.1.1: Description of SQL



Notes to the trainer:

- Trainer may use small groups for describing SQL.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce activity and ask trainees to answer the following questions:

1. What do you understand by SQL?
2. Differentiate SQL sub-Languages
3. What are SQL operators

Step 2: Ask trainees to share their findings.

Step 3: Provide the expert view.

Step 4: Address any questions or any concern

Step 5: Ask trainees to read key reading 3.1.1 in the trainee manual.



Points to Remember

- To interact with relational databases always require SQL programming language.
- You are recommended to use SQL sub-language to ensure the management of different access to the database system.
- To perform various computations and logical operations within queries you should always use SQL operators.



Application of learning 3.1.

Bright Future University is developing a new **Student Information Management System** to manage student records, academic performance and enrolment. The database structure that shows how the database will be implemented, was designed. the university needs to hire a database developer to implement database in MySQL by using SQL, to ensure that you are able to implement that database, you are asked to describe SQL Components (Sub-languages), their respective commands and the operators that can be used to Apply SQL commands.

Criteria	Indicators	Observation	
		Yes	No
SQL Sub-languages are correctly identified	1.DDL and its Commands are identified		
	2.DML and its Commands are identified		
	3.DDL and its Commands are identified		
	4.DCL and its Commands are identified		
	5.TCL and its Commands are identified		
SQL Operators are correctly identified	6.SQL Arithmetic Operators		
	7.SQL Bitwise Operators		
	8.SQL Compound Operators		
	9.SQL Logical Operators		
Decision			



Indicative content 3.2: Application of DDL Commands



Duration: 4 hrs



Theoretical Activity 3.2.1: Description of DDL commands



Notes to the trainer:

- Trainer may use small groups for describing DDL commands.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer to the following questions:

1. Describe DDL Create Commands
2. Describe DDL Drop Commands
3. DDL Alter Commands
4. Describe DDL Truncate Commands

Step 2: Involve trainees in presentation of their answers.

Step 3: Provide expert view and address any questions or concerns

Step 4: Ask trainees to read the key reading 3.2.1 in the trainee manual, for more clarification.



Points to Remember

- Only command to Create database and database object in SQL is **CREATE** command.
- To drop database and database object in SQL, always use **DROP** command.
- Only command to make any modification (add column, modify column and drop column) on table is **ALTER** command.
- To delete the record in table by remaining the structure of table in SQL, always use **TRUNCATE** command.



Practical Activity 3.2.2: Applying DDL Commands



Notes to the trainer

- This activity can be individual based; you are supposed to demonstrate trainees how to create database and database tables in DBMS.
- Consider well defined physical database schema.
- Verify that DBMS environment is well maintained.

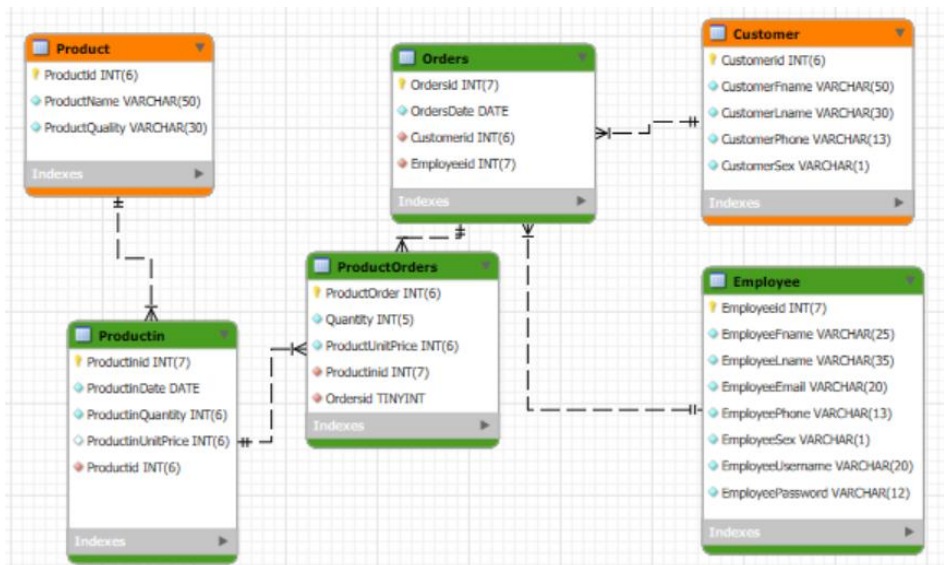


Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As database developer you are asked to go in computer lab to create database and tables by considering the provided physical database schema.



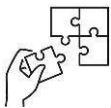
- Step 2:** Demonstrate how to create database and database tables while explaining the procedures.
- Step 3:** Ask trainees to create database and tables and make modifications where required
- Step 4:** Verify whether database and tables are properly created.



Points to Remember

To Create database and tables in MYSQL using XAMPP server

- Use this syntax to Create database: **CREATE DATABASE** database_name;
- Use this syntax to drop database: **DROP DATABASE** database_name
- Apply this syntax to modify table structure, to add Column: **ALTER TABLE** table_name **ADD** column_name datatype, to Modify column datatype and constraint: **ALTER TABLE** table_name **MODIFY COLUMN** datatype and constraint, to Drop column: **ALTER TABLE** table_name **DROP COLUMN** column_name, to Change Column name: **ALTER TABLE** table_name **CHANGE** Current_column_name New_column_Name Datatype and constraint, to Rename table: **ALTER TABLE** Table_Name **RENAME TO** New_Table_Name;
- Use this syntax to Truncate Table: **TRUNCATE TABLE** table_name



Application of learning 3.2.

Physical database schema for a university management system is provided to you. The schema outlines the structure for several tables, including Students, Courses, Enrollments, and Professors, along with their respective columns, data types, keys, and constraints. Your task is to use Data Definition Language (DDL) commands to build and maintain this database.

Initially, you'll need to **CREATE** the tables according to the schema, establishing all necessary relationships through primary and foreign keys. As the system evolves, you might need to **ALTER** existing tables to accommodate new requirements, such as adding a column to track students' graduation status or modifying the data type of the Course Description field to allow more text.

If a specific table, like Enrollments, is no longer needed due to a change in the system's design, you may be required to **DROP** it entirely. Additionally, before migrating data or resetting a table for new data, you might need to **TRUNCATE** tables such as Courses, clearing all records while retaining the table structure for future use.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
DDL Create command is well applied	1.Database is well created		
	2.Tables are correctly created		
	3.Datatype are appropriately used		
	4.Primary key attribute is properly selected		
	5.Foreign key column is properly used		
	6.Constraints are appropriately used		
DROP Command is well applied	7.Unwanted table was properly removed		
ALTER Command is well applied	8.Column datatype and constraint are properly modified		
TRUNCATE Command is well applied	9.Table is truncated		
Decision			



Indicative content 3.3: Apply DML Commands



Duration: 4 hrs



Theoretical Activity 3.3.1: Description of DML commands



Notes to the trainer:

- Trainer may use small groups for describing DDL commands



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer to the following questions:

1. Identify DML INSERT Commands
2. Describe DML UPDATE Commands
3. Elaborate DML DELETE Commands
4. Describe DML CALL Commands
5. Describe DML EXPLAIN CALL Commands
6. Describe DML LOCK Commands

Step 2: Ask trainees to present their answers to the whole classroom.

Step 3: Provide expert view and address any questions or concerns

Step 4: Ask trainees to read the key reading 3.3.1 in the trainee manual, for more clarification.



Points to Remember

- Only command to insert data in database table in SQL is **INSERT** command.
- To modify data from database table in SQL always use **UPDATE** command.
- Use **DELETE** command to delete data from database table in SQL
- Only command to call a stored procedure from database in SQL is **CALL** command.
- To explain call from database you are recommended to use **EXPLAIN CALL** command.
- Use **LOCK** command to lock database table.



Practical Activity 3.3.2: Apply DML Commands



Notes to the trainer

- This activity can be individual based; you are supposed to demonstrate trainees how to manipulate database data in DBMS.
- Consider well created database and database objects.



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

Bright Future University is in the process of implementing a new database system to manage its academic operations, including student enrollment, class assignments, and professor-course allocations. The database structure includes six key tables:

1.Student (StudentID int(10)PK, StudentName varchar(100), StudentEmail varchar(100), StudentPhone varchar(20), StudentBirthDay date)

2.Subject(SubjectID int(7)PK, SubjectName varchar(100))

3.Professor(ProfessorIDint(7)PK,ProfessorNamevarchar(100),ProfessorEmail varchar(100), ProfessorPhone varchar(20))

4.ProfessorSubject(ProfessorSubjectID Int(10), ProfessorID INT(10)FK, SubjectID INT(10)FK)

5.Class (ClassID INT(10)PK, ClassCode varchar(20),BeginDate date, EndDate Date, SubjectID int(7)FK, ProfessorID int(7)Fk)

6.ClassStudent(ClassStudentID int(10)PK, ClassID int(10)FK, StudentID int(10)FK)

which are already created with appropriate relationships and constraints.

As the database designer for this project, your task is to use these existing tables and perform the following tasks:

1. Insert Four Sample Records:

Add four sample records for each of the following tables: Student, Subject, Professor, ProfessorSubject, Class, and ClassStudent. Each record should represent actual student enrollment in courses, professors assigned to subjects, and class schedules.

2. Delete Two Records from the ProfessorSubject Table:

After inserting the sample records, identify and delete two records from the **ProfessorSubject** table, ensuring that the relationships between professors and subjects are maintained in the system.

3. Update Two Records in the Student Table:

Choose two student records from the student table and update specific fields such as StudentEmail or StudentPhone to reflect new information.

Step 2: Demonstrate how to manipulate database data, while demonstrating explain the procedures.

Step 3: Ask trainees to perform task described on step 1 and monitor the procedures.

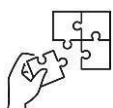
Step 4: Verify whether the tasks are clearly performed.

Step 5: Ask trainees to read key reading 3.3.2 in trainee manual



Points to Remember

- **To insert data in database table use a General Syntax:** INSERT INTO tablename (column1, column2,...columnn)VALUES(value1, value2,...valuen);
- **To update data from database, use a General Syntax:** UPDATE Table_name SET column1 = value1, column2 = value2, columnn = valuen WHERE condition;
- **To delete data from Database, use a General Syntax:** DELETE FROM Table_name WHERE condition;
- **To call a stored procedure from database use a General Syntax:** CALL procedure_name (argument1, argument2, argumentn);
- **To explain call from database, use a General Syntax:** EXPLAIN CALL stored_procedure_name(parameters);
- **To lock database table, use a General Syntax:** LOCK TABLES table_name [AS alias] lock_type [, table_name [AS alias] lock_type] ...;



Application of learning 3.3.

SKY secondary school located at Rusizi District, Murenge Sector, Bungo Village, uses a School management information System to handle its day-to-day operations. The SMS database is already set up, containing multiple tables to manage students, teachers, courses, and enrollments.

As technicians you are asked to manipulate the data in the provided database by performing various operations such as inserting new records, updating existing records, and deleting records as needed.

Database Structure: Below is the simplified structure of the SMIS database:

1. **Students Table** (students):
 - i. student_id (Primary Key, INT)

- ii. first_name (VARCHAR)
 - iii. last_name (VARCHAR)
 - iv. date_of_birth (DATE)
 - v. enrollment_date (DATE)
 - vi. grade_level (INT)
2. **Teachers Table** (teachers):
- i. teacher_id (Primary Key, INT)
 - ii. first_name (VARCHAR)
 - iii. last_name (VARCHAR)
 - iv. subject (VARCHAR)
 - v. hire_date (DATE)
3. **Courses Table** (courses):
- i. course_id (Primary Key, INT)
 - ii. course_name (VARCHAR)
 - iii. teacher_id (Foreign Key, INT)
4. **Enrollments Table** (enrollments):
- i. enrollment_id (Primary Key, INT)
 - ii. student_id (Foreign Key, INT)
 - iii. course_id (Foreign Key, INT)
 - iv. enrollment_date (DATE)

Tasks:

1. Insert New Data:

- A new student, *Emma Watson*, has enrolled in the school. Insert her information into the students table. She was born on *2008-09-15*, enrolled on *2024-09-01*, and is in grade 10.
- A new teacher, *Dr. Sarah Smith*, has been hired to teach *Physics*. Insert her information into the teachers table. Her hire date is *2024-08-20*.

2. Update Existing Data:

- *John Doe* (with student_id = 3) has advanced from grade 9 to grade 10. Update his grade_level in the students table.
- *Mrs. Jane Roberts* (with teacher_id = 5) has been promoted and will now teach *Mathematics* instead of *History*. Update her subject in the teachers table.

3. Delete Data:

- A course with the course_id of 7 (*Art History*) is no longer offered at the school. Remove this course from the courses table.
- A student, *Mark Wilson* (with student_id = 12), has transferred to another school. Delete his record from the student's table.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
INSERT command is well applied	Records are inserted		
UPDATE Command is well applied	Data are updated		
DELETE Command is well applied	Records are deleted		
Decision			



Indicative content 3.4: Apply DQL Commands



Duration: 3 hrs



Theoretical Activity 3.4.1: Description of DQL commands



Notes to the trainer:

- The trainer may use small groups to describe data query language command



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

1. Describe DQL SELECT Command
2. What are SQL aggregation functions and their use?
3. What are SQL clauses used in SQL statement?

Step 2: Ask trainees to present their answers

Step 3: Asks trainees to participate in grouping and agreeing on correct answers.

Step 4: Provide expert view for more clarification.

Step 5: Address any questions or concerns.

Step 6: Ask trainees to read the key reading 3.4.1 in the trainee manual.



Points to Remember

- It is mandatory to use **SELECT** command to retrieve data from SQL database.
- To performs a calculation on a set of values and returns a single value you are recommended to use an aggregate function.
- To Ensure that complex operations are performed correctly, you are recommended to use SQL clauses.



Practical Activity 3.4.2: Applying DQL Commands



Notes to the trainer

- This activity should be individual
- Avail a created database with data



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

Customer table:

Customerid	CustomerFname	CustomerLname	CustomerPhone	CustomerSex
1	Anne	HAWA	567	F
2	John	RWEMA	789	M
3	Regis	MANZI	678	M
4	Charles	RWEMA	780	M
5	Kellia	UWASE	+250783345459	F

Employee table

EmployeeId	EmployeeFname	EmployeeLname	EmployeeEmail	EmployeeSex	EmployeeUserName	EmployeePassword	EmployeePhone
1	Bonaventure	HABIMANA	habventure@gmail.c	M	k89	kl89	409
2	Aime	KEZA	keme@gmail.com	F	F789	Yun	+250788888888

Orders table

OrdersId	OrdersDate	Customerid	Employeeid
1	2014-09-17	4	1
2	2014-09-18	4	2
3	2014-09-19	2	2
4	2014-10-22	3	2
5	2024-10-17	2	1
6	2024-11-12	5	2

Based on the provided data stored in database;

- Display all customers we have in database and arrange their first names ascending
- Display of customers who ordered more than one time
- Generate a displays of Customer whose last name is RWEMA and Last name is John

Step 2: Demonstrate how to select data, while demonstrating explain the procedures.

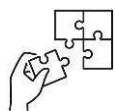
Step 3: Ask trainees to select data according to requested report

Step 4: Verify whether the data are properly selected.



Points to Remember

- To retrieve data from database by select command follow the general syntax: **SELECT** column1, column2..... **FROM** table_name;
- To select all columns of the table always use: **SELECT * FROM** table_name;
- While setting the condition to follow for the data retrieved use **WHERE** clause in syntax as followed: **SELECT** column1, column2..... **FROM** table_name **WHERE** condition;



Application of learning 3.4.

You are working for a Neighboring secondary school that uses a School Management System (SMS) to handle its day-to-day operations. The SMS database is already set up, containing multiple tables to manage students, teachers, courses, and enrollments with information.

Database Structure: Below is the simplified structure of the SMS database:

Notes: The given data are sample; the tables contain more information

Students table

student_id	first_name	last_name	date_of_birth	enrollment_date	grade_level
1	Emma	Watson	2008-01-15	2024-09-01	10
3	John	Doe	2008-09-15	2024-09-01	9
5	Smith	Doe	2007-09-15	2024-09-01	10
12	Mark	Wilson	2009-03-03	2024-09-01	9

Teachers table

teacher_id	first_name	last_name	subject	hire_date
1	Dr. Sarah	Smith	Physics	2024-08-20
5	Mrs. Jane	Roberts	History	2024-08-20
3	Sarah	bovia	Mathematics	2024-08-20

Courses table

course_id	course_name	teacher_id
1	Biology	3
7	Art History	1
4	Mathematics	3
2	Physics	1
3	history	5

Enrolments

enrollment_id	student_id	course_id	enrollment_date
1	1	1	2024-09-07
2	3	1	2024-09-07
3	12	1	2024-09-07
4	3	4	2024-09-08
5	1	4	2024-09-08

As a database developer your task release data depending on the manager needs:

1. display data that shows the information of all students
2. Display students who born in 2008
3. release data shows first name and last name of all students who enrolled in Biology
4. Display the maximum grade_level from students table
5. Display informations of student sort them ascending based on students date_of_birth
6. Display a number of students who enrolled in Mathematics whose grade_level is greater than or equal to 10

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Select command is well applied	Aggregation functions are used		
	Where clause is used		
	Order by clause is used		
	Group by is used		
	Having is used		
	Join is used		
Decision			



Indicative content 3.5: Applying DCL Commands



Duration: 2 hrs



Theoretical Activity 3.4.1: Description of DCL commands



Notes to the trainer:

- The trainer may use small groups group to describe DQL commands



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- Describe DCL GRANT Command
- Describe DCL REVOKE Command

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 3.5.1 in the trainee manual.



Points to Remember

- To grant access to the user of the system use **GRANT** command.
- To remove access to the user of the system use **REVOKE** command.



Practical Activity 3.5.2: Applying DCL Commands



Notes to the trainer

- This activity is individual based
- The trainer may avail a sample database which include tables and data
- Suggest database users and their roles in the database



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

With the provided users and their privileges in the database you are requested to apply DCL commands by:

1. Creating the provided users in the database
2. Granting privileges to the users as provided
3. Revoking access right to the users that are not currently active

Step 2: Demonstrate how to Grant and Revoke user's privileges while demonstrating explain the procedures.

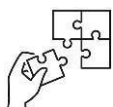
Step 3: Ask trainees to Grant and Revoke user's privileges

Step 4: Verify whether the privileges are properly Granted/Revoked to/from the user.



Points to Remember

- General Syntax for the GRANT command is: GRANT privilege_name
ON object_name
TO {user_name | PUBLIC | role_name}
[WITH GRANT OPTION];
- **General syntax: REVOKE** privilege_name
ON object_name
FROM {user_name | PUBLIC | role_name}



Application of learning 3.5.

STARS secondary school at Muhanga District, Bweramana Sector, Buramba Village uses a School Management System (SMS) to handle its day-to-day operations. The SMS database is already set up, containing multiple tables to manage students, teachers, courses, and enrollments with information. The database is not secured, everyone can access information in database, this may cause the data loss and falsified data. As Technician you are asked to perform the bellow activities in order to avoid those issues:

- ✓ Students record his/her information in students table and enroll in the courses

- ✓ Teacher views the courses he/she has to teach and a list of students enrolled in that courses. She/he can also add a new teacher in the database.
- ✓ Admin adding a new teacher from a teacher user

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Grant command is well applied	1. Administrator is logged in to MySQL		
	2.Users are created		
	3.Users are authenticated		
	4.Privileges are assigned to the users		
Revoke Command is well applied	5.Access right is revoked		
Decision			



Indicative content 3.6: Applying TCL Commands



Duration: 3 hrs



Theoretical Activity 3.4.1: Description of DCL commands



Notes to the trainer:

- The trainer may use small groups to describe TCL commands



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. Describe TCL COMMIT Command
- II. Describe Save Point Command
- III. Describe TCL Roll Back Command
- IV. Describe TCL Set Transaction Command
- V. Describe TCL set constraint Command

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 3.5.1 in the trainee manual.



Points to Remember

- Ensure all operations are validated and correct before using COMMIT to make changes permanent.
- Use SAVEPOINT to create a rollback point within a transaction for better error recovery.
- Apply ROLLBACK to undo changes since the last COMMIT or to a specific SAVEPOINT for maintaining data integrity.
- Define the transaction's isolation level and access mode using SET TRANSACTION to control data consistency and concurrency.
- Utilize SET CONSTRAINTS to defer constraint checks until the end of a transaction for more flexibility in data operations.



Practical Activity 3.6.2: Applying TCL Commands



Notes to the trainer

- This activity is individual
- Avail a database with tables that contain data



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

You manage a retail database with Employees, Orders, and Customers tables. Perform the following tasks using TCL commands to control the transaction flow:

- 1. Insert Records and Commit:**
 - Insert records into Employees with:
(EmpID: 1, Name: 'John Doe', Department: 'HR')
(EmpID: 2, Name: 'Jane Smith', Department: 'Finance')
 - Use COMMIT to save the changes.
- 2. Create Savepoint and Insert:**
 - Insert (OrderID: 101, ProductName: 'Laptop', Quantity: 2) into Orders.
 - Set a SAVEPOINT named savepoint1.
 - Insert another record: (OrderID: 102, ProductName: 'Phone', Quantity: 5).
- 3. Rollback to Savepoint:**
 - Realize the second order insert is incorrect; ROLLBACK TO savepoint1 to undo it.
- 4. Update and Full Rollback:**
 - Update Employees to set Department = 'Marketing' for EmpID = 1.
 - Delete the employee with EmpID = 2.
 - Use ROLLBACK to undo both changes.
- 5. Set Transaction and Query:**
 - Set the transaction to READ ONLY.
 - Retrieve all employees from the HR department.
- 6. Defer Constraints:**
 - Set constraints to DEFERRED.

- ii. Insert (OrderID: 103, CustomerID: 201) into Orders.
- iii. Update Customers to change Customer Name for CustomerID = 201 to 'Michael Johnson'.
- iv. Enforce constraints immediately after the changes.

Step 2: Demonstrate how to Grant and Revoke user's privileges while demonstrating explain the procedures.

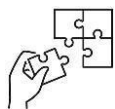
Step 3: Ask trainees to Perform the task provided on step 1

Step 4: Verify whether the privileges are properly Granted/Revoked to/from the user.



Points to Remember

- The general syntax to Permanently save all the changes made during the current transaction in the database. Use **COMMIT**;
- to set a point within a transaction to which you can later roll back. Use **SAVEPOINT** savepoint_name;
- to undo changes made during the current transaction, either fully or up to a SAVEPOINT. Use **ROLLBACK**;
- Rollback to a Specific Savepoint: **ROLLBACK TO SAVEPOINT** savepoint_name;
- to specify the characteristics of the transaction, such as isolation level or read/write access mode. Use **SET TRANSACTION** [READ WRITE | READ **ONLY**] [ISOLATION LEVEL {READ UNCOMMITTED | READ COMMITTED | REPEATABLE READ | SERIALIZABLE}];
Examples: **SET TRANSACTION READ ONLY ISOLATION LEVEL READ COMMITTED**;
- to set the behavior of constraint checking during a transaction. It can be used to defer or enforce constraints. Use **SET CONSTRAINTS** constraint_name [, ...] {IMMEDIATE | DEFERRED};



Application of learning 3.6.

You are tasked with managing a database for a school. The database contains information about students, courses, and grades. You will need to use SQL commands to create the database structure, insert data, update records, query information, and control transactions.

Tasks:

1. Create the Database Structure:

- i. Create a database named "SchoolDB".

- ii. Create a table named "Students" with columns: StudentID, FirstName, LastName, and GradeLevel.
- iii. Create a table named "Courses" with columns: CourseID, CourseName, and Department.
- iv. Create a table named "Grades" with columns: GradeID, StudentID, CourseID, Grade.

2. Insert Data:

- i. Insert 5 student records into the "Students" table.
- ii. Insert 3 course records into the "Courses" table.
- iii. Insert 10 grade records into the "Grades" table, linking students to courses and assigning grades.

3. Query Data:

- i. Find the average grade for a specific course.
- ii. List all students in a particular grade level.
- iii. Retrieve the names of students who have a grade higher than 90 in a specific course.

4. Transaction Management:

- i. Begin a transaction to update multiple records related to a student's information.
- ii. Create a savepoint before updating the student's grade.
- iii. If an error occurs during the update, roll back the transaction to the savepoint.
- iv. If the update is successful, commit the transaction.

5. Query Data:

- i. Find the average grade for a specific course.
- ii. List all students in a particular grade level.
- iii. Retrieve the names of students who have a grade higher than 90 in a specific course.

6. Transaction Management:

- i. Begin a transaction to update multiple records related to a student's information.

- ii. Create a savepoint before updating the student's grade.
- iii. If an error occurs during the update, roll back the transaction to the savepoint.
- iv. If the update is successful, commit the transaction.

7. Data Security:

- i. Grant privileges to a specific user to view and modify student data.
- ii. Revoke privileges from a user who no longer needs access.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Transaction control language commands are applied	1.Statement to begin a transaction is written		
	2.Statements to perform some operations of a transaction are written		
	3.Statement to create a save point is written		
	4.Statements to add operations in a transaction after a saved point are written		
	5.Statement to Roll Back a transaction to the created save point is written		
	6.Statement to COMMIT a transaction is written		
Decision			



Learning outcome 3 end assessment

Written assessment

1) Match the terms in COLUMN A related to their description in COLUMN B

ANSWERS	COLUMN A	COLUMN B
1=J	1. SQL Arithmetic Operators	Used to update an existing table structure, such as adding or modifying columns.
2=A	2. ALTER Table	B. Command to permanently save all changes made during the current transaction.
3=C	3. INSERT	C. Allows you to add new rows to a table.
4=B	4. COMMIT	D. Operator used for bit-level operations, e.g.: &.
5=H	5. SQL Aggregate Function	E. Command used to control access privileges to database objects.
6=E	6. GRANT	F. Keyword used to retrieve data from a database, often with conditions and sorting.
7=I	7. EXPLAIN CALL	G. Command to set a point in a transaction that you can roll back to.
8=F	8. SELECT	H. Function used to perform calculations on a set of values, such as SUM or AVG.
9=G	9. SAVEPOINT	I. Used to describe the details of how a stored procedure is called.
10=D	10. BITWISE AND Operator	J. Performs mathematical operations, like addition or subtraction, on numeric data.

2) Fill-in-the-Blank Questions

- I. The _____ operator is used in SQL for adding two numeric values together.
- II. The _____ command in SQL is used to create a new table in the database.
- III. To revoke previously granted privileges in SQL, the _____ command is used.
- IV. SQL's _____ command is used to insert new records into a table.
- V. The _____ SQL command is used to temporarily set a point to which a transaction can be rolled back.

Answers:

- I. The **+** operator is used in SQL for adding two numeric values together.
- II. The **CREATE TABLE** command in SQL is used to create a new table in the database.
- III. To revoke previously granted privileges in SQL, the **REVOKE** command is used.
- IV. SQL's **INSERT INTO** command is used to insert new records into a table.
- V. The **SAVEPOINT** SQL command is used to temporarily set a point to which a transaction can be rolled back.

3) Chose the correct answers:

I. **What is the correct syntax for creating a new database named "mydb"?**

- a) CREATE DATABASE mydb;
- b) CREATE DATABASE mydb();
- c) DATABASE CREATE mydb;
- d) NEW DATABASE mydb;

Answers: a) CREATE DATABASE mydb;

II. **Which clause is used to specify conditions for selecting rows in a SELECT statement?**

- a) WHERE
- b) FROM
- c) GROUP BY
- d) HAVING

Answers: a) WHERE

III. **What is the correct syntax for inserting a new row into a table named "Customers"?**

- A. INSERT INTO Customers (CustomerID, CustomerName) VALUES (1, 'John Doe')
- B. INSERT Customers (CustomerID, CustomerName) = (1, 'John Doe')
- C. ADD ROW Customers (CustomerID, CustomerName) = (1, 'John Doe')
- D. CREATE ROW Customers (CustomerID, CustomerName) VALUES (1, 'John Doe')

Answers: A. INSERT INTO Customers (CustomerID, CustomerName) VALUES (1, 'John Doe')

IV. **Which SQL aggregate function calculates the average value of a column?**

- A. SUM()
- B. AVG()

C. COUNT()

D. MAX()

Answers: B. AVG()

4) What command is used to delete a database?

Answers: DROP DATABASE database_name;

5) What SQL clause is used to group rows based on a specified column?

Answers: SELECT department, COUNT(*) FROM employees GROUP BY department;

Practical assessment

GS AGAPE is a secondary school that is located in your sector, the school has a large number of students within different options; for that reason, the school needs a comprehensive database to manage students, teachers, courses, and grades because the manual system it uses returns errors in the termly reports and annual reports. Your first task as a database developer is to use DDL commands to create the necessary tables: Students, Teachers, Courses, and Grades, ensuring the correct relationships, are in place. After creating the tables, populate them with sample data using DML commands, including inserting records for students, teachers, and courses, as well as updating and deleting specific entries as needed.

Then, apply DQL commands to retrieve information, such as the list of students enrolled in a specific course or the grades of a particular student in term and at the end of the year. Manage permissions to database by ensuring that only authorized users can view or modify certain data. Lastly, employ TCL commands to handle transactions, ensuring that operations like grade updates are completed successfully and, if any issues arise, the system can roll back to maintain data integrity.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
DDL commands are properly applied	1.Database is well created		
	2.Tables are correctly created		
	3.Datatype are appropriately used		
	4.Primary key attribute is properly selected		

	5.Foreign key column is properly used		
	6.Constraints are appropriately used		
DML commands are properly applied	7.Records are inserted		
	8.Data are updated		
	9.Records are deleted		
DQL commands are properly applied	10.Aggregation functions are used		
	11.Where clause is used		
	12.Order by clause is used		
	13.Group by is used		
	14.Having is used		
	15.Join is used		
DCL commands are properly applied	16. Administrator is logged in to MySQL		
	17.Users are created		
	18.Users are authenticated		
	19.Privileges are assigned to the users		
	20.Access right is revoked		
TCL commands are properly applied	21.Statement to begin a transaction is written		
	22.Statements to perform some operations of a transaction are written		
	23.Statement to create a save point is written		
	24.Statements to add operations in a transaction after a saved point are written		
	25.Statement to Roll Back a transaction to the created save point is written		
	26.Statement to COMMIT a transaction is written		
Decision			

END



Further information to the trainer

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Hector Garcia-Molina, J. U. (2008). Database Systems: The Complete Book. Upper Saddle River, New Jersey, USA: Pearson Prentice Hall.

<https://beginner-sql-tutorial.com/sql-grant-revoke-privileges-roles.htm>

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<https://www.dbvis.com/thetable/sql-ddl-the-definitive-guide-on-data-definition-language/>

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Raghu Ramakrishnan, J. G. (2003). Database Management Systems. Boston, Massachusetts, USA: McGraw-Hill.

Learning Outcome 4: Implement Database security



Indicative contents

4.1 Enforcement of data access control

4.2 Management of Auditing and logging

4.3 Implementation of Data encryption

4.4. Configuration of database backup and restore

Key Competencies for Learning Outcome 4: Implement Database Security

Knowledge	Skills	Attitudes
• Description of database security • Description of data control access • Description of auditing and logging • Description of data encryption • Introduction of data backup and restore	• Implementing data access control • Managing Auditing and logging • Implementing Data encryption • Configuring database backup and restore	• Having accountability skills while enforcing data access control and managing auditing and logging • Having adaptability skills while implementing data encryption • Being Patient while Configuring database backup and restore



Duration: 19 hrs

Learning outcome 4 objectives:



By the end of the learning outcome, the trainees will be able to:

1. Describe properly database security based on database security measures
2. Describe properly data access control based on database security measures
3. Enforce properly access control based on database security measures
4. Manage clearly auditing and logging based on the security policies
5. Implement correctly data encryption based on data security measures
6. Configure regularly Backup and Recovery of data based on DBMS



Resources

Equipment	Tools	Materials
• Computer	• Ms SQL Server • Browsers	• Internet



Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail Computer Lab with installed Ms SQL server and web Browser
- Avail a Physical database schema of any case study



Indicative content 4.1: Enforcement of Data Access Control



Duration: 4hrs



Theoretical Activity 4.1.1: Description of database security



Notes to the trainer:

- Trainer may use groups to describe database security



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I.What do you understand by database security
- II.Explain types of database security

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.1.1 in the trainee manual.



Points to Remember

- Database security is the process, tool and controls that secure and protect databases against accidental and intentional threats.
- To Identify database security types, focus on Physical Security, authentication and Authorization, Data Encryption, auditing, and Backup and Recovery.



Theoretical Activity 4.1.2: Description of data access control



Notes to the trainer:

- Trainer may use small groups to describe data control access



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What is data access control?
- II. Identify data classifications
- III. Differentiate role from permission
- IV. Differentiate authentication from authorisation

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.1.2 in the trainee manual.



Points to Remember

- Indicate the categories of data in the database
- To Identify the terms used in database control access focus on Role, Permission, Authentication, authorization



Practical Activity 4.1.3: Authenticating database by creating database users in SQL Server



Notes to the trainer

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

D&G University is expanding its student information system (SIS) to support more users as part of a digital transformation project. As the university's database developer, you

have been tasked with ensuring robust user management and security for the SQL Server database supporting this system. Your tasks are:

- To **identify the existing user accounts** in the system and audit their current permissions to ensure they align with best practices.
- To **create new logins and users** for additional staff, including the admissions and academic departments, ensuring that each user has appropriate access and **assign server-level and database-level roles** to these users based on their job responsibilities.
- To **configure SQL Server authentication settings and test the authentication system** by logging in with newly created accounts to verify that access control is functioning as expected.

Step 2: Demonstrate how to create accounts and their authentication while explaining the procedures.

Step 3: Ask trainees to create accounts and their authentication

Step 4: Verify whether accounts and their authentication are properly created.



Points to Remember

- Before adding users to the database, check for existing users to avoid errors caused by duplicate usernames in the DBMS.
- A newly created user will use the "new login" feature in SQL Server to access the database.
- Authorize database users by assigning them appropriate "database roles" and "server roles."
- Adjust the configuration manager according to the authentication methods that will be implemented.
- Log in with different credentials to verify the effectiveness of the authentication process.



Practical Activity 4.1.4: Authorizing database users in SQL server



Notes to the trainer

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As the database developer for ABC Corporation, you have been tasked with enhancing the security and authorization controls within the company's SQL Server environment.

Your tasks are:

- To create roles to manage user permissions efficiently. Begin by creating a server-level role named CustomServerRole and assign an appropriate owner.
- Within the Test1 database, create a database role named Test1DBRole to handle specific database-level permissions.
- Once the roles are set up, proceed to assign permissions to ensure proper access control. Grant server-level permissions.

For Test1DBRole,

- Assign database-level permissions including SELECT, INSERT, UPDATE, and DELETE within the Test1 database.
- Assign these roles to users. Link CustomServerRole to a specific login that requires server-level access, and assign Test1DBRole to a user within the Test1 database to ensure they have the necessary permissions to manage data.
- After configuring these roles and permissions, test the authorization by logging in with the respective user credentials. Perform various actions and attempting to create a database to ensure the user permissions are functioning correctly as defined.
- Set up an ongoing process to monitor and maintain these roles and permissions.

Step 2: Demonstrate how to authorise database users while explaining the procedures.

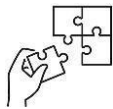
Step 3: Ask trainees to perform the task provided on step1

Step 4: Verify whether users are properly authorised.



Points to Remember

- Formulate a role name that reflects the access rights associated with that role.
- Assign permissions to the created role to define what actions it can perform.
- Assign the roles to the created user(s) to grant them the specified access rights.
- Test authorization by logging in with user credentials and verifying the assigned permissions.



Application of learning 4.1.

Bright Future Academy school located at Musanze District, Kanama Sector Munini Village, manages a large amount of data for students, teachers, courses, grades, and administrative operations in a SQL Server database named **SchoolDB**. To ensure secure access and maintain proper controls over the data, the school need to set up and manage roles, permissions, authentication, and authorization within SQL Server Management Studio (SSMS).as Database administrator you are asked to perform the following tasks in order to secure its database.

Tasks to Perform:

1. **Define Roles and Permissions**
2. **Authenticate database**
3. **Authorize: database users**

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Database is properly Authenticated	1.Authentication method is defined.		
	2.Login credentials are configured.		
	3.Strong password policies are enforced.		
	4.Login auditing is configured		
Database Users are properly authorized	5.Database users and roles are mapped.		
	6.Users are assigned to permissions.		
	7.Least privilege principle is applied.		
	8.Authorization is tested.		
	9.Changes of Transaction are applied to database		



Indicative content 4.2: Management of Auditing and Logging



Duration: 5hrs



Theoretical Activity 4.2.1: Description of database Auditing and logging



Notes to the trainer:

- This activity should be individual
- Avail a secured database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What do understand by database auditing
- II. Explain the use of logging in database

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.2.1 in the trainee manual.



Points to Remember

- Logging in databases records events such as data changes, user activities, and system errors, providing a way to track operations, detect security incidents, and facilitate recovery from failures.



Practical Activity 4.2.2: Managing database logging



Notes to the trainer

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to do the task described below:

XYZ Corporation, a growing financial services company, uses a SQL Server-based Financial Management System (FMS) to handle sensitive data related to clients, transactions, and employee activities. Given the importance of security, data integrity, and performance, the company needs to implement comprehensive logging and monitoring on its SQL Server to track various activities. These logs will be used for audit purposes, performance tuning, and ensuring compliance with industry standards.

As an employee of XYZ corporation you are assigned to manage logging for XYZ Corporation's FMS, you will use SQL Server Management Studio (SSMS) to set up, monitor, and maintain SQL Server logs for security, performance, and error tracking.

Step 2: Demonstrate how to manage logging while explaining the procedures.

Step 3: Ask trainees to manage the logging

Step 4: Verify whether logging is well managed.



Points to Remember

- Determine which events, like DELETE or UPDATE operations and failed logins, need to be logged.
- Set up SQL Server error logs and Extended Events sessions to capture specific activities.
- Use SSMS to view and monitor error logs and Extended Events for tracking logged activities.
- Review logs for patterns of unauthorized activities or failed login attempts using SQL queries.



Practical Activity 4.2.3: Managing database auditing



Notes to the trainer

- This activity should be individual
- Avail a created database with information



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As the Database Administrator at DataSecure Solutions, your role involves configuring and managing auditing for the CompanyDB database using SQL Server Management Studio (SSMS) to ensure security and compliance.

- To begin, you will identify the key events that need to be audited
- Next, configure the audit settings by creating a SQL Server Audit with a designated target.
- Setting up a Server Audit Specification to track server-level events and a Database Audit Specification to monitor specific database-level activities
- Enable the audit and review the audit logs in SSMS to monitor activities and identify any unauthorized access or changes.
- Using the Audit Logs Viewer, analyze the audit data by filtering entries based on user activity, timestamps, and actions performed, paying close attention to any suspicious activities.
- If any unauthorized access or suspicious activity is detected, you will take corrective actions by adjusting user permissions, tightening security settings, or modifying the audit specifications to improve monitoring accuracy.

Step 2: Demonstrate how to manage auditing while explaining the procedures.

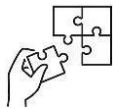
Step 3: Ask trainees to manage database auditing as requested to task 1

Step 4: Verify whether auditing is properly managed.



Points to Remember

- Determine events to be audited, such as login attempts, data modifications, and permission changes.
- Set up SQL Server Audit, Server Audit Specification, and Database Audit Specification for targeted events.
- Enable audit settings and review audit logs in SSMS for monitoring activities.
- Use SSMS to analyse audit logs for user activities and detect any unusual actions.
- Adjust permissions, tighten security, or update audit settings if suspicious activity is found.



Application of learning 4.2.

As the Database Administrator for Bright Future Academy, you are responsible for ensuring the security and compliance of the SchoolDB database, which stores sensitive information such as student records, grades, and personal data. To maintain security and adhere to compliance standards, you will implement logging and auditing mechanisms using SQL Server Management Studio (SSMS).

- First, identify logging requirements, focusing on tracking events and failed login attempts.
- Then, configure logging settings, creating an Extended Events session named SchoolDBActivityLog to capture these activities, ensuring logs are stored securely.
- Regular monitoring of SQL Server error logs and Extended Events logs.
- Set up a process to periodically archive log data for future analysis or audits, and if suspicious activities are detected, you will take corrective action such as adjusting user permissions or reviewing security settings.

On the auditing side,

- Identify key data to be audited and permission or schema changes.
- Using SSMS, configure audit settings by creating a SQL Server Audit with a target destination, link it to a Server Audit Specification to track server-level and set up a Database Audit Specification for auditing SchoolDB-level activities.

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Database Logging is properly performed	1.Logging requirements identified.		
	2.Logging settings configured (error logs, Extended Events session).		
	3.Logs stored in a secure location.		
	4.Regular monitoring of log data performed.		
	5.Log data analysed for failed login attempts or unauthorized actions.		
	6.Log data archived periodically.		
	7.Corrective action taken for suspicious activities.		
Database Auditing is properly performed	8.Data to be audited identified.		
	9.SQL commands executed to configure audit settings.		
	10.SQL Server audit created.		
	11.Server audit specification created.		
	12.Database audit specification created.		



Indicative content 4.3: Implementation of Data Encryption



Duration: 4 hrs



Theoretical Activity 4.3.1: Description of data encryption



Notes to the trainer:

- Trainer may use small groups to describe data Encryption



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What is data encryption
- II. Give and explain data encryption techniques

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.3.1 in the trainee manual.



Points to Remember

- Understand that the conversion of plaintext into ciphertext is known as encryption, which is an essential aspect of database security.
- Recognize that data encryption falls into different categories, including Symmetric Encryption, Asymmetric Encryption, and Hashing.



Practical Activity 4.3.2: Implementing Data Encryption in SQL Server



Notes to the trainer

- This activity should be performed in computer lab and is individual
- Avail a created database with information and users



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the topic and ask trainees to read the task described below:

As the lead database developer at TechSolutions Inc., you are tasked with improving the security of the company's customer and financial data by applying various encryption techniques. The company handles sensitive data, including customer information and financial transactions, and requires strong data protection measures.

- First, you will implement **symmetric encryption** to secure large volumes of data at rest
- Using **AES (Advanced Encryption Standard)**, encrypt the data
- Next, incorporate **asymmetric encryption** for secure communications and key exchange between the company's internal systems and external partners.
- Utilize **RSA encryption** to secure data transmission, allowing external partners to encrypt information using TechSolutions' public key, which can only be decrypted with the private key held securely by the company.
- Finally, implement **hashing** for password storage and data integrity checks.
- Use a secure hashing algorithm like **SHA-256** to hash user passwords before storing them in the database, ensuring that even if the database is compromised, the original passwords remain protected.
- Additionally, apply hashing to verify the integrity of data files, ensuring that any unauthorized changes can be detected.

Step 2: Demonstrate how to encrypt data while explaining the procedures.

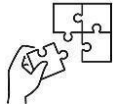
Step 3: Ask trainees to encrypt data as required

Step 4: Verify whether the data are properly encrypted



Points to Remember

- Use SQL Server Management Studio (SSMS) to create a master key, set up a symmetric key, and encrypt a column using the symmetric key.
- Create an asymmetric key in SSMS and use it to encrypt data.
- Create a computed column that utilizes a hashing function to ensure data integrity.
- Backup encryption keys and certificates, review encryption configurations, and regularly rotate keys and certificates to maintain security.



Application of learning 4.3.

As the Database Administrator for "Bright Future Academy," you need to ensure the confidentiality and integrity of sensitive data stored in the **SchoolDB** database. To protect this data from unauthorized access and breaches, you must implement data encryption techniques using SQL Server Management Studio (SSMS).

Your task is to apply encryption methods to safeguard sensitive information within **SchoolDB** and ensure that encryption keys and certificates are managed securely.

Tasks to Perform:

1. **Symmetric Encryption**
2. **Asymmetric Encryption**
3. **Hashing**

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Data encryption is well implemented	Symmetric Encryption		
	1.Symmetric encryption method applied.		
	2.Encryption key created and securely stored.		
	3.Sensitive data encrypted using symmetric encryption.		
	Asymmetric Encryption		
	4.Asymmetric encryption method applied.		
	5.Public and private key pair generated.		
	6.Sensitive data encrypted using asymmetric encryption.		
	Hashing		
	7.Hashing algorithm chosen.		
	8.Sensitive data hashed.		
	9.Hashes verified for integrity checks.		



Indicative content 4.4: Configuration of Database Backup and Restore



Duration: 6 hrs



Theoretical Activity 4.4.1: Description of data backup and restore



Notes to the trainer:

- Trainer may use small groups to describe data backup and restore



Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to answer the following questions:

- I. What is a database backup
- II. What is a database restore?

Step 2: Ask trainees to present their answers

Step 3: Provide expert view for more clarification.

Step 4: Address any questions or concerns.

Step 5: Ask trainees to read the key reading 4.4.1 in the trainee manual.



Points to Remember

- The process of creating and maintaining a copy of the database, its data, and its configuration in different locations is known as **backup**.
- Recognize that the process of retrieving data from a backup and applying it to a database to make it operational again is referred to as **restoring database data**.



Practical Activity 4.4.2: Configuration of Database Backup and Restore



Notes to the trainer

- This activity should be individual
- Avail a created database with information



Key steps:

While **delivering this activity**, pass through the following steps:

Step 1: Introduce the topic and ask trainees to do the task described below:

As the database administrator (DBA) for City General Hospital, you have been tasked with setting up a reliable backup and restore strategy for the SQL Server-based HMS database. The IT Director highlights the importance of ensuring data integrity, particularly due to regulatory compliance requirements, which mandate that medical records be protected against accidental loss and must remain accessible during critical times, such as patient treatment and billing processing.

- Use SQL Server Management Studio (SSMS) to schedule and automate the full, differential, and transaction log backups. Ensure backup job logs are maintained for auditing purposes.
- Set up SQL Server Agent alerts to monitor backup job status and configure notifications for job failures or storage issues.
- Document a comprehensive disaster recovery plan with step-by-step instructions for restoring data, including point-in-time restores and handling backup failures.
- Conduct restore tests quarterly, recording the time required for each restore.

Step 2: Demonstrate how to perform database backup and recovery while explaining the procedures.

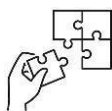
Step 3: Ask trainees to perform database backup and recovery.

Step 4: Verify whether database backup and recovery are properly performed.



Points to Remember

- Establish a recommended backup schedule that includes weekly full backups, daily differential backups, and hourly transaction log backups for databases using the Full recovery model.
- Use SQL Server Management Studio (SSMS) to create full, differential, and transaction log backups.
- Restore databases from full backups, roll back changes using transaction log backups, and perform point-in-time recovery to revert to a specific moment in time.
- Regularly test backups and recovery plans, validate backup integrity, and document procedures to ensure consistent and accurate recovery processes.



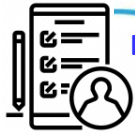
Application of learning 4.4.

the Database Administrator for BrightFuture Academy, you are responsible for setting up a reliable backup and recovery strategy for the SchoolDB database, ensuring that sensitive data, protected with encryption techniques, is regularly backed up and can be restored in the event of data loss or corruption. Your tasks involve:

- Configuring various backup methods
Propose and configure a backup schedule using SQL Server Management Studio (SSMS).
- Perform a full database recovery from a full backup, a rollback recovery to revert unwanted changes using transaction log backups, and a point-in-time recovery to restore the database to a specific time prior to unwanted modifications.
- Test the backup and recovery plan

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Database backup and restore are properly configured	Backup Methods		
	1.Database full back up is created		
	2. Differential backup is configured and performed.		
	3.Incremental (transaction log) backup is set up and performed.		
	Backup Schedule		
	4.Backup schedule is created (weekly full, daily differential, hourly transaction log backups).		
	5.Scheduled tasks for the backup plan in SSMS is configured.		
	Perform Recovery Methods		
	6.Full database recovery is performed		
	7.Rollback recovery using transaction log backups is completed		
	8.Point-in-time recovery performed		
	9.Backup and Recovery Plan is tested		
	10.Restores in a tested environment is performed		
	11.Backup integrity verified using "Verify Backup Integrity" in SSMS.		
	12.Backup and recovery procedures are documented.		
Decision			



Learning outcome 4 end assessment

Theoretical assessment

Question1: Respond True /False to the following statements:

1. **Database security** involves only controlling physical access to the server. (T/F)
2. **Access control policies** define the conditions under which user access is allowed or denied. (T/F)
3. The **authentication system** in SQL Server is only concerned with creating user accounts. (T/F)
4. **Authorization** involves assigning roles to users and granting them specific permissions. (T/F)
5. **Hashing** is used for data encryption in SQL Server to provide confidentiality. (T/F)

Question2: Read carefully the below statements and choose the correct answer based on the provided options (10 Marks)

1. What is the purpose of **data access control** in a database?
 - A. To monitor server performance
 - B. To define roles and permissions
 - C. To provide high availability
 - D. To compress data files
2. Which type of **encryption** uses the same key for both encryption and decryption?
 - A. Symmetric encryption
 - B. Asymmetric encryption
 - C. Hashing
 - D. Data masking
3. What is a **full backup**?
 - A. A backup of only changed data since the last backup
 - B. A complete copy of the entire database
 - C. A backup of log files only
 - D. A backup of user accounts

4. **Auditing** helps in:
- A. Performance tuning of queries
 - B. Tracking and recording database activities
 - C. Creating database schemas
 - D. Encrypting sensitive data
5. What does **logging** in SQL Server involve?
- A. Configuring backup schedules
 - B. Monitoring and analyzing server activities
 - C. Creating user accounts
 - D. Performing database normalization

Question3: Match the Columns (10 Marks)

Match the items in Column A with their appropriate descriptions in Column B.

Answer:	Column A	Column B
1...	1. Symmetric Encryption	A. Uses different keys for encryption and decryption
2...	2. Full Backup	B. Checks data integrity
3...	3. Role-Based Access Control (RBAC)	C. Complete snapshot of the database
4...	4. Auditing	D. Same key for encryption and decryption
5...	5. Point-in-Time Recovery	E. Tracks and logs events
6...	6. Incremental Backup	F. Restores to a specific point in time
7...	7. Hashing	G. Tracks only changes since the last full or incremental backup
8...	8. Authentication	H. Verifying user identities
9...	9. Logging	I. Capturing and storing system events and actions
10...	10. Discretionary Access Control (DAC)	J. Owner of the data decides who gets access

Question4: One-Word Response Questions (10 Marks)

1.is the process of verifying a user's identity in SQL Server called?
2. Which backup type captures all the changes made since the last full back up?
3. What kind of policy allows access based on the discretion of the data owner?
4. Which method is used to ensure data integrity and is irreversible?
5. Which component in SQL Server allows you to monitor server activities and detect unauthorized access?

Answers:

Question 1: True/False

1. False
2. True
3. False
4. True
5. False

Question 2: Multiple Choice

1. B
2. A
3. B
4. B
5. D

Question 3: Matching

1. D
2. C
3. E
4. B
5. F
6. G
7. B
8. H
9. I
10. J

Question 4: One-Word Response

1. Authentication
2. Differential
3. Discretionary
4. Hashing
5. Auditing

Practical assessment

As a newly hired Database Security Administrator for “Secure Fin Solutions”, a medium-sized financial company, your role focuses on setting up and configuring security features for their recently implemented SQL Server database that manages sensitive customer information, transaction records, employee data, and other critical information. Using SQL Server Management Studio (SSMS), you are required to complete various tasks:

- Starting with a security overview and setup by identifying potential vulnerabilities
- Define users roles and assigning permissions
- Establish access control policies based on these roles and classify data as Public, Confidential, or Highly Confidential.
- Create user accounts for the FinanceTeam and SupportTeam, assign roles, and test by logging in as these users to verify permissions, while regularly reviewing authentication logs for unauthorized access. Authorization will involve creating server-level roles such as DatabaseAdmin, assigning permissions at server and database levels, and testing by logging in as a DatabaseAdmin user to ensure proper functionality.
- Configure logging settings to capture events and archive log data regularly.
- Configure auditing by setting up server and database audit specifications to track key activities. Data encryption techniques will be applied.
- Configuration of database backups and test recovery methods

Checklist:

Criteria	Indicators	Observation	
		Yes	No
Database is properly Authenticated	1.Authentication method is defined.		
	2.Login credentials are configured.		
	3.Strong password policies are enforced.		
	4.Login auditing is configured		
Database users are properly Authorised	5.Database users and roles are mapped.		
	6.Users are assigned to permissions.		
	7.Least privilege principle is applied.		
	8.Authorization is tested.		
	9.Changes of Transaction are applied to database		
Database Logging is properly performed	10.Logging requirements identified.		
	11.Logging settings configured (error logs, Extended Events session).		
	12.Logs stored in a secure location.		
	13.Regular monitoring of log data performed.		
	14.Log data analysed for failed login attempts or unauthorized actions.		
	15.Log data archived periodically.		
	16.Corrective action taken for suspicious activities.		
Database Auditing is properly performed	17.Data to be audited identified.		
	18.SQL commands executed to configure audit settings.		
	19.SQL Server audit created.		
	20.Server audit specification created.		
	21.Database audit specification created.		
Data encryption is well implemented	Symmetric Encryption		
	22.Symmetric encryption method applied.		
	22.Encryption key created and securely stored.		
	23.Sensitive data encrypted using symmetric encryption.		
	Asymmetric Encryption		
	24.Asymmetric encryption method applied.		
	25.Public and private key pair generated.		
	26.Sensitive data encrypted using asymmetric encryption.		
	Hashing		

	27.Hashing algorithm chosen.		
	28.Sensitive data hashed.		
	29.Hashes verified for integrity checks.		
Database backup and restore are properly configured	Backup method		
	30.Database full back up is created		
	31. Differential backup is configured and performed.		
	32.Incremental (transaction log) backup is set up and performed.		
	Back up schedule		
	33.Backup schedule is created (weekly full, daily differential, hourly transaction log backups).		
	34.Scheduled tasks for the backup plan in SSMS is configured.		
	Perform recovery methods		
	35.Full database recovery is performed		
	36.Rollback recovery using transaction log backups is completed		
	37.Point-in-time recovery performed		
	38.Backup and Recovery Plan is tested		
	39.Restores in a tested environment is performed		
	40.Backup integrity verified using "Verify Backup Integrity" in SSMS.		
	41.Backup and recovery procedures are documented.		
Decision			



Further information to the trainer

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