CHAPTER 9: DATABASE MANAGEMENT SYSTEM

9.1 Introduction

This unit specifies competencies required to manage database system. They include identification of database management systems, designing of database, Creation and manipulation of database, database testing e.g. using dummy data, implementation of the designed database, establishing transaction and concurrency mechanism and managing database security

9.2 Performance Report

o   Established Database requirements
o   Identified database components
o   Adopted a Suitable database system
o   Performed Database operations
o   Applied Appropriate Data Attributes
o   Extracted data from database using SQL
o   Performed test data and validated the results
o   Identified transaction and concurrency mechanisms
o   Established restrictions to the database

9.3 Learning Outcome

9.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
o   Identify database management system
o   Design database
o   Create and manipulate database
o   Perform database testing
o   Implement designed database
o   Establish transaction and concurrency mechanism
o   Manage database security

9.3.2 Learning Outcome 1: Identify database management system

9.3.2.1 Learning Activities

The following are the performance criteria:
o Database requirements are established based on user needs.
o Main features in databases are identified according to expected output.
o Database components are identified
o Classification and categories of databases is done
o Functionality of databases is identified as per the requirements
o Suitable database system is adopted as per user requirements

Trainees to demonstrate knowledge in relation to:
o Define database management system, components and terminologies
o Classification of databases
o Understand various database management system

9.3.2.2 Information Sheet

A **database management system (DBMS)** is a software package designed to define, manipulate, retrieve and manage data in a database. A DBMS generally manipulates the data itself, the data format, field names, record structure and file structure. It also defines rules to validate and manipulate this data. A DBMS relieves users of framing programs for data maintenance. Fourth-generation query languages, such as SQL, are used along with the DBMS package to interact with a database.

Some other DBMS examples include: MySQL, SQL Server, Oracle, dBASE, FoxPro

Classification based on Data Model: The most popular data model in use today is the relational data model. Well-known DBMSs like Oracle, MS SQL Server, DB2 and MySQL support this model.

- **Centralized database system: the** DBMS and database are stored at a single site that is used by several other systems.
- **Distributed database system**: the actual database and the DBMS software are distributed from various sites that are connected by a computer network
- **Heterogeneous distributed database system:** different sites might use different DBMS software, but there is additional common software to support data exchange between these sites
- **Homogeneous distributed database systems:** use the same DBMS software at multiple sites
- **Multiuser database system:** a database management system, which supports multiple users concurrently
- **Object-oriented data model:** a database management system in which information is

represented in the form of objects as used in object-oriented programming
- **Single-user database system:** a database management system which supports one user at a time
- **Traditional models:** data models that preceded the relational model

Read: Classification of databases: https://opentextbc.ca/dbdesign01/chapter/chapter-6-classification-of-database-systems/

9.3.2.3 Self-Assessment
i.   What is database management?
ii.   Explain database classification?
iii.   What is the difference between centralized and distributed database systems?
iv.   What is the difference between homogenous distributed database systems and heterogeneous distributed database systems?
v.   Provide three examples of the most popular relational databases used.
vi.   DBMS is software.
   - A. True
   - B. False
vii.   DBMS manages the interaction between _____ and database.
   - A. Users
   - B. Clients
   - C. End Users
   - D. Stake Holders
viii.   Database is generally _____
   - A. System-centered
   - B. User-centered
   - C. Company-centered
   - D. Data-centered
ix.   Which of the following is not involved in DBMS?
   - A. End Users
   - B. Data
   - C. Application Request
   - D. HTML
x.   As database administrator how will you explain the primitive operations common to all record management System?

9.3.2.4 Tools, Equipment, Supplies and Materials
MySQL, SQL Server, Oracle, dBASE, computer

9.3.2.5 References
- https://www.techopedia.com/definition/24361/database-management-systems-dbms
- https://opentextbc.ca/dbdesign01/chapter/chapter-6-classification-of-database-systems/

- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 12 edition 2016

9.3.3 Learning Outcome 2: Design database

9.3.3.1 Learning Activities
The following are the performance criteria:
o Appropriate database structures are determined
o Database design is implemented based on requirements.
o Database modeling is done as per the design implemented
o Database operations are performed

Trainees to demonstrate knowledge in relation to:
o Define data abstraction, instances and schemas
o Types of Database structures
o Database operations: INSERT, SELECT, UPDATE, DELETE
o Data models : ER- Models, Relational Models, Hierarchical models, Network Models

9.3.3.2 Information Sheet

Data abstraction is the reduction of a particular body of data to a simplified representation of the whole. Abstraction, in general, is the process of taking away or removing characteristics from something in order to reduce it to a set of essential characteristics.

Instance: The data stored in database at a particular moment of time is called **instance** of database. Database **schema** defines the variable declarations in tables that belong to a particular database; the value of these variables at a moment of time is called the **instance** of that database.

Types of database models
o Hierarchical database model
o Relational model
o Network model
o Object-oriented database model
o Entity-relationship model
o Document model
o Entity-attribute-value model
o Star schema

Read: Database model: https://www.lucidchart.com/pages/database-diagram/database-models

A **database operation** is the vehicle through which users and applications have access to data in relational databases. Each database operation accesses one relational database.
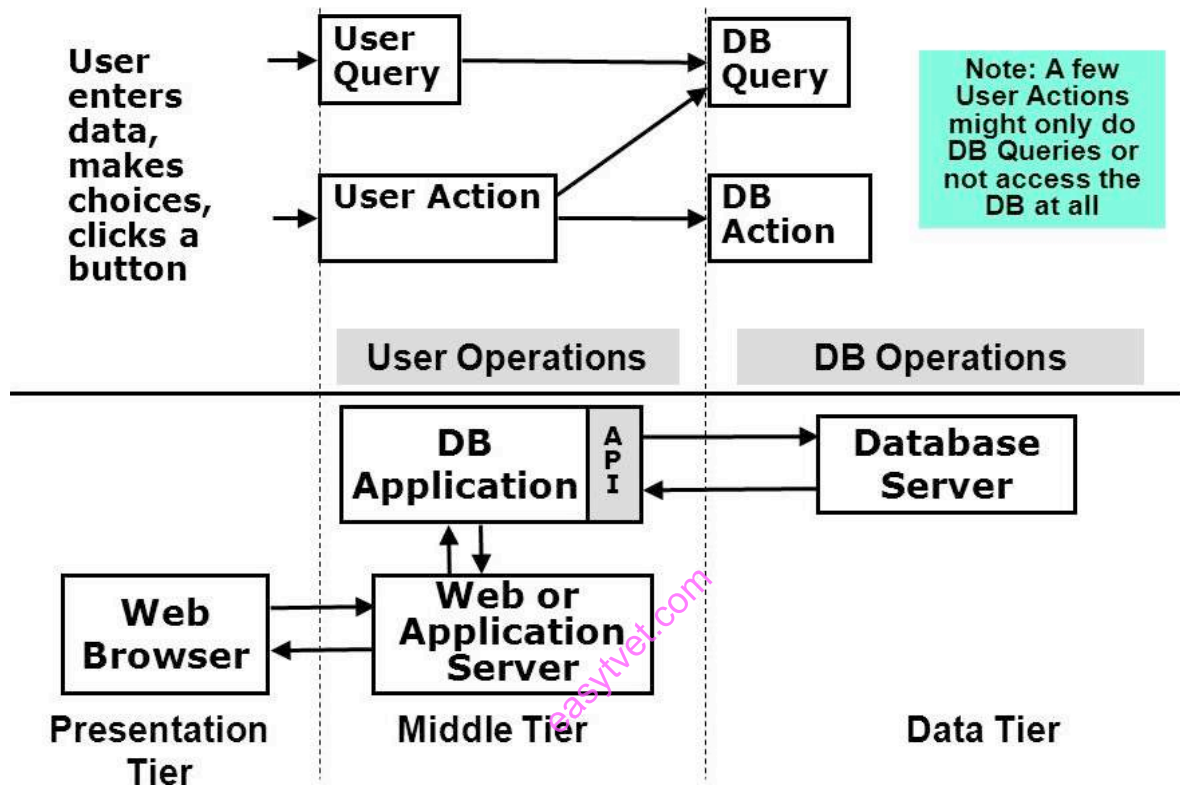
Source: https://slideplayer.com
Figure 74: User database operations

The INSERT INTO statement is used to insert new records in a table:
INSERT INTO table_name (*column1, column2, column3, ...*)
VALUE (*value1, value2, value3, ...*)

The SELECT statement is used to select data from a database:
SELECT (*column1, column 2,...*)
FROM *table_name*

The UPDATE statement is used to modify the existing records in a table:
UPDATE *table_name*
SET *column1= value1, column2 = value2, ...*
WHERE condition;

The DELETE statement is used to delete existing records in a table:
DELETE FROM *table_name* WHERE *condition*;

Watch: MySQL queries: https://youtu.be/XMY6Wt1NREg

Data Models are fundamental entities to introduce abstraction in a DBMS.
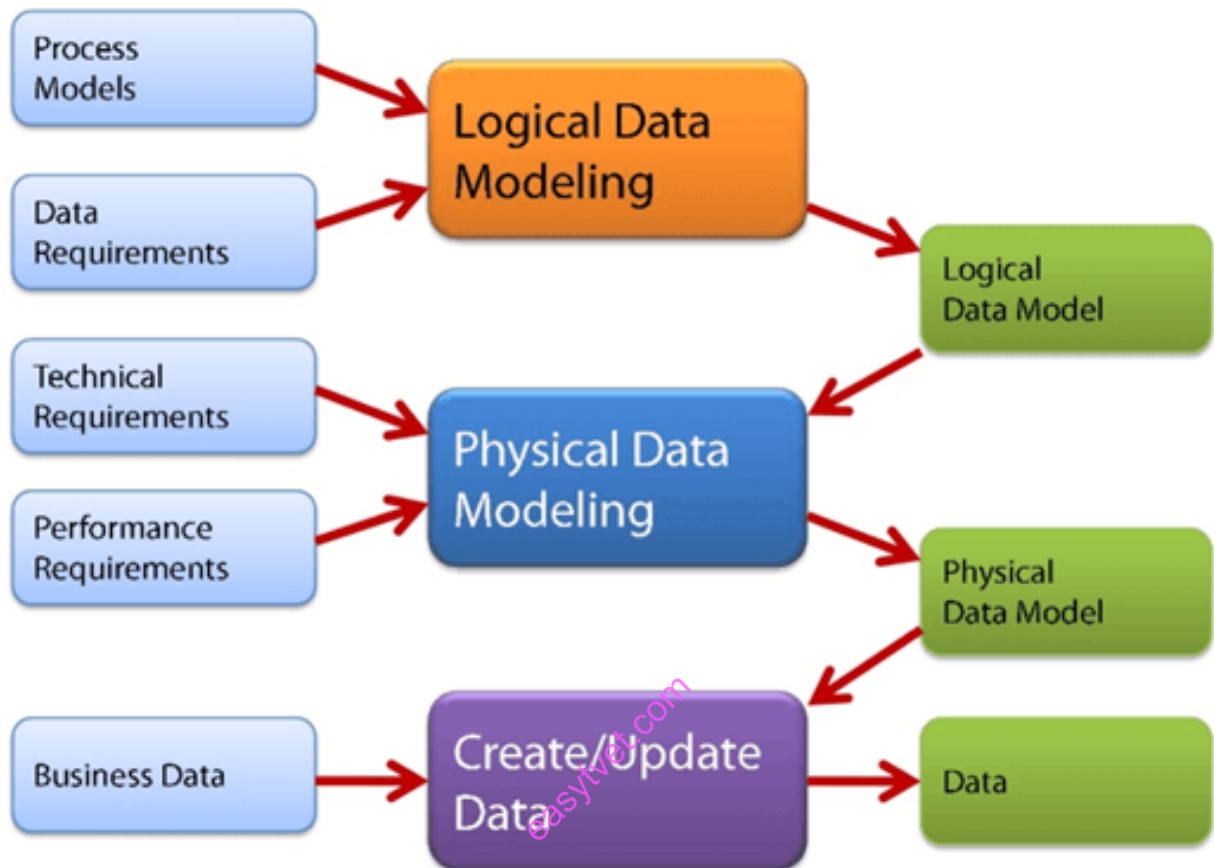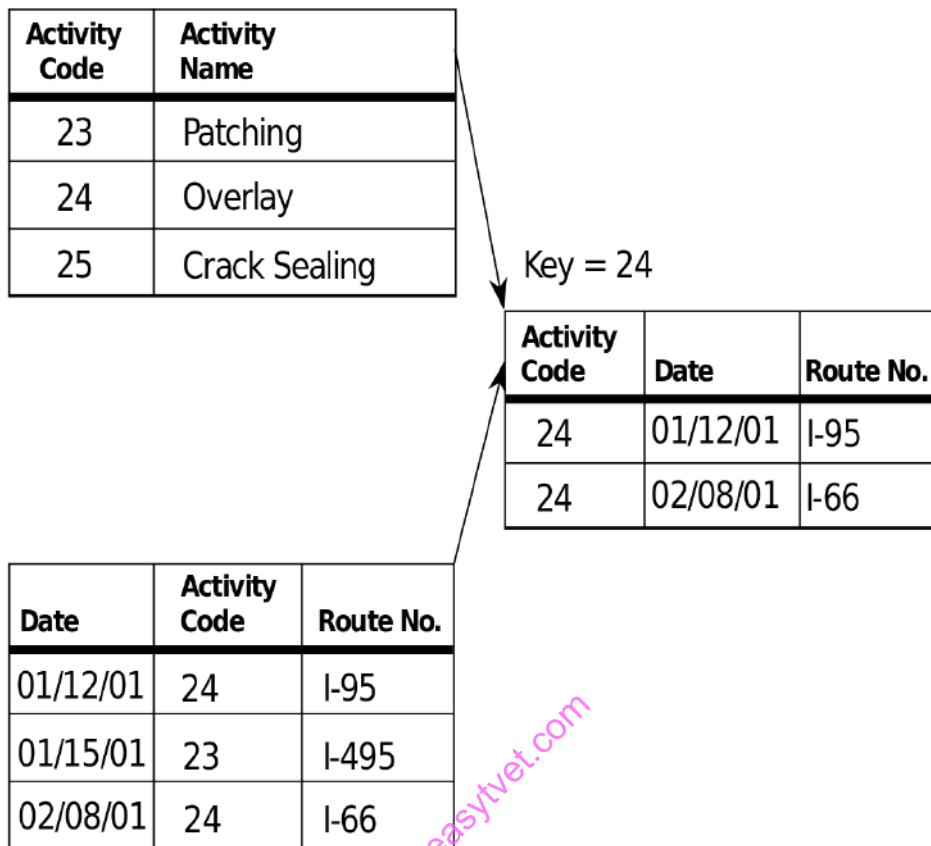
Figure 75: Data Model

An entity–relationship model (or ER model) describes interrelated things of interest in a specific domain of knowledge. A basic **ER model** is composed of entity types (which classify the things of interest) and specifies relationships that can exist between entities (instances of those entity types).
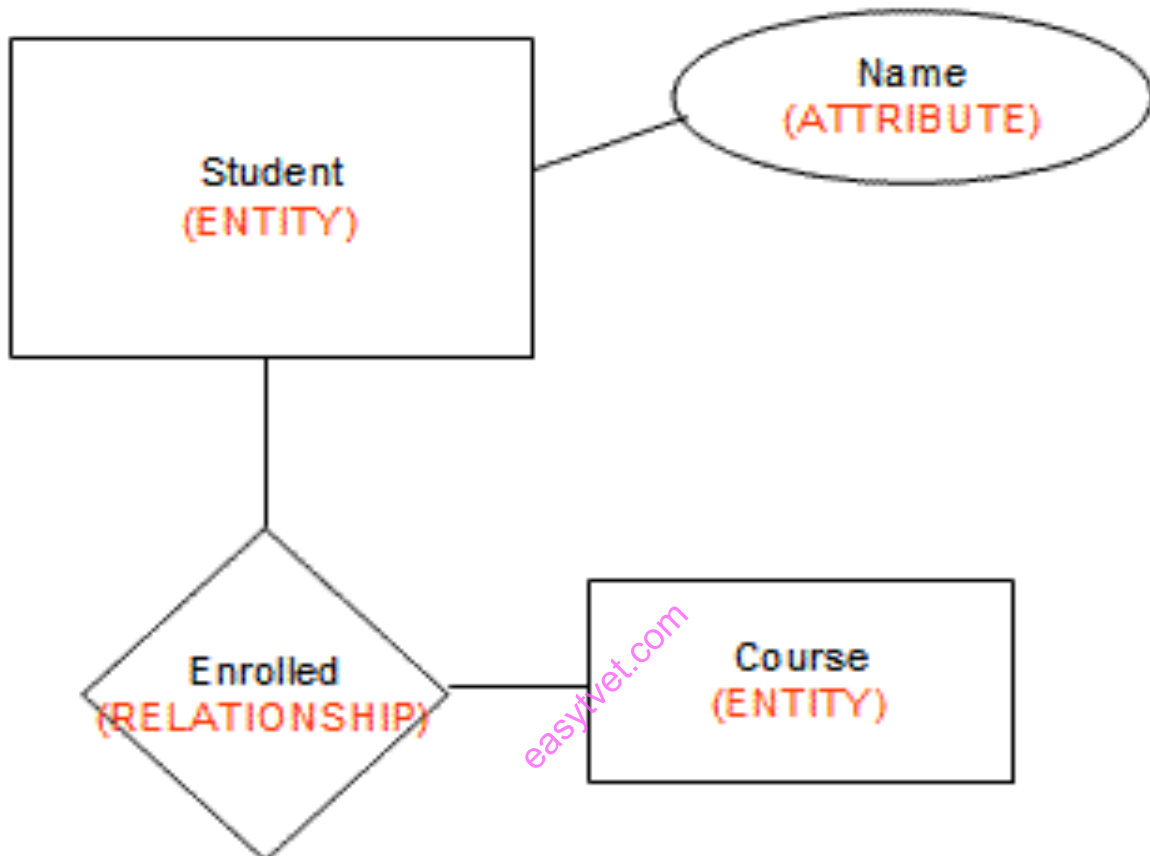
Figure 76: Entity-relationship model

In the relational model, all data must be stored in relations (tables), and each relation consists of rows and columns.

Activity Code	Activity Name
23	Patching
24	Overlay
25	Crack Sealing

Key = 24

Activity Code	Date	Route No.
24	01/12/01	I-95
24	02/08/01	I-66

Date	Activity Code	Route No.
01/12/01	24	I-95
01/15/01	23	I-495
02/08/01	24	I-66

Source: https://en.wikipedia.org
Figure 77: Relation model

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Hierarchical Models (aka Hierarchical Linear Modelsor HLM) are a type of linear regression models in which the observations fall into hierarchical, or completely nested levels. Hierarchical Models are a type of Multilevel Models.
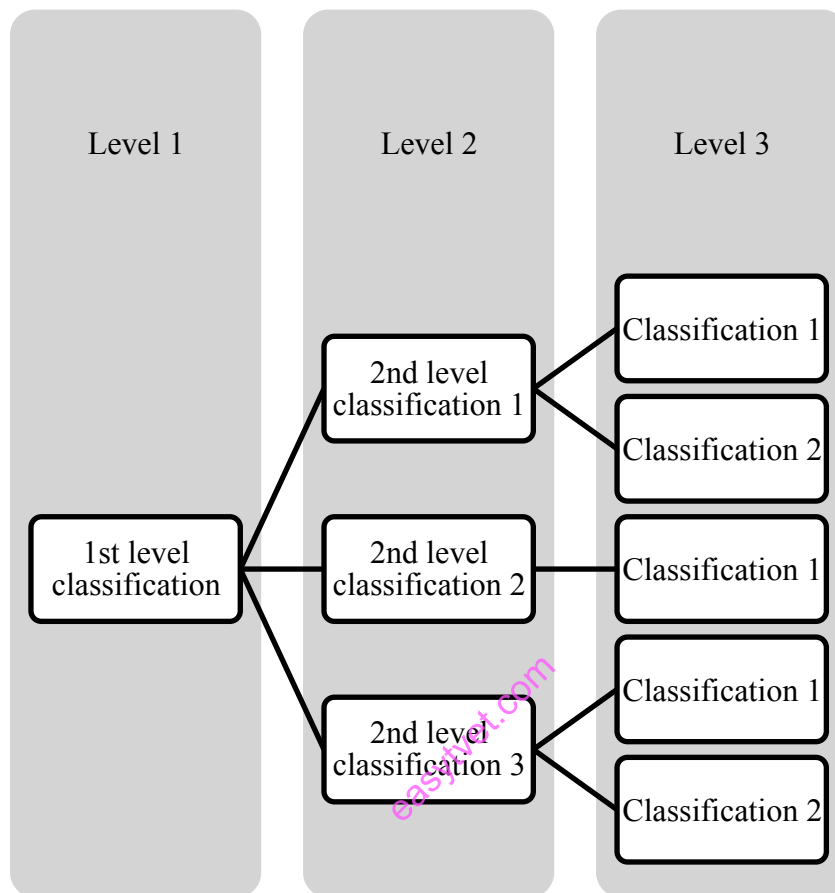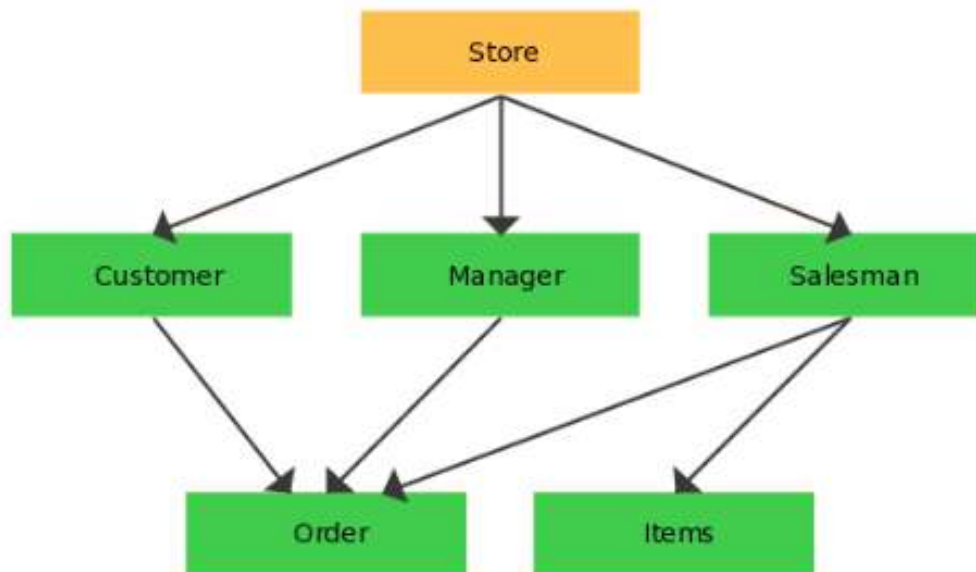

Figure 78: Hierarchical model

A network model is a database model that is designed as a flexible approach to representing objects and their relationships. A unique feature of the network model is its schema, which is viewed as a graph where relationship types are arcs and object types are nodes.

Source: http://www.dbmsinternals.com

Figure 79: Network model

9.3.3.3 Self-Assessment

i.   Write a SQL query to fetch all records FROM table?
ii.   Write a SQL query to create a new table with data and structure copied from another table?
iii.   Who proposed the relational model?
vi.   Define database model.
v.   What is the purpose of SQL?
vi.   What is DBMS used for?
vii.   What is E-R model in the DBMS?
viii. Which SQL function is used to count the number of rows in a SQL query ?
       A. COUNT()
       B. NUMBER()
       C. SUM()
       D. COUNT(*)
ix.   What mode of authentication does SQL Server NOT provide?
       A. Windows-only security
       B. Both SQL Server and Windows-only security
       C. Mixed security
       D. SQL Server only security
x.   If you don't specify ASC or DESC after a SQL ORDER BY clause, the following is used by default

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A. ASC

B. DESC

C. There is no default value

D. None of the mentioned

xi. Which of the following statement is true?

A. DELETE does not free the space containing the table and TRUNCATE free the space containing the table

B. Both DELETE and TRUNCATE free the space containing the table

C. Both DELETE and TRUNCATE does not free the space containing the table

D. DELETE free the space containing the table and TRUNCATE does not free the space containing the table

9.3.3.4 Tools, Equipment, Supplies and Materials

SQL Server Database Modeler, Aqua Data Studio ER Modeler, Computer

9.3.3.5 References

- https://www.w3schools.com/sql/default.asp
- https://www.softwaretestinghelp.com/database-design-tools/
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 12 edition 2016
- SQL QuickStart Guide: The Simplified Beginner's Guide To SQL authored by ClydeBank Technology published by CreateSpace Independent Publishing Platform 2015

9.3.4 Learning Outcome 3: Create and manipulate database

9.3.4.1 Learning Activities

The following are the performance criteria:

o Appropriate data Attributes are applied appropriately

o Data relationships are established as per the tables created

o Model and index of the data is done.

o Data is extracted from database using SQL

Trainees to demonstrate knowledge in relation to:

Creation of tables, Primary and secondary key

Linking of tables, Data variables, Database integration, Database Querying-SQL

9.3.4.2 Information Sheet

Tables can be created using **CREATE TABLE statement** and it actually has the following syntax:

CREATE TABLE [IF NOT EXISTS} `TableName` (`filename` dataType [optional parameters] ENGINE = storage Engine;

One is selected as the **primary key**. Those not selected are known as secondary keys. For example, an employee has an employee number, a National Insurance (NI) number and an email address. If the employee number is chosen as the primary key then the NI number and email address are **secondary keys.**
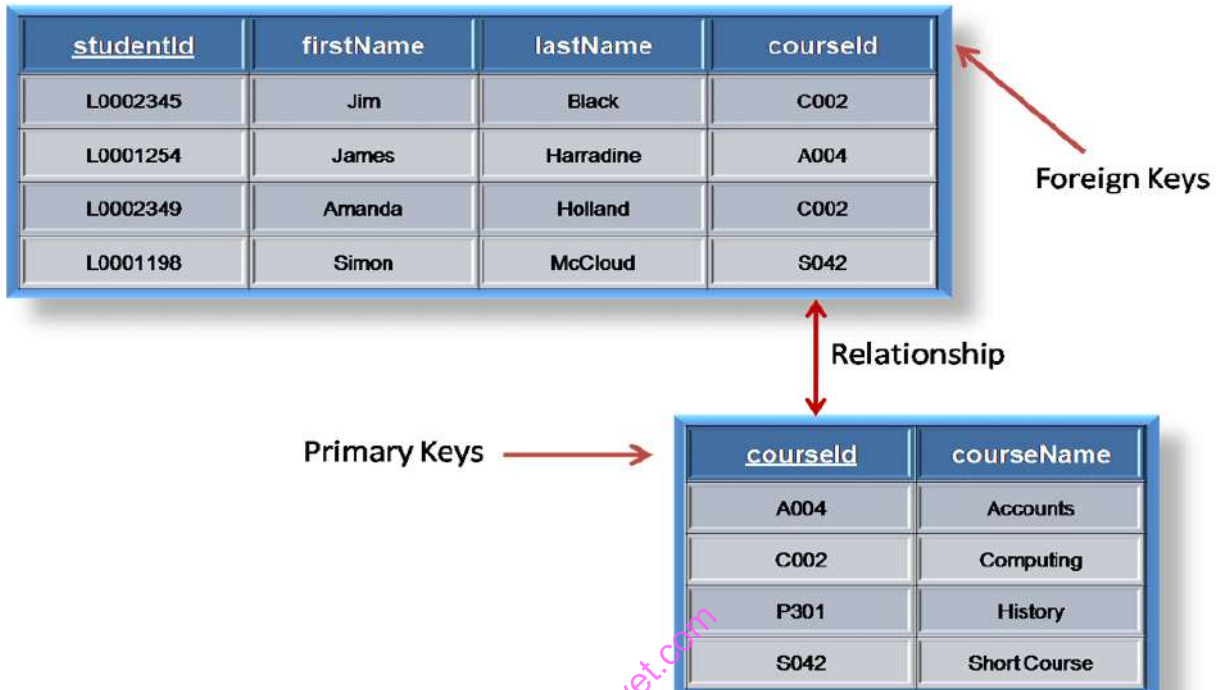
Source: https://www.researchgate.net
Figure 80: Database table

Linking of table is a very common requirement in SQL. Different types of data can be stored in different tables and based on the requirement the tables can be linked to each other and the records can be displayed in a very interactive way.
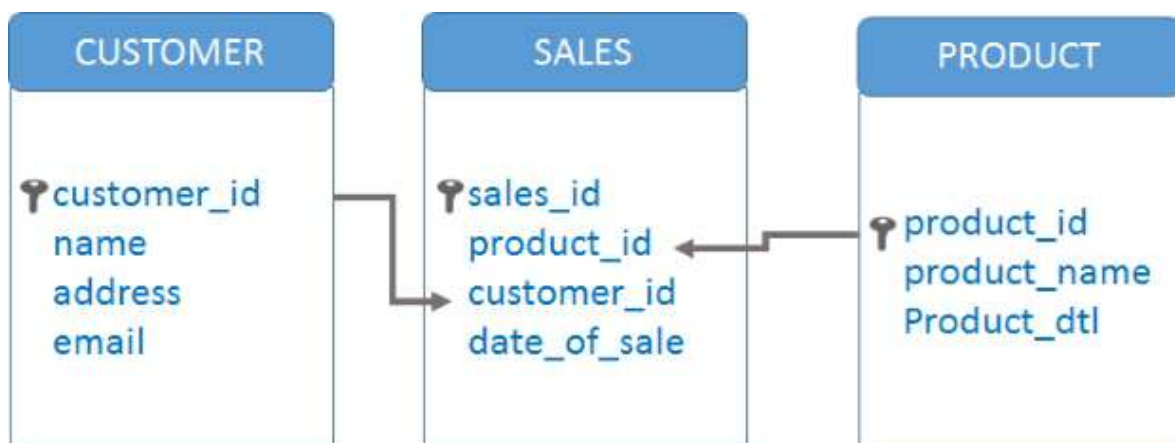

Source: https://www.plus2net.com
Figure 81: Table linkages

A **variable** is any characteristics, number, or quantity that can be measured or counted. A variable may also be called a data item. Age, sex, business income and expenses, country

of birth, capital expenditure, class grades, eye colour and vehicle type are examples of variables.

An **integration database** is a database, which acts as the data store for multiple applications, and thus integrates data across these applications (in contrast to an Application Database). An integration database needs a schema that takes all its client applications into account.
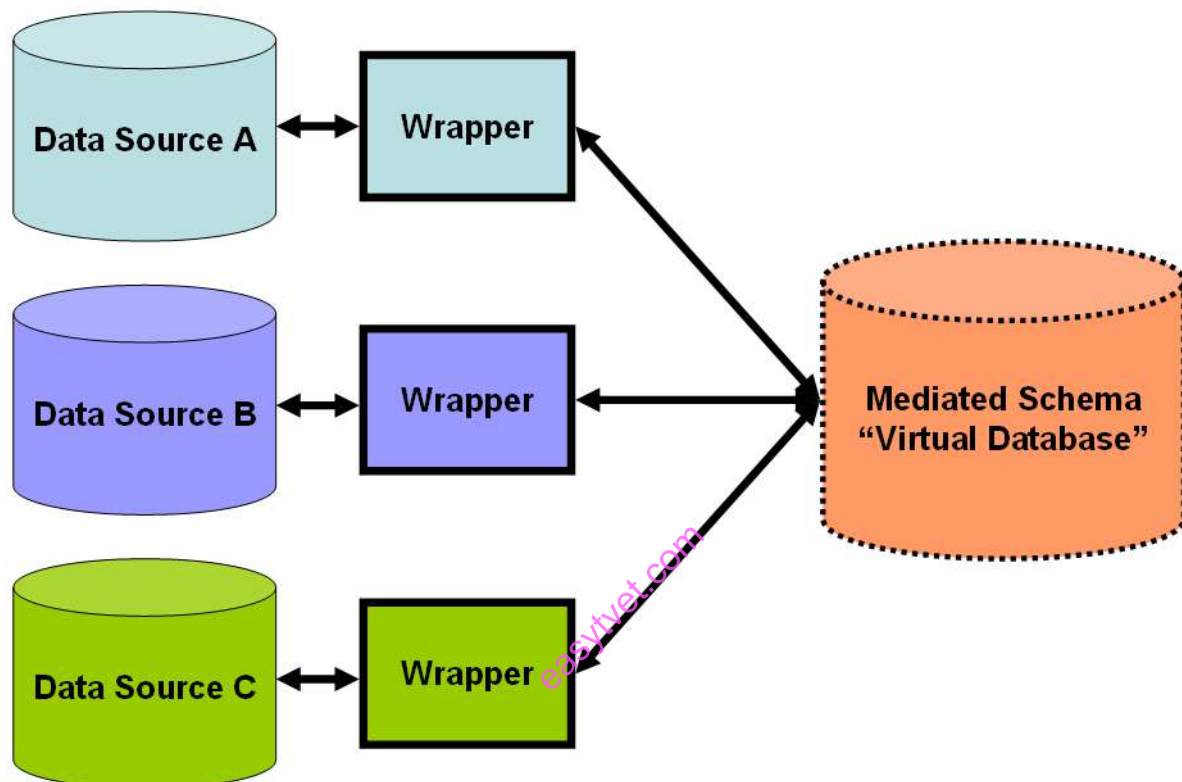
Source: https://en.wikipedia.org/wiki/Data_integration
Figure 82: Integration of database

SQL is a domain-specific language used in programming and designed for managing data held in a relational database management system, or for stream processing in a relational data stream management system.

 Watch: SQL Queries: https://www.coursera.org/lecture/core-database/part-1-sql-query-language-vevDZ

9.3.4.3 Self-Assessment
i. How to create table?
ii. What is table linkage?
iii. Define data variable?
iv. What the difference between primary key and secondary key?
v. What is SQL?
vi. A medical Centre wishes to computerize all its patients' records
   a) Create database for the Centre and save it as your name and personal number.

b) InDesign View, Create a table with the following properties and save it as patient Bio Table.

Field Name	Properties
Patient Name	Text (20)
Sex	Text (1)
Residence	Text (20)
Patient code	Text (4)
Date of visit	Date/Time(short date)
Diagnosis	Text (25)

c) Create a form for patient Bio table and enter the records below, save it as **patient bio form**

Patient Name	Sex	Residence	Patient Code	Date of visit	Diagnosis
Victor sam	M	Kangemi	ADS011	3/8/2018	Septic Wound
Stella mugo	F	Kisumu	ADS025	9/1/2019	Malaria
Mwangi Nema	F	Buru buru	ADS014	23/4/2018	Inflamed joints
Njambi ella	F	Bulenga	ADS034	14/2/2019	Infections in chest
Michael wanyama	M	Naivasha	ADS019	3/2/2019	Malaria

d) InDesign view, create another table with the following properties and save it as patient billing Table.

Field Name	Properties
Patient Code	Text (4), Primary Key
Prescription	Memo
Consult_fee	Number
Treat_fee	Number
Medical bill	Number

Medical is a calculated field which is Consult_fee+ Treat_fee

e) Populate the Patient Billing Table with the following Data;

Patient Code	Prescription	Consult_fee	Treat_fee	Medical bill
ADS011	Coartem	17,000	28,000	
ADS025	Tetanous	17,000	20,000	
ADS014	Ciproflaxin tabs, PPF	17,000	25,000	
ADS034	Chloroquine Infection	17,000	17,000	
ADS019	Referref	17,000	8,000	

f) Create a one-to-one relationship between the Patient Bio Table and the Patient Billing Table.

g) Create a query which extract from patient bio table only those patients who were not diagnosed with malaria. Save it as anti-malaria.

h) i.) Create a report showing Name, Residence, Prescription and Medical Bill. Save it as clinic report.

ii.) Include a report footer of your name and personal number.

iii.) Print all your work.

vii. A logical schema is -

A. Is the entire database

B. Describe data in terms of relational tables and columns, object-oriented classes, and XML tags

C. Describes how data is actually stored on disk.

D. Both (A) and (C)

vii. The database environment has all of the following components except:

A. Users.

B. Separate files

C. Database.

D. Database administrator

viii. The way a particular application views the data from the database that the application uses is a

A. Module.

B. Relational model.

C. Schema.

D. Sub schema.

ix. Which is the subset of SQL commands to manipulate Oracle Database structures, including tables,

A. Data Definition Language (DDL)

B. Data Manipulation Language (DML)

C. Both of above

D. None

9.3.4.4 Tools, Equipment, Supplies and Materials
MySQL, Computer

9.3.4.5 References
- https://www.guru99.com/how-to-create-a-database.html
- https://www.plus2net.com/sql_tutorial/sql_linking_table.php
- https://www.coursera.org/lecture/core-database/part-1-sql-query-language-vevDZ
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 12 edition 2016
- SQL QuickStart Guide: The Simplified Beginner's Guide To SQL authored by ClydeBank Technology published by CreateSpace Independent Publishing Platform 2015

9.3.5 Learning Outcome 4: Perform database testing

9.3.5.1 Learning Activities
The following are the performance criteria:
o Test data is prepared according to the database design
o Run the test data based on the expected output
o Check the test results based on the clients needs
o Validate the results
o Report the findings

Trainees to demonstrate knowledge in relation to:
o Integration testing, DB Query testing, Database test techniques
o Schema testing, Stored procedure, Trigger, Stress, Views, Benchmarking etc.
o Perform database testing, Generate test report

9.3.5.2 Information Sheet

Integration testing is a level of software testing where individual units are combined and tested as a group. The purpose of this level of testing is to expose faults in the interaction between integrated units. Test drivers and tests tubs are used to assist in Integration Testing.

Database Testing is checking the schema, tables, triggers, etc. of the database under test. It may involve creating complex queries to load/stress test the database and check its responsiveness it. It also checks data integrity and consistency.

Database Schema Testing: As mentioned earlier, it involves testing each object in the Schema.

Verifying Databases and devices:
o Verifying the name of database
o Verifying the data device, log device and dump device
o Verifying if enough space allocated for each database
o Verifying database option setting

Stored Procedure Tests
It involves checking whether a stored procedure is defined and the output results are compared. In a Stored Procedure test, the following points are checked:
o Stored procedure name
o Parameter names, parameter types, etc.
o Output − whether the output contains many records. Zero rows are affected or only a few records are extracted.
o What is the function of Stored Procedure and what a stored procedure is not supposed to do?
o Passing sample input queries to check if a stored procedure extracts correct data.

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- Stored Procedure Parameters: Call stored procedure with boundary data and with valid data. Make each parameter invalid once and run a procedure.
- Return values: Check the values that are returned by stored procedure. In case of a failure, nonzero must be returned.
- Error messages check: Make changes in such a way that the stored procedure fails and generate every error message at least once. Check any exception scenarios when there is no predefined error message.

In a Trigger test, the tester must perform the following tasks −
- Make sure the trigger name is correct.
- Validate the trigger if it is generated for a specific table column.
- Trigger's update validation.
- Update a record with a valid data.
- Update a record with invalid data and cover every trigger error.
- Update a record when it is still referenced by a row in other table.
- Ensure rolling back transactions when a failure occurs.
- Find out any cases in which a trigger is not supposed to roll back transactions.

Stress Testing involves getting a list of major database functions and corresponding stored procedures. Follow the steps given below for Stress Testing:
- Write test scripts to try those functions and every function must be checked at least once in a full cycle.
- Perform the test scripts again and again for a specific time period.
- Verifying the log files to check any deadlocks, failure out of memory, data corruption, etc.

Benchmark Testing

If your database does not have any data problems or bugs, system performance can be checked. A poor system performance can be found in benchmark testing by checking the parameters given below:
- System level performance
- Identify most-likely-used functions/features
- Timing – maximum time, minimum time and average time to perform functions
- Access volume

Database tests are typically a three-step process:
- Setup the test. You need to put your database into a known state before running tests against it.
- Run the test. Using a database regression-testing tool, run your database tests just like you would run your application tests.
- Check the results.

9.3.5.3 Self-Assessment

i. What is database testing?

ii. Differentiate trigger testing and stress testing?

iii. When you are testing database, what do you need to check normally as an IT technician?

iv. How would you know for database testing, whether trigger is fired or not?

v. While testing stored procedures what are the steps does a tester takes?

vi. _____ involves getting a list of major database functions and corresponding stored procedures.

    A. Benchmark Testing

    B. Stress Testing

    C. Trigger test

    D. None

vii. Trigger testing which tasks tester must perform?

    A. Make sure the trigger name is correct.

    B. Validate the trigger if it is generated for a specific table column.

    C. Trigger's update validation.

    D. Update a record with a valid data.

    E. Both of above

    F. None of above

viii. _____ is checking the schema, tables, triggers.

    A. Database Testing

    B. Database Schema Testing

    C. Benchmark Testing

    D. None of above

9.3.5.4 Tools, Equipment, Supplies and Materials

LINQ, SP Test tool

9.3.5.5 References

- https://www.guru99.com/data-testing.html
- https://www.tutorialspoint.com/database_testing/database_testing_techniques.htm
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 12 edition 2016

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9.3.6 Learning Outcome 5: Implement designed database

9.3.6.1 Learning Activities
The following are the performance criteria:
o Scope is defined as per the design
o Organize database project according to time frame
o Select database management system products
o Develop initial implementation plan and schedule
o Design the database
o Install and test database
o Develop detailed conversion plan
o Convert existing applications
o Fine tune the database
o Perform training
o Periodically review database performance

Trainees to demonstrate knowledge in relation to:
o Run the designed database
o Test the design and database functionality

9.3.6.2 Information Sheet
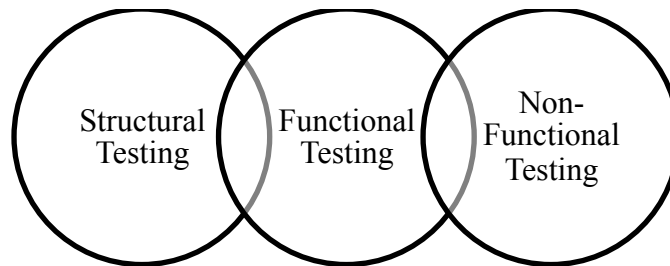
The design process:
The design process consists of the following steps:
o Determine the purpose of your database

This helps prepare you for the remaining steps.
o **Find and organize the information required:** Gather all of the types of information you might want to record in the database, such as product name and order number.
o **Divide the information into tables:** Divide your information items into major entities or subjects, such as Products or Orders. Each subject then becomes a table.
o **Turn information items into columns:** Decide what information you want to store in each table. Each item becomes a field, and is displayed as a column in the table. For example, an Employees table might include fields such as Last Name and Hire Date.
o **Specify primary keys:** Choose each table's primary key. The primary key is a column that is used to uniquely identify each row. An example might be Product ID or Order ID.
o **Set up the table relationships:** Look at each table and decide how the data in one table is related to the data in other tables. Add fields to tables or create new tables to clarify the relationships, as necessary.
o **Refine your design:** Analyze your design for errors. Create the tables and add a few records of sample data. See if you can get the results you want from your tables. Make adjustments to the design, as needed.
o **Apply the normalization rules:** Apply the data normalization rules to see if your tables are structured correctly. Make adjustments to the tables, as needed.

Database Testing is checking the schema, tables, triggers, etc. of the database under test. It may involve creating complex queries to load/stress test the database and check its responsiveness. It checks data integrity and consistency.

Source: www.guru99.com
Figure 83: Types of database testing

9.3.6.3 Self-Assessment

i.   What is database testing?

ii.   Explain design process of database?

iii.   _____ choose each table's primary key. The primary key is a column that is used to uniquely identify each row. An example might be Product ID or Order ID.
   A. Refine your design
   B. Specify primary keys
   C. The design process
   D. None of Above
   E. Both of above

iv.   Analyze your design for errors. Create the tables and add a few records of sample data. See if you can get the results you want from your tables. Make adjustments to the design, as needed.
   A. Refine your design
   B. The design process
   C. None of above
   D. Both A and B
   E. Apply the normalization rules

v.   An enterprise data model is a relational model that shows the high-level entities for the organization and associations among those entities.
   A. True
   B. False

vi.   Term that is considered as a basis for most robust authentication schemes, is said to be
   A. Identification
   B. Registration
   C. Encryption
   D. Refine information

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9.3.6.4 Tools, Equipment, Supplies and Materials
Computer, Data Factory, MockupData, SQL Server

9.3.6.5 References
- https://support.office.com/en-us/article/database-design-basics-eb2159cf-1e30-401a-8084-bd4f9c9ca1f5
- https://www.guru99.com/data-testing.html
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 2016

9.3.7 Learning Outcome 6: Establish transaction and concurrency mechanism

9.3.7.1 Learning Activities
The following are the performance criteria:
- Transaction mechanisms used in database management system are identified
- Management of multiple transactions in database management system are identified

Trainees to demonstrate knowledge in relation to:
- Transaction mechanisms
- Concurrency mechanisms
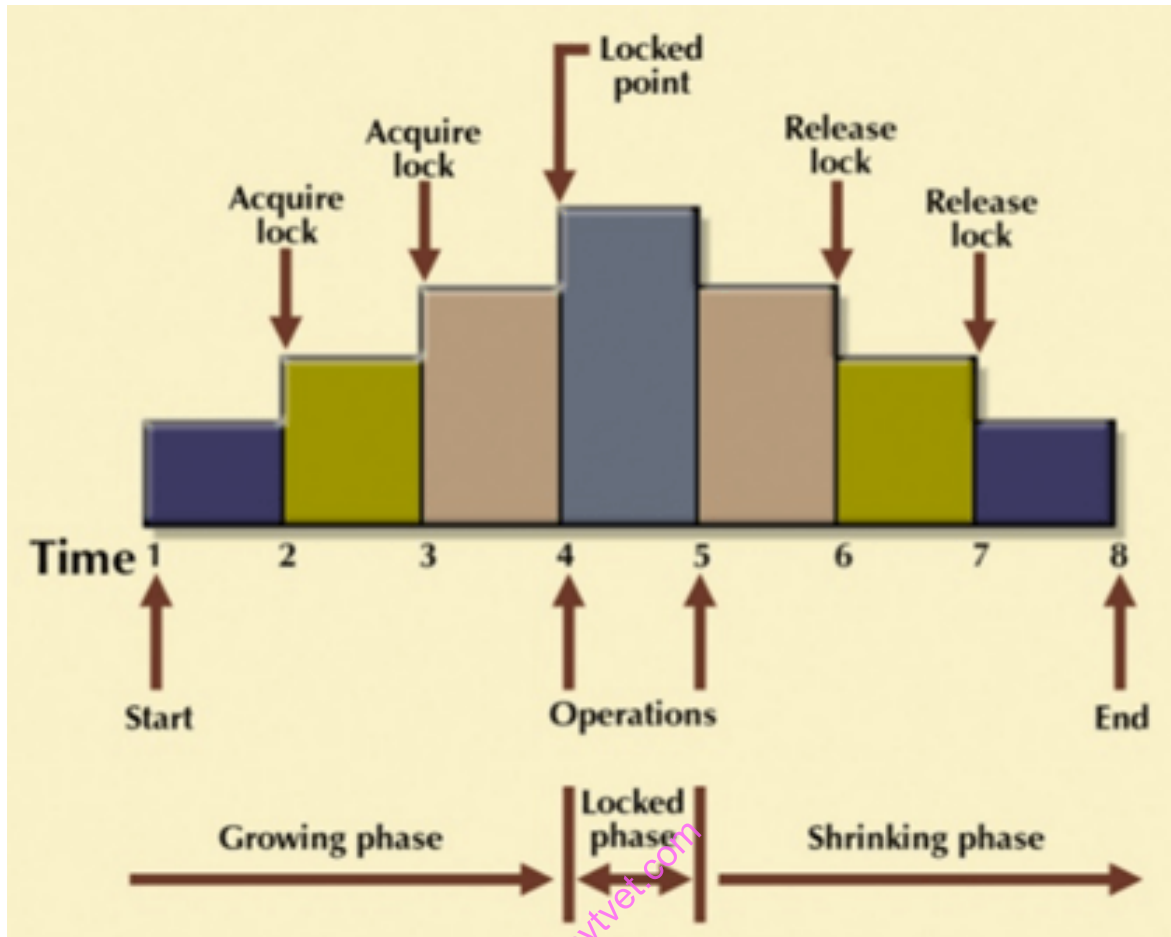- Management of multiple transactions

9.3.7.2 Information Sheet
Transaction mechanisms occur if the transaction does not complete successfully, a ROLLBACK statement returns the data to the state it was in prior to the beginning of the transaction. If the transaction completes successfully, a COMMIT statement permanently stores the data in the database.

Due to the nature of SQL and relational database architecture, where each update can act on only one table at a time and where there are no trailers in the usual sense, two update statements must be executed simultaneously. Both update statements must either succeed and COMMIT or fail and ROLLBACK.

In a transaction a group of updates must either COMMIT or ROLLBACK together. First a transaction is declared, and then either the COMMIT or the ROLLBACK SQL statement is issued for all the statements that have been issued since the transaction declaration.

Concurrency mechanism ensures that database transactions are performed concurrently without violating the data integrity of the respective databases. Thus concurrency control is an essential element for correctness in any system where two database transactions or more, executed with time overlap, can access the same data.

Source: www.guru99.com
Figure 84: Concurrency mechanism

Managing Multiple Transactions. Transaction management is used to maintain the integrity of a data source when operations on one or more data sources need to be treated as a single operation. The most common example of transaction management comes from banking.
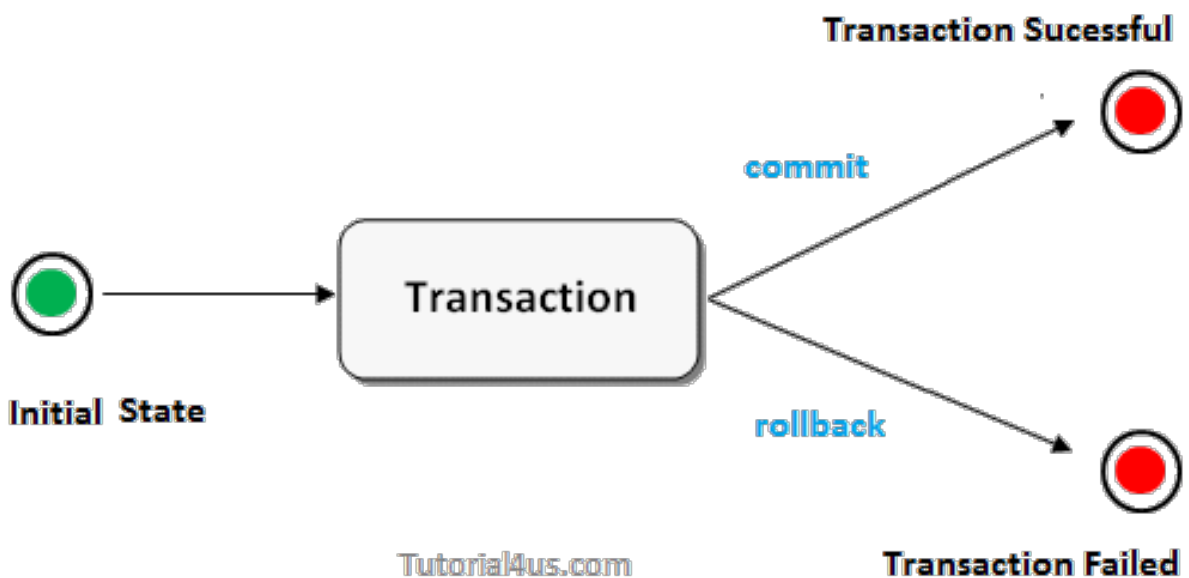
Source: Tutorials4us.com
Figure 85: Transaction management

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9.3.7.3 Self-Assessment

i.   What is transaction mechanism?

ii. Differentiate between transaction mechanism and concurrency mechanism?

iii. What is managing multiple transactions?

iv. Any non-serial interleaving of T1 and T2 for concurrent execution leads to
  A. A serializable schedule
  B. A schedule that is not conflict serializable
  C. A conflict serializable schedule
  D. A schedule for which a precedence graph cannot be drawn

v.   Which of the following locks the item from change but not from read?
  A. Implicit lock
  B. Explicit lock
  C. Exclusive lock
  D. Shared lock

vi. A transaction in which either all of the database actions occur or none of them do is called:
  A. Atomic
  B. Consistent
  C. Isolated
  D. Durable

vii. Which of the following occurs when one transaction reads a changed record that has not been committed to the database?
  A. No repeatable read
  B. Phantom read
  C. Dirty read
  D. Consistent read

9.3.7.4 Tools, Equipment, Supplies and Materials

Computer, MySQL

9.3.7.5 References

- http://ftp.magicsoftware.com/www/help/uniPaaS/mergedprojects/MGHELPW/Data_Management/SQL_Considerations/Transaction_Mechanism.htm
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 2016

9.3.8 Learning Outcome 7: Manage database security

9.3.8.1 Learning Activities
The following are the performance criteria:
o Restriction of access to the database is established
o Backup and recovery methods are identified and implemented.

Trainees to demonstrate knowledge in relation to:
o Restriction of access as per Internal policy
o Types of restrictions
o Backup and recovery methods

9.3.8.2 Information Sheet
Database security is generally planned, implemented and maintained by a database administrator and or other information security professional.

Some of the ways database security is analyzed and implemented include:
o Restricting unauthorized access and use by implementing strong and multifactor access and data management controls
o Load/stress testing and capacity testing of a database to ensure it does not crash in a distributed denial of service (DDoS) attack or user overload
o Physical security of the database server and backup equipment from theft and natural disasters
o Reviewing existing system for any known or unknown vulnerabilities and defining and implementing a road map/plan to mitigate them

Backing up and restoring data is one of the most important responsibilities of IT professionals

Following are the main types of backups:
o **Normal or Full Backups:** When a normal or full backup runs on a selected drive, all the files on that drive are backed up. This, of course, includes system files, application files, user data — everything. Those files are then copied to the selected destination (backup tapes, a secondary drive or the cloud), and all the archive bits are then cleared.
o **Incremental Backups:** A common way to deal with the long running times required for full backups is to run them only on weekends. Many businesses then run incremental backups throughout the week since they take far less time. An incremental backup will grab only the files that have been updated since the last normal backup. Once the incremental backup has run, that file will not be backed up again unless it changes or during the next full backup.
o **Differential Backups:** An alternative to incremental database backups that has a less complicated restore process is a differential backup. Differential backups and recovery are similar to incremental in that these backups grab only files that have been updated since the last normal backup. However, differential backups do not clear the archive bit.

So a file that is updated after a normal backup will be archived every time a differential backup is run until the next normal backup runs and clears the archive bit.

Read: Database backup:
https://www.solarwindsmsp.com/content/types-of-database-backups

Watch: How to backup database using MySQL: https://youtu.be/mr8Lpkx5yag

Database design Methodology
Designing of database is most important responsibility of the software professionals who are dealing with the database related projects. For this they follow the Design Methodology. It helps the designer to plan, manage, control, and evaluate database development projects.

Design methodology: A structured approach that uses procedures, techniques, tools, and documentation aids to support and facilitate the process of design. A design methodology consists of phases each containing a number of steps, which guide the designer in the techniques appropriate at each stage of the project.

Phases of Design Methodology
The database design methodology is divided into three main phases. These are:
• Conceptual database design
• Logical database design

Conceptual database design: The process of constructing a model of the information used in an enterprise, independent of all physical considerations. The conceptual database design phase begins with the creation of a conceptual data model of the enterprise, which is entirely independent of implementation details such as the target DBMS, application programs, programming languages, hardware platform, performance issues, or any other physical considerations.

Logical database design: It is a process of constructing a model of the information used in an enterprise based on specific data model, but independent of a particular DBMS and other physical considerations. The logical database design phase maps the conceptual model on to a logical model, which is influenced by the data model for the target database (for example, the relational model). The logical data model is a source of information for the physical design phase. The output of this process is a global logical data model consisting of an Entity-Relationship diagram, relational schema, and supporting documentation that describes this model, such as a data dictionary. Together, these represent the sources of information for the physical design process, and they provide the physical database designer with a vehicle for making tradeoffs that are so important to an efficient database design.

Physical database design

It is a description of the implementation of the database on secondary storage; it describes the base relations, file organizations, and indexes used to achieve efficient access to the data, and any associated integrity constraints and security measures.

Whereas logical database design is concerned with the what, physical database design is concerned with the how. The physical database design phase allows the designer to make decisions on how the database is to be implemented. Therefore, physical design is tailored to a specific DBMS. There is feedback between physical and logical design, because decisions taken during physical design for improving performance may affect the logical data model.

For example, decisions taken during physical for improving performance, such as merging relations together, might affect the structure of the logical data model, which will have an associated effect on the application design.

Steps of physical database design methodology

After designing logical database model, the steps of physical database design methodology are as follows:

Step 1: Translate global logical data model for target DBMS It includes operations like the Design of base relation, derived data and design of enterprise constraints.

Step 2: Design physical representation: It includes operations like analyzing of transactions, selection of file organizations, selection of indexes and estimates the disk space requirements. Step 2 is most important part in designing of physical design of database. It is used to determine the optimal file organizations to store the base relations and the indexes· that are required to achieve acceptable performance, that is, the way in which relations and tuples will be held on secondary storage.

One of the main objectives of physical database design is to store data in an efficient ay. There are a number of factors that we may use to measure efficiency:

• Transaction throughput

This is the number of transactions that can be processed in a given time interval.

In some systems, such as airline reservations, high transaction throughput is critical to the overall success of the system.

• Disk storage

This is the amount of disk space required to store the database files. The designer may wish to minimize the amount of disk storage used.

9.3.8.3 Self-Assessment

i.   What are types of backup?
ii.   What is database security?
    A. Data encryption
    B. A view
    C. Fingerprint
    D. All of the above

iii. Data security threats include
   A. Privacy invasion
   B. Hardware protection
   C. Fraudulent manipulation od data
   D. All of the above
iv. _____ is responsible for using that the database remains in a consistent state despite system failure.
   A. Storage Manager
   B. Transaction manager
   C. End user
   D. Sophisticated
v. Prevention of access to the database by unauthorized users is referred to as:
   A. Integrity
   B. Productivity
   C. Security
   D. Reliability
vi. How will you know your database is unsecure and which software will you use to make it secure

9.3.8.4 Tools, Equipment, Supplies and Materials
PostgreSQL database backup tools, MS SQL database backup solutions

9.3.8.5 References
- https://www.solarwindsmsp.com/content/types-of-database-backups
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 2016