**UNIT – I**

**Data:**

Data are raw facts. The word raw indicates that the facts have not yet been processed to reveal their meaning.

**Information:**

Information is the result of processing raw data to reveal its meaning. Data processing can be as simple as organizing data to reveal patterns or as complex as making forecasts or drawing inferences using statistical modeling.

**Database**

A database is a shared integrated computer structure that stores a collection of

* End-user data that is raw facts of interest to the end-user.
* Metadata or data about data, through which the end-user data are integrated and managed.

The metadata provide a description of the data characteristics and the set of relationships that link the data found within the database.

**DBMS**

A database management system is a collection of programs that manages the database structure and controls access to the data stored in the database. In a sense, a database resembles a very well-organized electronic filing cabinet in which powerful software, known as a database management system, helps manage the cabinet’s contents.

**Advantages of DBMS**

1. **Improved data security:**

The more users access the data, the greater the risks of data security breaks/breaches. Corporations invest considerable amounts of time, effort and money to ensure that corporate data are used properly. A DBMS provides a framework for better enforcement of data privacy and security policies.

1. **Minimized data inconsistency:**

Data inconsistency exists when different versions of the same data appear in different places.

1. **Better data integration**

Wider access to well-managed data promotes an integrated view of the organization’s operations and a clearer view of the big picture. It becomes much easier to see how actions in one segment of the company affect other segments.

1. **Improved data sharing**

The DBMS helps create an environment in which end users have better access to more data and better-managed data. Such access makes it possible for end users to respond quickly to changes in their environment.

1. **Improved data access**

The DBMS makes it possible to produce quick answers to ad hoc queries. From a database perspective, a query is a specific request issued to the DBMS for data manipulation.

1. **Improved decision making**

Better-managed data and improved data access make it possible to generate better quality information, on which better decisions are based.

1. **Increased end-user productivity**

The availability of data, combined with the tools that transform data into usable information, empowers end users to make quick, informed decisions that can make the difference between success and failure in the global economy.

E**volution of DBMS**

In the ancient times when there was no computer, the data began to be stored in voluminous data repositories, called books. An eventually with the improvement in technology and expansion in knowledge the whole communities of books transferred to the first real “database” libraries. The main objective of the database is to ensure that data can be stored and retrieved easily and effectively. It is a compilation of data in a structured way. In a database, the information is stored in a tabular form where data may or may not be interlinked. Hence we can say that basically database is a compilation of database files and each database file is further a collection of records.

1. **Flat Files (1960s – 1980s):**

Flat file database is a database that stores information in a single file or table. In a text file, every line contains one record where fields either have fixed length or they are separated by commas, whitespaces, tabs or any other character. In a flat file database, there is no structural relationship among the records and they cannot contain multiple tables as well.

**Advantages:**

1. Flat file database is best for small databases.
2. It is easy to understand and implement. Fewer skills are required to handle a flat file database

**Disadvantages:**

1. Flat file database waste the computer space by requiring it to keep the information on items that are logically cannot be available.
2. Information retrieving is very time consuming in a large database.
3. **Hierarchical database (1970s – 1990s):**

As the name indicates, hierarchical database contains data in a hierarchically-arranged data. More perceptively it can be visualized as a family tree where there is a parent and a child relationship. Each parent can have many children but one child can only have one parent i.e; one-to-many relationship. Its hierarchical structure contains levels or segments which are equivalent to the file system’s record type. All attributes of a specific record are listed under the entity type.

In hierarchical database, the entity type is the main table, rows of a table represent the records and columns represent the attributes.

**Advantages:**

1. In a hierarchical database pace of accessing the information is speedy due to the pre-defined paths. This increase the performance of a database
2. The relationships among different entities are easy to understand.

**Disadvantages:**

1. Hierarchical database model lacks flexibility.
2. Maintenance of data is inefficient in a hierarchical model. Any change in the relationships may require manual reorganization of the data.
3. **Network database (1970s – 1990s):**

The inventor of network model is **Charles Bachmann**. Unlike hierarchical database model, network database allows multiple parent and child relationships i.e., it maintains many-to-many relationship. Network database is basically a graph structure. The network database model was created to achieve three main objectives:

1. To represent complex data relationships more effectively.
2. To improve the performance of the database
3. To implement a database standard

In a network database a relationship is referred to as a set. Each set comprises of two types of records, an owner record which is same as parent type in hierarchical and a member record which is similar to the child type record in hierarchical database model.

**Advantages:**

1. The network database model makes the data access quite easy and proficient as an application can access the owner record and all the member records within a set.
2. This model is conceptually easy to design.
3. The network model also ensures the data independence because the application works independently of the data.

**Disadvantages:**

1. The model lacks structural independence which means that to bring any change in the database structure, the application program must also be modified before accessing the data.
2. A user friendly database management system cannot be established via network model.
3. **Relational Database (1980s-present)**

Relational database model was proposed by E.F. Codd. After the hierarchical and network model, the birth of this model was huge step ahead. It allows the entities to be related through a common attribute. So in order to relate two tables, they simply need to have a common attribute. In the tables there are primary keys and alternative keys. Primary keys form a relation with the alternative keys. This property makes this model extremely flexible.

Thus using relational database ample information can be stored using small tables. The accessing of data is also very efficient. The user only has to enter a query and the application provides the user with the asked information.

Relational databases are established using a computer language, SQL. This language forms the basis of all the database applications available today, from Access to Oracle.

**Advantages:**

1. Relational database uses normalization structure which helps to achieve data independence more easily.
2. Security control can also be implemented more effectively by imposing an authorization control on the sensitive attributes present in a table.
3. Relational databases uses a language which is easy and human readable.

**Disadvantages:**

1. The response to a query becomes time-consuming and inefficient if the number of tables between which the relationships are established increases.
2. **Object Oriented Database (1990s-Present):**

Object Oriented Database management system is the database system in which the data or information is presented in the form of objects, much like in object-oriented programming language. Furthermore, object oriented DBMS also facilitate the user by offering transaction support, language for various queries, and indexing options. Also, these database systems have the ability to handle data efficiently over multiple servers.

Unlike relational database, object-oriented works in the framework of real programming languages like Java or C++.

**Advantages:**

1. If there are complex relationships between the entities, the object oriented database handles them much faster than any of the other models.
2. Navigation through the data is much easier.
3. Objects do not require assembly or disassembly hence saving the coding and execution time.

**Disadvantages:**

1. Lower efficiency level when data or relationships are simple
2. Data can be accessible via specific language using a particular API which is not the case in relational databases.
3. **Object-relational database (1990s – Present)**

Defined in simple terms, an object relational database management system displays a modified object-oriented user-display over the already implemented RDBMS. When various software interact with this modified database management system, they will customarily operate in a manner such that the data is assumed to be save as objects.

The basic working of this database management system is that it translates the useful data into organized tables, distributed in rows and columns and from then onwards, it manages data the same way as done in a RDBMS. Similarly, when the data is to be accessed by the user, it is again translated from processed to complex form.

**Advantages:**

1. Data remains encapsulated in object-relational database.
2. Concept of inheritance and polymorphism can also be implemented in this database.

**Disadvantages:**

1. Object relational database is complex
2. **Web enabled database (1990s-Present)**

Web enabled database simply put a database with a web-based interface.

This implies that there can be a separation of concerns; namely the web designer does not need to know the details about the DB’s underlying design. Similarly, the DB designer needs to concern himself with the DB’s web interface.

A web enabled database uses three layers to function: **a presentation layer**, **a middle layer** and **the database layer**.

**Advantages:**

1. A web enabled database allows users to get the information they need from a central repository on demand.
2. The database is easy and simple to use.
3. The data accessibility is easy via web-enabled database

**Disadvantages:**

1. It can be hacked very easily
2. Web enabled databases support the full range of DB operations, but in order to make them easy to use, they must be dumped down.

**Classification of DBMS**

A DBMS can support many different types of database. DBMS can be classified according to the number of users, the DB location and the expected type and extent of use.

1. **Based on Data Models**

Depending on the data model they use, the DBMSs can be classified as hierarchical, network and relational.

* 1. **Hierarchical DBMS:**

Hierarchical DBMS organizes the data records in a tree structure i.e hierarchy of parent-child relationships. In a hierarchical database, a parent record may have more than one child, but a child always has only one parent. This is called a one-to-many relationship.

* 1. **Network DBMS**

It organizes the data records linked to one another through pointers, which is an association between two records. A network database is similar to a hierarchical database except that each child can have more than one parent record. This is called as man-to-many relationship.

* 1. **Relational DBMS**

It organizes the data records in the form of table and relationships among the tables are set using common fields. It is simple in nature because data is simply represented in tabular format

1. **Based on number of users**

The database is classified based on the number of users are

* 1. **Single user**

A single user database supports only one user at a time. In other words, if user A is using the database, users B and C must wait until user A is done. A single user database that runs on a personal computer is called a desktop database.

* 1. **Multi user.**

A Multiuser database supports multiple users at the same time. When the multiuser database supports a relatively small number of users (usually fewer than 50) or a specific department within an organization, it is called as workgroup database. When the database is used by the entire organization and supports many users (more than 50, usually hundreds) across many departments, the database is known as an enterprise database.

1. **Based on Database Distribution**

There are four main distribution systems for database systems and these in turn can be used to classify the DBMS as

* 1. **Centralized database**

A database that supports data located at a single site is called as centralized database. This database can be used by several other systems too.

* 1. **Distributed Database**

A database that supports data distributed across several different sites is called as distributed database. The extent to which a database can be distributed and the way in which such distribution is managed

* 1. **Homogenous Distributed Database**

Homogenous distributed database systems use the same DBMS software from multiple sites. Data exchange between these various sites can be handled easily.

* 1. **Heterogeneous Distributed Database**

In a heterogeneous distributed database system, different sites might use different DBMS software, but there is additional common software to support data exchange between these sites.

1. **Based on the purpose**

Depending on the purpose the DBMS serves, it can be classified as **general purpose or special purpose.**

* 1. **Operational Database**

A database that is designed primarily to support a company’s day-to-day operations is classified as an operational database.

* 1. **Data warehouse**

A Data warehouse focuses primarily on storing data used to generate information required to make tactical or strategic decisions. Such decisions typically require extensive “data manipulation” to extract information to formulate pricing decisions, sales forecasts, market positioning and so on. Most decision support data are based on historical data obtained from operational databases. Additionally, the data warehouse can store data derived from any many sources. To make it easier to retrieve such data, the data warehouse structure is quite different from that of an operational or transactional database.

**Unit - II**

**File-based System**

File-based system was an early attempt to computerize the manual filing system. It is basically a collection of application programs that performed services for the end users. Each program within a file based system defines and manages its own data. In this system a large number of files are needed to perform various tasks.

**For example:** In sales department of an enterprise, one user will be maintaining the details of how many sales personnel are there in the sales department and their grades, these details will be stored and maintained in a separate file. Another user will be maintaining the salesperson salary details working in the concern, the detailed salary report will be stored and maintained in a separate file. Although both of the users are interested in the data’s of the salesperson they will be having their details in separate files and they need different programs to manipulate their files. This will lead to wastage of space and redundancy or replication of data’s, which may lead to confusion, sharing of data among various users is not possible, data inconsistency may occur.

The approach to data management, in which separate data files are created and stored for each application program, is called the Traditional File approach.

**Characteristics of File-based system**

1. It is a group of files storing data of an organization
2. Each file is independent from one another.
3. Each file is called a flat file.
4. Each file contained and processed information for one specific task, such as accounting or inventory.
5. File are designed by using programs written in programming languages such as C,C++
6. Each file must have its own file management system.

**Drawbacks of File-Based System**

In the early days, database applications were built on top of file systems. The drawbacks of using the file systems to store data are

1. **Uncontrolled redundancy of data:**

Each subsystem of an organization maintains a set of files without data sharing; the same data will be available in different files. This will result in increased disk space requirement, increased time of data entry and inconsistency of data.

1. **Inconsistency of data:**

The uncontrolled redundancy of data will permit the system to have the same data in different files. As a result, there is a possibility of a particular data element will be entered differently in different files which is nothing but inconsistency of particular data. While performing basic data processing operations, this inconsistency will give misleading results.

1. **Inflexibility:**

The conventional file processing system will not be flexible enough to provide the desired results because of its insensitiveness to dynamics of the real world.

1. **Limited Data Sharing:**

In the conventional file processing system, the data is stored in decentralized manner on different standalone systems, there is a remote probability of sharing of data. The limited data sharing is due to the nesting of files within each subsystem of the organization.

1. **Poor enforcements of standards:**

While designing files under conventional file processing system, each group follows its own standards of defining field name, field width, field type and so. This will create serious difficulty while modifying programs and data structures of the files by different groups of users will lead to low programming productivity.

1. **Excessive program maintenance:**

The maintenance group will find difficulty to relate names of fields of different files for the same attribute. Many of the program variables may be defined differently in different programs. While modifying the file structures of some applications it will take more time to implement the modifications correctly. All these difficulties will lead to excessive maintenance effort.

1. **Low programmer productivity:**

Programmer productivity is a measure of time taken to develop an application. In conventional file processing system, there will be inflexibility, poor enforcement of standards and excessive maintenance effort. Hence the programmer productivity will become considerably low in conventional processing systems.

**DBMS APPROACH**

In order to remove all the limitations of a file-based system, a new approach was required that must be more effective. So, the concept of database was introduced. This approach is known as database approach / DBMS approach

A database is a computer based record keeping system whose over all purpose is to record and maintains information. The database is a single, large repository of data, which can be used simultaneous by many departments and users. With the database approach, instead of disconnected files with redundant data, all data items are integrated with minimum amount of duplication and maintain only at one location. In this approach, related data is shared by multiple application programs.

**Characteristics of DBMS:**

DBMS approach possesses the following characteristics.

1. It is central repository of shared data. It allows several users to access the database concurrently.
2. A primary feature of the database approach is a standardized, uniform approach to database access. This means that the same overall procedures are used by all application programs to retrieve data and information.
3. Data should be correct with respect to the real world entity that they represent.
4. Data should be protected from unauthorized users.
5. Duplication of data is minimized

**Data Model**

**A data model is a relatively simple representation, usually graphical of more complex real-world data structures**. In general terms, a model is an abstraction of a more complex real-world object or event. A model’s main function is to help understand the complexities of the real world environment. Within the database environment, a data model represents data structures and their characteristics, relations, constraints, transformations and other constructs with the purpose of supporting a specific problem domain.

Data models can facilitate interaction among the designer, the applications programmer and the end user. In short, data models are communication tool.

**Evolution of Data Models**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Generation** | **Time** | **Model** | **Examples** | **Comments** |
| First | 1960s to 1970s | File System | VMS/ VSAM | Used mainly on IBM mainframeManaged records, not relationships |
| Second | 1970s | Hierarchical and Network Data Model | IMSADABASIDS-II | Early database systems |
| Third | Mid-1970’s to present | Relational Data Model | DB2OracleMs-SQL-Server | Conceptual simplicityER-modeling and support for relational data modeling |
| Fourth | Mid-1980s to present | Object Oriented | Versant FastObject.net | Support complex dataExtended relational products |
| Next Generation | Present to future | XML  | DbXMLDB2 UDBOracle10g | Organization and management of unstructured dataRelational and object models add support for XML documents |

**Hierarchical Data Model**

The hierarchical model was developed in the 1960s to manage large amounts of data for complex manufacturing projects such as the **APOLLO rocket** that landed on the moon in 1969. Its basic logical structure is represented by an upside-down tree. The hierarchical structure contains levels or segments. A segment is the equivalent of a file system’s record type. Within the hierarchy the top layer (root) is perceived as the parent of the segment directly beneath it. The segment below other segments is the children of the segments above.

In short hierarchical model represents a set of one-to-many relationships between a parent and its children segment.



**Advantages:**

1. It promotes data sharing
2. Parent child relationship promotes conceptual simplicity.
3. Database security is provided and enforced by DBMS
4. Parent/child relationship promotes data integrity
5. It is efficient with 1:M relationships

**Disadvantages:**

1. Complex implementation requires knowledge of physical data storage characteristics.
2. Navigational system yields complex application development, management and use requires knowledge of hierarchical paths.
3. Changes in structure require changes in all application programs.
4. There is no data definition or data manipulation language in the DBMS.
5. There is a lack of standards.

**NETWORK DATA MODEL**

The network model was created to represent complex data relationships more effectively than hierarchical model, **to improve database performance and to impose a database standard**. The lack of database standards was troublesome to programmers and application designers because it made database designs and applications less portable.

In the network model, the user perceives the network database as a collection of records in 1:M relationships. However, unlike the hierarchical model, the network model allows a record to have more than one parent. In network database terminology, a relationship is called a set. Each set is composed of at least two record types; an owner record and a member record. A set represents a 1:M relationship between the owner and the member.

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**Advantages:**

1. It handles more relationship types such as M:N AND multi-parent.
2. Data access is more flexible.
3. Data owner membership promotes data integrity
4. It includes DDL and DML in DBMS

**Disadvantages:**

1. Navigations system yields complex implementation, application development and management.
2. Structural changes require changes in all application programs.

**Relational Model**

The relation model was introduced in **1970 by E.F. Codd** in his land mark paper **“A Relational Model of Data for Large Shared Databanks”.** The relational model represented a major breakthrough for both users and designers.

The relational model foundation is a mathematical concept known as relation. To avoid complexity of abstract mathematical theory, you can think of a relation a matrix composed of intersecting rows and columns. Each row in a relation is called a **tuple**. Each column represents an attribute. The relational model also describes a precise set of data manipulation constructs based on advanced mathematical concepts.

Today even micro-computers can run sophisticated relational database software such as ORACLE, DB2, MYSQL and other mainframe relational software.

**Advantages:**

1. Structural independence is promoted.
2. Tabular view substantially improves conceptual simplicity.
3. ADHOC query capability is based on SQL
4. Powerful RDBMS isolates the end user from physical level details.

**Disadvantages**

1. The RDBMS requires substantial hardware and system software overhead
2. Conceptual simplicity gives relatively untrained people, the tools to use a good system poorly.

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**Object Oriented Data Model**

Increasingly complex real world problems demonstrated a need for a data model that more closely represented the real world. In the object oriented data model both data and their relationships are contained in a single structure known as an object. In turn, the OODM is the basis for the object oriented data base management system

An OODM reflects a very different way to define and use entities. Like the relational model’s entity, an object is described by its factual content. But quite unlike an entity, an object includes information about relationships between the facts within the object, as well as information about its relationships with other objects. Therefore, the facts within the object are giving greater meaning. The OODM is said to be a semantic data model because semantic indicates meaning.

The OO data model is based on the following components:

1. An object is an abstraction of a real world entity. In general terms, an object may be considered equivalent to an ER model’s entity. More precisely, an object represents only one occurrence of an entity.
2. Attributes describe the properties of an object.
3. Objects that share similar characteristics are grouped in classes. A class is a collection of similar objects with shared structure and behavior. In a general sense, a class resembles the ER model’s entity set. However a class is different from an entity set in that it contains a set of procedures known as methods. A class’s method represents a real world action such as finding a selected person’s name, changing a person’s name or printing a person’s address. In other words, methods are the equivalent of procedures in traditional programming languages. In OO terms, methods define an object’s behavior.
4. Classes are organized in a class hierarchy. The class hierarchy resembles a upside down tree in which each class has only one parent.
5. Inheritance is the ability of an object within the class hierarchy to inherit the attributes and methods of the classes above it.

**Components of DBMS OR Database Environment**

The database system refers to an organization of components that define and regulate the collection, storage, management and use of data within a database environment. From a general management point of view, the database system is composed of **five major parts**.

1. **Hardware:** Hardware refers to all the system’s physical devices
2. **Software**

Although the most readily identified software is the DBMS itself, to make the database system function fully, three types of software are needed.

1. **Operating system:** It manages all hardware components and makes it possible for other software to run on the computers.
2. **DBMS Software:** It manages the database within the database system
3. **Application programs and utility software:** It is used to access and manipulate data in the DBMS and manages the computer environment in which data access and manipulation take place. Application programs are most commonly used to access data found within the database to generate reports, tabulations and other information to facilitate decision making.
4. **People:**

This component includes all users of the database system. On the basis of primary job functions five types of users can be identified in a database system. **System administrators, Database administrators, database designers, system analysts and programmers and end users.**

1. **System Administrators:** These people are responsible to oversee the database systems general operations.
2. **Database Administrators:** DBMS manages the DBMS and ensure that the database is functioning properly.
3. **Database Designers:** These people design the database structure.
4. **System Analysts and Programmers:** They design and implement the application programs
5. **Procedure**

Procedures are the instructions and rules that govern the design and use of the database system. Procedures are a critical, although occasionally forgotten, component of the system. Procedures play an important role in a company because they enforce the standards by which business is conducted within the organization and with customers. Procedures also are used to ensure that there is an organized way to monitor and audit both the data that enter the database and the information that is generated through the use of the data.

1. **Data**

The word data covers the collection of facts stored in the database. Because data are the raw material from which information is generated, the determination of what data are to be entered into the database and how that data are to be organized is a vital part of the database designers’ job.

**DATABASE ARCHITECTURE**

Database architecture essentially describes the location of all the pieces of information that make up the database application. The database architecture can be broadly classified into following types:

* 1. Single-tier architecture
	2. Two-tier architecture
	3. Three-tier architecture
	4. N-tier architecture
1. **Single Tier Architecture**
	* 1. Single-tier architecture consists of a single computer that contains a database and a front-end to access the database.
		2. Generally this type of system is found in small businesses. There is one computer which stores all of the company’s data on a single database. The interface used to interact with the database may be part of the database or another program which ties into the database itself.
		3. During the 1970’s and 1980’s most database management systems resided on large mainframes or minicomputers. The systems were centralized and single tier, which means the DBMS software and the data reside in one location and the dumb terminals were used to access the DBMS.
		4. Single-tier architecture is equivalent of running an application on a personal computer. All the required components to run the application are located within it. User interface, business logics and data storage are all located on the same machine. They are the easiest to design, but the least scalable because they are not part of a network.

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**Advantages:**

1. A single-tier system requires only one stand-alone computer.
2. It also requires only one installation of proprietary software. This makes it the most cost-effective system available.

**Disadvantages:**

1. May be used by only one user at a time
2. A single-tier system is impractical for an organization which requires two or more users to interact with the organizational data store at the same time.
3. **Two-tier Architecture**
4. Two-tier architecture consists of two systems, a client and a server. The database is stored on the server, and the interface used to access the database is installed on the client.
5. The architecture of any client-server environment is by definition at least a two-tier system, the client being the first tier and the server being the second. The client request services directly from server i.e. client communicates directly with the server without the help of another server or server process. In two-tier computing model, the user interface runs on the client and the database is stored on the server. The actual application logic can on either the client or the server.

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**Advantages:**

1. Least complicated to implement.
2. Tools are relatively inexpensive
3. The 2-tier client/server provides much more attractive GUI applications than was possible with earlier technology.
4. 2-tier architecture maintains a persistent connection between the client and database.

**Disadvantages:**

1. As the application development is done on client side, maintenance cost of application, as well as client side tools etc. is expensive. That is why in 2-tier architecture the client is called “fat client”
2. The actual processing of data takes on the remote client, the data has to be transported over the network. This leads to the increased network stress.
3. **Three-tier Architecture**

In three-tier architecture, the client requests are handled by intermediate servers which coordinate the execution of the client request with subordinate servers. It adds middleware which provides a way for clients of one DBMS to access data from another DBMS.

Generally two-tier client server model is used to access the data from one DBMS server that is centralized system. Another method of distribution is to store several equivalent databases in different places, which is termed as Distribute Database System.

The data are distributed geographically and located closest to where they will be used.



**First-Tier (Client Tier)**

In this tier, client sends request for the information. The main responsibility of this tier is to receive user events and to control the user interface and presentation of data. As most of the software is removed from the client, the client is called **“Thin Client”.**

**Second-Tier (Application Server tier / Middle tier)**:

The complex application logic is loaded here and available to the client tier on request from client. This tier can protect direct access of data.

**Third-Tier (Database Server Tier):**

The third-tier contains the data that is needed for the application i.e, this tier is responsible for data storage. This server mostly operates on a relational database.

 **Advantages:**

1. Security is improved since the client does not have direct access to the database; it is more difficult for a client to obtain unauthorized data. Business logic is generally more secure since it is placed on a more secure central server.
2. Load balancing is easier with the separation of the core business logic from the database server.
3. The need for less expensive hardware because the client is thin
4. Change management is easier and faster to execute, because program logic/business logic is implemented on the centralized server.
5. The added modularity makes it easier to modify or replace one tier without affecting the other tier.

 **Disadvantages**

1. The client does not maintain a persistent database connection
2. A separate proxy server may be required
3. Network traffic will be increased, if a separate proxy server is used.
4. The physical separation of application servers containing business logic functions and database servers containing databases may somewhat affect performance.
5. **N-tier Architecture**

In 3-tier architecture, each server performs a specialized task or service. A server can therefore use services from other servers in order to provide its own service. As a result, 3-tier architecture is potentially an n-tiered

To turn 3-tier architecture into an n-tier system, the middle tier can be allowed to have multiple application objects rather than a single application. Each of these application objects must have a well-defined interface which allows them to contact and communicate with one another.



**Advantages:**

1. Overall performance has been improved
2. The business logic is centralized
3. Enhanced security level is obtained.
4. N-Tier computing model also make applications more readable and reusable
5. N-Tier architectures make application more robust because there is no single point of failure
6. Provides many services to many clients
7. Enhanced scalability and availability

**Disadvantages:**

1. Much more complicated to design than 2-tier and 3-tier client-server computing models
2. Load balancing is harder
3. Reliability is more difficult to achieve
4. More difficult to maintain software

**DBMS Vendors and their Products**

Some of the popular DBMS vendors and their corresponding products are listed as follows

|  |  |
| --- | --- |
| **Vendor** | **Product** |
| **Microsoft** | ACCESSEXCELSQL SERVER |
| **ORACLE** | ORACLE DBMSMYSQL |
| **SYBASE** | ADAPTIVE SERVER ENTERPRISEADAPTIVE SERVER ANYWHERE SATCOM |
| **IBM** | DB2INFORMIX DYNAMIC SERVER |

**UNIT – III**

**Basic building blocks of an ER-Model**

The basic building blocks of Entity Relationship diagram are **Entity, Attribute, Relationship and constraints.**

1. **ENTITY:**

An entity is a person, place, object, event or concept in the user environment about which the organization where wishes to maintain data. Entities can be represented by means of **rectangle and named** with the entities they represent.

 **Eg:**

 **Person:** EMPLOYEE, STUDENT, PATIENT

 **Place:** STORE, WAREHOUSE, STATE

 **Object:** MACHINE, BUILDING, AUTOMOBILE

 **Event:** SAL, REGISTRATION, RENEWAL

 **Concept:** ACCOUNT, COURSE, WORK CENTER

**Types of Entity Sets**

Entities are of different types. They are

1. Weak Entity
2. Strong Entity

|  |  |  |
| --- | --- | --- |
| **Entities** | **Description** | **Symbolic Representation** |
| Weak Entity | Weak entity is one whose existence depends on other entity. An entity that does not has an attribute which may act as a primary key or key attribute is called weak entity. ***A weak entity in ER diagram can be represented as*double outlined box** |  |
| Strong Entity | It is one whose existence does not depend on other entity. An entity that has an attribute which may act as a primary key or key attribute is called strong entity. **A strong entity in ER diagram is represented by Single Outlined box** |  |

1. **ATTRIBUTES:**

It is a property or characteristic of an entity that is of interest to the organization. The attributes can be represented by means of **ellipses**. Every ellipse represents one attribute and is directly connected to its entity. Attributes are of different types. They are

|  |  |  |
| --- | --- | --- |
| **Attributes** | **Description** | **Symbolic Representation** |
| Simple Attribute | An attribute that consist of a single atomic value. It cannot be broken down into smaller components.**Eg: Age, Salary** |  |
| Derived Attribute | An attribute that’s value is derived from a stored attribute. **For eg,“age”** its value is derived from the stored attribute “**Date\_of\_Birth”** |  |
| **Composite Attribute** | An attribute that can be broken down into small components.**Eg:** Address (Hno, street, city, pin code) |  |
| **Multi-valued Attribute** | An attribute that may take on more than one value for a given entity instance.**Eg:** Multiple Phones Numbers, Multiple email-ids, etc. |  |
| **Single Valued Attribute** | A single-valued attribute can have only a single value. For **eg,** A person can have only one **“Date\_of\_Birth”, ”Age”,** etc. It can be simple or composite attribute. That is **Date\_of\_Birth** is a composite attribute, where **“Age”** is a simple attribute. But both are single valued attributes.  | Simple AttributeAs Single-Valued AttributeComposite AttributeAsSingle Value Attribute |

1. **RELATIONSHIPS:**

A Relationship is an association among the instances of one or more entity types. Relationships are represented by diamond-shaped box. Name of the relationship is written inside the diamond box. There are three kinds of relationships are available, they are

1. **Unary Relationship:**

A unary relationship is a relationship between the instances of single entity types.



1. **Binary Relationship**

A binary relationship is a relationship between the instances of two entity types and is the most common type of relationship encountered in data modeling. The following three figures shows the binary relationship

**Employee**

**Parking\_Place**

Is\_assign

 **One-to-One**

**Product\_line**

**Product**

Contains

 **One-to-Many**

**Student**

**course**

Registers

 **Many-to-Many**

The first indicates that an employee is assigned one parking place and each parking place is assigned to one employee.

The second indicates that a product line may contain several products, and each product belongs to only one product line.

The third shows that a student may register for more than one course, and that each course may have many student registrants.

1. **Ternary Relationship:**

A ternary relationship is a simultaneous relationship among the instances of three entity types. A typical business situation that leads to a ternary relationship is as follows.

PART

VENDOR

Supplies

Warehouse

**Advantages ER Model**

1. **Conceptual Simplicity**

ER-Model represents the concepts of a database along with its entities and relationships in an easy way. It becomes even easier to create and manage the complex database designs by using ER-model

1. **Visual Representation**

ER-Model provides a visual representation of data and the relationships among data. It helps the database designers, programmers and end users to understand the structure of data in easy way. It also minimizes the data redundancy.

1. **Effective Communication Tool**

The data base designer can use ER-model to get different views of data as seen by programmers, managers and end users etc. ER-model works as an effective communication tool.

1. **Integrated with Relational Database Model**

ER-model is well integrated with the relational database model. This integration makes relational database design a very structured process.

**Disadvantages of ER Model**

1. **Popular for High level Design**

The ER-Model is especially popular for high level database design

1. **No Industry Standard**

There is no industry standard notation for developing an ER-diagram

1. **Limited Relationship Representation**

ER-model represents limited relationships among the entities.

**Degree of Relationships**

The degree of a relationship is the number of entity types that participate in that relationship. Thus, the relationship completes is of degree 2, since there are two entity types **EMPLOYEE** and **COURSE**. The three most common relationship degrees in E-R models are **unary, binary** and **ternary**. **Higher degree relationships** are possible, but they are rarely encountered in practice. **The degree of a relationship is also called cardinality.**

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**Extended entity relationship model (EERM)**

EER is a high-level data model that incorporates the extensions to the original ER model. Enhanced ERD are high level models that represent the requirements and complexities of complex database.

In addition to ER model concepts EE-R includes −

1. Subclasses and Super classes.
2. Specialization and Generalization.
3. Category or union type.
4. Aggregation.

These concepts are used to create EE-R diagrams.

1. **Sub Class and Super Class**
* Sub class and Super class relationship leads the concept of Inheritance.
* The relationship between sub class and super class is denoted with  symbol.
1. **Super Class**
* Super class is an entity type that has a relationship with one or more subtypes.
* An entity cannot exist in database merely by being member of any super class.

**For example:** Shape super class is having sub groups as Square, Circle, Triangle.

1. **Sub Class**
* Sub class is a group of entities with unique attributes.
* Sub class inherits properties and attributes from its super class.
**For example:** Square, Circle, Triangle are the sub class of Shape super class.



1. **Specialization and Generalization**
	1. **Specialization**
	* Specialization is a process that defines a group entities which is divided into sub groups based on their characteristic.
	* It is a top down approach, in which one higher entity can be broken down into two lower level entity.
	* It maximizes the difference between the members of an entity by identifying the unique characteristic or attributes of each member.
	* It defines one or more sub class for the super class and also forms the superclass/subclass relationship.

**For example**



In the above example, Employee can be specialized as Developer or Tester, based on what role they play in an Organization.

* 1. **Generalization**
	+ Generalization is the process of generalizing the entities which contain the properties of all the generalized entities.
	+ **It is a bottom approach,** in which two lower level entities combine to form a higher level entity.
	+ Generalization is the reverse process of Specialization.
	+ It defines a general entity type from a set of specialized entity type.
	+ It minimizes the difference between the entities by identifying the common features.
	**For example:**



In the above example, Tiger, Lion, Elephant can all be generalized as Animals.

1. **Category or Union**
* Category represents a single super class or sub class relationship with more than one super class.
* It can be a total or partial participation.
* **For example** Car booking, Car owner can be a person, a bank (holds a possession on a Car) or a company. Category (sub class) → Owner is a subset of the union of the three super classes→ Company, Bank, and Person. A Category member must exist in at least one of its super classes.



1. **Aggregation**
* Aggregation is a process that represent a relationship between a whole object and its component parts.
* It abstracts a relationship between objects and viewing the relationship as an object.
* It is a process when two entity is treated as a single entity.



* In the above example, the relation between College and Course is acting as an Entity in Relation with Student.

**CODD’S RULES**

1. **The Information rule:**

All information in relational database must be logically represented as column values in rows within tables.

1. **The rule of Guaranteed Access:**

Every value in a table is guaranteed to be accessible through a combination of table name, primary key value and column name.

1. **Systematic treatment of null values**

Nulls must be represented and treated in a systematic way, independent of data type.

1. **Dynamic on-line catalog**

The metadata must be stored and managed as ordinary data that is in tables.

1. **Comprehensive sub-language rule**

The system must support for data definition view definition, data manipulation

1. **The View update rule**

Any view that is theoretical updatable must be up datable through the system.

1. **The insert, update rule**

The database must support set level inserts, updates and deletes.

1. **Physical data independence rule**

Application programs are logical unaffected when physical access methods or storage structure are changed.

1. **The logical data independence rule**

Application programs are logically unaffected when changes are made to the table structure that, preserve the original table values.

1. **The data integrity rule**

All relational integrity constraints must be definable in the relational language.

1. **The distribution rule**

The end users and application programmers are unaffected by the data location.

1. **Non-subversion rule**

If the system supports low level access to the data, there must not be a way to bypass the integrity rules of the database.

**RELATIONAL DATA MODEL**

The relational data model is the conceptual basis of relational databases **proposed by Dr. E.F. Codd in 1970.** The relational model is considers as one of the most popular developments in the database technology because it can be used for representing most of the real world objects and the relationships between them.

The main construct for representing data in the relational model is a relation, where each relation is a table with rows and columns. A row is also called a record. A column is also called a field. A database table is similar to a spreadsheet. In simplest terms, a relational database is one that presents information in tables with rows and columns. This simple tabular representation enables even novice users to understand the contents of a database, and it permits the use of simple, high-level languages to query the data. The major advantages of the relational model over the older data models are its simple data representation and the ease with which even complex queries can be expressed.

Relational database establish a well-defined relationship between database tables. However, the relationships that can be created among the tables enable a relational database to efficiently store huge amount of data and effectively retrieve selected data.

Relational database design provides guidelines to define tables, columns, and establish relationships between tables. A well-designed relational database should not be stored in more than one place. This is because duplicate data not only waste storage spaces but also easily lead to inconsistencies. It should also ensure data integrity and accuracy.

**RELATIONAL INTEGRITY**

Database Integrity means the **completeness, correctness** and **consistency of data**. It ensures that data entered into the database must be complete, accurate, valid and consistent. It is another form of database protection.

In a relational data model, data integrity or data accuracy can be achieved using integrity rules or constraints. An integrity constraint is a condition that is specified on a database schema, and restricts the data that can be stored in an instance of the database. If a database instance satisfies all the integrity constraints specified on the database schema, it is a legal instance.

Integrity constraints maybe divided into three main categories

1. Domain Integrity Constraints
2. Entity Integrity Constraints
3. Referential Integrity Constrains
4. **Domain Integrity Constraints**

This constraint allows the user **not to accept null values** and allows the user to accept the correct data based on the conditions defined. The domain integrity constraints are

1. **Not Null:**

This constraint allows the user not to accept null values.

1. **Check**

This constraint allows the user to accept the correct data based on the conditions defined.

**Syntax: Constraint <cons\_name>check(condition)**

1. **Entity Integrity Constraints**

This constraint allows the user not to accept duplicate values and null values. The Entity Integrity constraints are

1. **Primary Key**
2. **Unique**
3. **Primary Key:**

This constraint allows the user not to accept duplicate values and null values. The primary key constraint can be set for only one column at column level and if we want to set primary key on more than one column then it can be set at table level. At a time we can set primary key constraint for 16 columns, such constraint can be called as composite key.

1. **Unique:**

This constraint allows the user not to accept duplicate values but accept null values.

1. **Referential Integrity Constraints:**

The Referential Integrity Constraint enforces relationship between tables. It designates a column or combination of columns as a foreign key. The foreign key establishes a relationship with a specified primary or unique key in another table, called the referenced key. In this relationship, the table containing the foreign key is called the child table and the table containing the referenced key is called the parent table. The referential integrity constraints are of two types. They are

1. **References**

This constraint allows the user to provide relation or reference from one table to another.

1. **Foreign Key**

Foreign key constraint is the one to which the child column values refer the values of parent table primary or unique key. Foreign key or reference key constraint can be at table level or at column level. If you define the foreign key at table level then it is called a composite-foreign key.

All the above constraint can be written in two levels. They are –

1. **Column Level Constraints**

A constraint which can be defined immediately after defining a column, such constraint can be called as column level constraint.

1. **Table Level Constraints**

A constraint which can be defined after defining all the columns of a table, such constraint can be called as table level constraint. The table level constraint can be defined under the following situations-

* 1. A Constraint which depends on other columns of a table.
	2. A Primary key constraint can be set on more than one column

**Unit – IV**

**History of SQL Standard**

* **SQL** stands for **“Structured Query Language”.**
* SQL can be pronounced as “SEQUEL”.
* SEQUEL means Simple/Structured English Query language.
* SQL is the international standard language for relational database management systems.
* SQL is considered a **fourth-generation language.**
* It is a special-purpose language used to define, access and manipulate data in RDBMS.
* SQL provides a set of statements for storing and retrieving data to and from a relational database.
* The original version called **SEQUEL** (Simple English Query Language) was designed by **IBM in mid-1970s.**
* SQL was introduced as a commercial database system in 1979 by Oracle Corporation.

**SQL commands**

SQL commands are instructions used to communicate with the database to perform specific task that work with data. SQL commands can be used not only for searching the database but also to perform various other functions. SQL commands are group into different categories depending on their functionality.

1. **Data Definition Language Commands**

These commands are used to create, modify and remove the database objects. The DDL commands are **create, alter, drop, rename** and **truncate.**

1. **Data Manipulation Language commands**

These commands are used for inserting, modifying and deleting data from the table. The DML commands are **insert, update** and **delete**.

1. **Data Retrieval Language commands/Data Query Language Commands**

This command is used for retrieving data from the database.The DQL command is **Select.**

1. **Data Control Language commands**

These commands are used for providing security. It means these commands are used to grant privileges to access the data one user to another. It is also used to revoke the privileges which are granted. The DCL commands are **Grant** and **Revoke**

1. **Transaction Control Language commands**

These commands are used to make the transaction either permanent or temporary. The TCL commands are **commit, rollback** and **savepoint**.

**SQL Datatypes**

A datatype can be defined as the type of values to be stored. Oracle supports different types of data types.

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No.** | **Name** | **Types** | **Description** |
| **1** | **Scalar** | **Number** | The number data type can store positive, negative numbers, zeros, fixed point numbers and float point numbers with a precision of 38. The decimal points which varies between -84 to 127. |
| **Char** | It is used when a fixed length character string is required. It can store alpha-numeric values. The column length of such a data type can vary between 1 to 2000 bytes. By default it is one byte. |
| **Varchar2** | It supports a variable length character string. It is also used to alpha-numeric values. The size of this data type ranges from 1 to 4000 bytes. While defining this data type we should specify the size. Using varchar2 saves disk space when compared to char.  |
| **Date** | This data type is used to store data and time in a table. Oracle database makes its own format to store data in a fixed length of 7 bytes each for century, month, day, year, hour, minute and second. The default date format is “dd-mon-yy”. The valid date is from jan 1, 4712 BC to Dec 31, 4712 AD. |
| **Long Raw** | It is used to store images in an unstructured format i.e binary data of variable length. It holds a maximum of 2 GB. This data type should be used only once in a table if required. |
| **2** | **Composite**  | **LOB’s** | It is known as Large Object data type. This can store unstructured information such as sound clips, video files, images, graphics, documents, etc, upto 4 GB in size. They allow efficient, random piece-wise access to the data. The LOB’s are BLOB, CLOB and BFILE. |

**SQL Functions**

SQL support different types of functions. They are

1. Numeric Functions
2. String Functions
3. Aggregate Functions
4. Date Functions
5. Conversion Functions

**NUMERIC FUNCTIONS:**

**1. abs():** This function is used to convert a negative value to positive value.

 **Syntax:**abs(No.)

 sql> select abs(100-120) from dual;

 20

**2. Sqrt():** This function returns the square root of a given number.

 **Syntax** – SQRT(No.)

 **SQL>** select SQRT (81) from dual;

 9

**3. Mod():** This function returns the modulus(remainder).

 **Syntax**: mod(divident, divisor)

**SQL>** select mod(15,2) from dual;

 1

**4. Power():** This function returns the power of given number as per the raised number

specified.

 **Syntax:**power(number, raised number)

**SQL**> select power(4,3) from dual;

 64

**5. round():** This function is used to round off the required number of decimals.

 **Syntax** - round(No, No. of decimals)

 **SQL**> select round(23.6789,2) from dual;

 23.68

**SQL**> select round(23.6789,1) from dual;

 23.7

**STRING FUNCTIONS**

**1. upper():** This function converts a string into upper case.

 **Syntax:**upper('string')

**sql>** select upper('hello') from dual;

 HELLO

**2. lower():** This function converts a string into lower case

 **Syntax:**lower('string')

 **sql>** select lower('HELLO') from dual;

 hello

**3. initcap():** This function converts a string into initial caps.

 **Syntax:** initcap('string')

 **sql>** select initcap('computer education') from dual;

 Computer Education

**4. ltrim():** This function is used to remove the unnecessary spaces or characters available to a string.

 **Syntax:** ltrim('string','unnecessary char’)

 **sql>** select ltrim('xyxycomputer','xy') from dual;

 computer

**sql>** select ltrim('xyzxycomputer','xy') from dual;

 zxycomputer

**5. rtrim:** This function is used to remove the unnecessary characters or spaces available on the right side of a string.

 **Syntax:**rtrim('string','unnecessary char')

**sql>** select rtrim('computerxyxy','xy') from dual;

 computer

**sql>** select rtrim('computerxyzxy','xy') from dual;

 computerxyz

**AGGREGATE FUNCTIONS**

1. **Sum():** This function calculates sum of group of values

 **Syn: sum(col\_name)**

 **Eg: SQL>**select sum(sal) from emp;

 **34999**

1. **Average():** This function returns the average of group of values

 **Syn: average(col\_name)**

 **Eg: SQL>**select average(sal) from dual;

 **6999**

1. **Max():** This function returns the highest value from group of values

 **Syn: max(col\_name)**

 **Eg: SQL>**select max(sal) from emp;

 **10000**

1. **Min():** This function returns the least value from group of values

 **Syn: min(col\_name)**

 **Eg: SQL>**select min(sal) from emp;

 **1000**

1. **Count():** This function counts the number of values in a group

 **Syn: count(col\_name)**

 **eg: SQL>**select count(sal) from emp;

 **5**

**DATE FUNCTIONS:**

**1. Sysdate:** This returns the system date in the format of dd-mon-yy.

 sql> select sysdate from dual;

 08-may-07

**2. last\_day():** This function returns the last date of a given date.

 **Syntax:**last\_day(date)

 sql> select last\_day(sysdate) from dual;

 31-may-07

**3. next\_day():** This function returns the next date of a given date.

 **Syntax:**next\_day(date,'dy')

sql> select next\_day(sysdate,'thu') from dual;

 10-may-07

**4. add\_months():** This function is used to add/subtract the number of months to a given date.

 **Syntax:**add\_months(date,no of months)

sql> select add\_months(sysdate,2) from dual;

 08-jul-07

sql> select add\_months(sysdate,-2) from dual;

 08-mar-07

**5. Months\_between():** This function returns the number of months present b/w two given dates.

 **Syntax:**months\_between(date1,date2)

sql> select months\_between(sydate,to\_date('01-jan-07')) from dual;

 4

**CONVERSION FUNCTIONS**

**1. To\_char():** This function converts a string/value into characters or in a specified format.

**Syntax:**to\_char(value,'format')

**Eg:**

**SQL>**select to\_char(sysdate,'dd-mon-yyyy') from dual;

 08-may-2007

**SQL>** select to\_char(sysdate,'w-dy') from dual;

 2-tue

**SQL>** select to\_char(sysdate,'q') from dual;

 2

**2. To\_date():** This function is used to convert a string value into date format

 **Syntax:**to\_date('value','format')

**Eg:**

**SQL>** select to\_date('10-mar-2007','dd-mon-yyyy') from dual;

 10-mar-07

**3. To\_number():**  This function converts a string value into numeric.

 **Syntax:**to\_number('value');

**Eg:**

**SQL>** select to\_number('10') + 10 from dual;

 20

**DDL commands with examples**

The DDL commands are **create, alter, drop, rename and truncate**

1. **CREATE:**

It is a Data Definition language. This command is used to create database objects.

 **Syntax:**

Create table tname

 (col1datatype(width) [default] [constraint ],

col2datatype(width) [default] [ constraint ],

col3datatype(width) [default] [ constraint ],

col4datatype(width) [default] [ constraint ],

col5datatype(width) [default] [constraint ],…..);

**Eg: SQL>** create table student

 ( rno number(4),

name varchar2(15),

gender char, doj date,

course varchar2(10), fees number(8));

 **Table created.**

1. **ALTER:**

It is a Data Definition language command. This command is used to perform the following tasks. They are –

1. Used to add new columns in the existed table.
2. Used to add constraints to the columns of a table.
3. Used to increase or decrease the column width of table.
4. Used to modify the type of a column.
5. Used to remove the constraints
6. Used to enable or disable the constraints
7. Used to remove the columns of a table.

 **Syntax:**

Alter table tname [add/modify/drop] [Enable/Disable] (col / constraint)

**SQL>** create table student(rno number(3), name varchar2(15));

 Table created

 **Eg:**

1. **SQL>** Alter table student add(sex char, doj date, course varchar2(15),

fees number(8));

 **Table altered**

1. **SQL>** Alter table student modify(rno number(5));

  **Table altered.**

1. **SQL>** Alter table student add(constraint t1 primary key(rno))

  **Table altered**

1. **SQL>** Alter table student add(constraint t2 check(rno>=1 and rno<=100));

  **Table altered.**

1. **SQL>** Alter table student disable constraint t1;

  **Table altered**

1. **SQL>** Alter table student enable constraint t1;

 **Table altered**

1. **SQL>** Alter table student drop constraint t1;

 **Table altered**

1. **SQL>** Alter table student drop column sex;

 **Table altered.**

1. **DROP:**

It is a Data Definition language command. This command is used to remove the database objects permanently from the database.

 **Syntax:** drop table <tname>

 **eg:** **SQL>** drop table student;

 **Table Dropped**

1. **Rename:** This command is used to rename the database objects

**Syntax:** Rename <oldTname> to <NewTname>

 **Eg: SQL>**Rename emp to employee;

 **Table Renamed**

1. **Truncate:**

It is a data definition language command. This command is used to remove all the records of a table permanently.

**Syntax**: Truncate table <tname>

 **Eg: SQL>** Truncate table student;

 **Table Truncated.**

**DML commands**

The Data manipulation language commands are used for inserting, modifying and deleting records in a table. The data manipulation language commands are

1. Insert
2. Delete
3. update
4. **Insert:**

It is a Data Manipulation language command. This command is used to insert values into a table.

 **Syntax-**1: ( Inserting values in all the columns of a table)

insert into tname values (&col1,'&col2','&col3','&col4',.....)

 **Syntax-2:** (inserting in selected columns of a table )

insert into tname ( col1,col2,col3) values (&col1,'&col2','&col3)

**Eg:**

SQL> insert into student values(&rno,'&name','&sex','&doj','&course',&fees)

 Enter value for rno = 101

Enter value for name = amjad

 Enter value for sex = m

 Enter value for doj = 10-jan-06

 Enter value for course = bsc

 Enter value for fees =6000

 **1 row created**

**Inserting values only in selected columns of a table:**

**SQL>** insert into student (rno,name,course) values (&rno,'&name','&course')

Enter value for rno =103

 Enter value for name = rahul

 Enter value for course =bcom

 **1 row created**

1. **DELETE**

It is a Data Manipulation Language command. This command is used to delete the rows/records of a table. The deleting of rows/records will be temporary, if we want to make them permanent deletion then commit command has to be implemented after deleting.

**Syntax: Delete Tname [where]**

**Eg:**

**SQL>** delete emp;

**SQL>** commit;

 Records of emp table will be deleted permanently.

**SQL>** delete emp where sal>=2000;

 This statement deletes the rows of emp table whose salary is >=2000

 **SQL>** delete emp where sal>=2500 and sal<=5000;

 This statement deletes the rows of emp table whose salary is >=2500

 and<=5000

1. **UPDATE**

It is a Data Manipulation Language command. This command is used to update/ modify the existed data of a table.

 **Syntax:**

Update tnameset col1=value, [<col2>=value , <col3>= value... ] [where]

**Eg: Create a table and insert 5 to 10 records without tot, avgs and grade**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Rno** | **Name** | **M1** | **M2** | **M3** | **Tot** | **Avgs** | **Grade** |
| **101** | **Anand** | **54** | **55** | **55** |  |  |  |
| **102** | **Sunil** | **78** | **77** | **80** |  |  |  |
| **103** | **Sami** | **45** | **44** | **56** |  |  |  |
| **104** | **Tahseen** | **55** | **52** | **57** |  |  |  |
| **105** | **Mohsin** | **45** | **46** | **47** |  |  |  |
| **106** | **Srikanth** | **55** | **08** | **59** |  |  |  |
| **107** | **Arun** | **36** | **37** | **39** |  |  |  |

**Eg:**

 **SQL>**update student set tot=m1+m2+m3, avgs=(m1+m2+m3)/3;

 **7 rows updated**

**SQL>** update student grade='Distinction' where m1>=35 and m2>=35 and

m3>=35 and avgs>=75

**SQL>** update student grade='First' where m1>=35 and m2>=35 and m3>=35

 And avgs>=60 and avgs<75

**SQL>** update student grade='Second' where m1>=35 and m2>=35 and

 m3>=35 and avgs>=50 and avgs<60

**SQL>** update student grade='Third' where m1>=35 and m2>=35 and m3>=35

 andavgs>=35 and avgs<50

**SQL>** update student grade='Fail' where m1<35 or m2<35 or m3<35;

**SQL>** Select \* from student;

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Rno** | **Name** | **M1** | **M2** | **M3** | **Tot** | **Avgs** | **Grade** |
| 101 | Anand | 54 | 55 | 55 | **164** | **54.67** | **Second** |
| 102 | Sunil | 78 | 77 | 80 | **235** | **78.33** | **Distinction** |
| 103 | Sami | 45 | 44 | 56 | **145** | **48.33** | **Third** |
| 104 | Tahseen | 55 | 52 | 57 | **164** | **54.67** | **Second** |
| 105 | Mohsin | 45 | 46 | 47 | **138** | **46** | **Third** |
| 106 | Srikanth | 55 | 08 | 59 | **122** | **40.67** | **Fail** |
| 107 | Arun | 36 | 37 | 39 | **112** | **37.33** | **Third** |

**Queries OR Select Statement**

Queries are one of the things that make databases so powerful. A **“Query”** is nothing but extracting either the entire data/records or required data from the database. A query can be performed by using Data Query language command called **“Select”.**

The **Select statement** is used to query or retrieve data from a table in the database. A query may retrieve information from specified columns or from all of the columns in the table. The Query can be performed either on a single table or on multiple tables. The select statement is used to perform either simple or complex queries.

**Syntax:**

 Select [distinct] [\*/<col1,col2,....>] [alias names] from <tname1> [,<tname2>,.]

[where] [order by] [group by] [having] [set operators] [joins] [sub-queries]

**Eg:**

* 1. **SQL>** select \* from tab;

 This statement displays list of objects available under a current user.

* 1. **SQL>**select \* from emp;

 This statement displays the rows of aemp table

* 1. **SQL>** select empno,ename,job,sal from emp;

 This statement displays the empno,ename,job and salary details

**Distinct:**

The distinct command in select statement allows the user to display unique data of the table

**Eg:**

1. **SQL>** select distinct empno from emp;
2. **SQL>** select distinct empno,ename from emp;

**Alias names:**

Alias names are nothing but the temporary names which can be set for the columns of a table while performing query.

**Eg:**

**SQL>**select empno as Employee\_No, ename as Emp\_Name, sal as Salary from emp;

 **Employee\_No Emp\_Name Salary**

 101 kiran 5000

 102 anand 5600

**SQL>**select empno,ename,sal, sal\*5/100 as bonus from emp;

 **empno ename sal bonus**

 101 anand 5000 250

**SELECT... WHERE CLAUSE**

The **where clause** in select statement allows the user to retrieve the data from the table as per the condition specified

**Eg:**

1. SQL> select \* from emp;
2. SQL> select \* from emp where sal>=5000;
3. SQL> select \* from emp where sal>=2500 and sal<=5000;
4. SQL> select \* from emp where sal between 2500 and 5000

**SELECT .. ORDER BY**

The order by clause in select statement allows the user to retrieve the data of a database either in ascending order or in descending order.

**Eg:**

**SQL>** select \* from emp order by empno ;

**SQL>** select \* from emp order by empnodesc;

**SQL>** select \* from emp where dept='computers' order by empno;

**SQL>** select \* from emp where dept='computers' order by empnodesc;

**SELECT .. GROUP BY**

**The group by clause** is used to divide the rows of a table into smaller groups based on specific column. Once the groups made, then group functions can be used to return summary information for each group. **The group by clause** in select statement is used to combine a group of rows based on the values of a particular column or expression.

**Eg**

 **Empno ename job sal**

 101 anand medical 5000

 102 rahul computers 6500

 103 ravi medical 2500

 104 sumith medical 3000

 105 rao executive 2500

 106 arvind steno 3000

**Eg:**

 **SQL>**select job from emp group by job

 **job**

medical

computers

executive

steno

**SQL>**select job,count(job) from emp group by job;

 **job count(job)**

 medical 3

 computers 1

 executive 1

 steno 1

SQL>select job,count(job),sum(sal) from emp group by job;

 **job count(job) sum(sal)**

 medical 3 10500

 computers 1 6500

 executive 1 2500

 steno 1 3000

SQL>select job,count(job),sum(sal),avg(sal) from emp group by job;

**job count(job) sum(sal) avg(sal)**

medical 3 10500

computers 1 6500

executive 1 2500

steno 1 3000

SQL>select job,count(job),sum(sal),max(sal) from emp group by job;

**Job count(job) sum(sal) max(sal)**

medical 3 10500 5000

computers 1 6500 6500

executive 1 2500 2500

steno 1 3000 3000

SQL>select job,count(job),sum(sal),max(sal),min(sal) from emp group by job;

 **job count(job) sum(sal) max(sal) min(sal)**

 medical 3 10,500 5000 2500

 computers 1 6,500 6500 6500

 executive 1 2,500 2500 2500

 steno 1 3,000 3000 3000

**SELECT .. GROUP BY .. HAVING Clause**

The **HAVING Clause** is very similar to **where clause** but the **Having clause** should always be used with Group By clause. **The Having clause** is also used to extract the required information from the table based on the condition specified.

**Eg:**

**SQL>**select job,count(job),sum(sal),max(sal),min(sal) from emp group by job;

 **job count(job) sum(sal) max(sal) min(sal)**

 medical 3 10,500 5000 2500

**SET OPERATORS**

The set operators are used to combine information of similar type from one or more than one table. The set operators look similar to SQL joins although there is a big difference. SQL joins tends to combine columns from different tables, whereas SQL set operators combine rows from different queries. There are different types of set operators. They are -

1. Union
2. Union All
3. Intersect
4. Minus
5. **UNION:**

This set operator is used to join the outputs of two or more queries into a single set of rows and columns having distinct records.

**Eg:**

**SQL>** select deptno from empunion selectdeptno from dept;

1. **UNION ALL:**

This set operator is used to join the outputs of two or more queries into a single set of rows and columns without the removal of any duplicates.

**Eg:**

**SQL>** select deptno from emp union all select deptno from dept;

1. **INTERSECT:**

This set operator is used to retrieve the data which is common in both tables.

**Eg:**

 **SQL>** select deptno from emp intersect select deptno from dept;

1. **MINUS:**

This set operator is used to retrieve the data one table which is not available in other table.

**Eg:**

**SQL>** select deptno from emp minus select deptno from dept;

 **SQL>** select deptno from dept minus select deptno from emp;

**SQL JOINS**

The joins are used to retrieve the data which is scattered in different tables. The joins are of different types. They are -

1. Simple join
2. Self join
3. Outer join
4. Cartesian Join
5. **Simple joins:**

In simple joins the rows of different table can be retrieved based on its respective conditions. The simple joins are of two types. They are -

1. Equi Join
2. Non-Equi Join
3. **Equi-join:**

In Equi-Join the rows of different tables can be retrieved based on equalities. The Equi-joins can be performed by using "=" operator

**Eg:**

**SQL>** select x.\* , y.\* from emp x, dept y where x.deptno=y.deptno;

**SQL>** select x.deptno,ename, sal,y.deptno,dname,loc from emp x, dept y

wherex.deptno = y.deptno;

1. **Non Equi joins:**

In non equi-joins the rows of different tables can be retrieved based on non-equalities. The Non-equi joins can be performed by using relational operators like >,< and <>

**Eg:**

**SQL>** select x.\* , y.\* from emp x, dept y where x.deptno<>y.deptno;

**SQL>** select x.deptno,ename, sal,y.deptno,dname,loc from emp x, dept y

 wherex.deptno>y.deptno;

1. **Self Joins:**

The Self join is mainly preferred to join a table with itself. This means that each row of the table is combined with itself and with every other row of the table. The Self join can be viewed as a join of two copies of the same table. The table is not actually copied, but SQL performs the command as though it were.

**Eg:**

**SQL>**Select x.ename || 'Worker of '|| y.ename from emp x, emp y where

x.mgr= y.empno;

1. **Outer Joins:**

This SQL Join condition returns all rows from both tables which satisfy the join condition along with rows which do not satisfy the join condition from one of the tables. In outer joins the rows of different tables can be retrieved. This is similar to the combination of Equi and non Equi joins. It means the rows of different tables can be retrieved either it equalities or non-equalities. The outer joins can be performed by using "(+)"

 **Eg:**

**SQL>** select x.deptno,ename,job,sal,y.deptno,dname,loc from emp x, dept y where x.deptno (+) = y.deptno;

**SQL>** select x.deptno,ename,job,sal,y.deptno,dname,loc from emp x, dept y where x.deptno = y.deptno (+);

**SUB-QUERIES**

Sub-query means placing an inner query within a WHERE or HAVING clause of outer query.

1. The inner query provides values for the search condition of the outer query. Such queries are referred to as sub-queries or nested sub-queries, and may be nested multiple times.
2. A statement containing sub-query is called a parent statement.
3. A sub-query is normally expressed inside parentheses.
4. The first query in the SQL statement is known as the outer query.
5. The query inside the SQL statement is known as the inner query.
6. The inner query is executed first.

**Advantages:**

1. Sub queries allow a developer to build powerful commands out of simple ones
2. The nested sub query is very useful when you need to select rows from a table with a condition that depends on the data in the table itself.

**Eg:**

 **SQL>**Select ename from emp where deptno =

 (select deptno from emp where ename=’MILLER’)

 **SQL>**Select ENAME from emp where sal = (select max(sal) from emp);

**CORRELATED SUBQUERIES**

A query is called correlated sub query when both the inner query and the outer query are interdependent. For every row processed by the inner query, the outer query is processed as well. The inner query depends on the outer query before it can be processed.

A correlated sub-query is nested sub-query which is executed once for each ‘candidate row’ considered by the main query and which on execution uses a value from a column in the outer query. This causes the correlated sub-query to be processed in a different way from the ordinary nested sub-query.

**Eg:SQL>**Select \* from emp x where sal> (select avg(sal) from emp where

deptno=x.deptno);

**Unit – V**

**Introduction of PL/SQL**

* + - * **PL/SQL** stands for **Procedural structured query language**.
			* A procedure can be defined as block of statements which performs a particular task.
			* It combines the data manipulation power of SQL and procedural power of standard programming languages.
			* It was developed by Oracle Corporation in the early 1990s to enhance the capabilities of SQL. So, it integrates well with SQL\*Plus and other application development products of Oracle.
			* PL/SQL is the superset of SQL. So, it fully supports SQL DML, TCL commands and SQL data types.
			* PL/SQL also has Boolean and composite data types to handle complex data.
			* It supports standard programming features such as control statements, procedures and functions.
			* PL/SQL is not a case-sensitive language. i.e, you can use both lowercase and uppercase letters in a PL/SQL code.

**PL/SQL Elements**

Like every other programming language, PL/SQL has a set of elements. They are

1. Identifiers
2. Reserve Words
3. Delimiters
4. character set
5. Literals
6. Lexical units
7. **Identifiers:**

Identifiers are used to name PL/SQL program items and units, which include constants, variables, exceptions, cursors, cursor variables, sub-programs and packages. To define identifiers the following rules to be followed.

1. The first character of identifier name should always begins with alphabet.
2. In between identifier name there should not any special symbol except underscore
3. Duplication identifier names cannot be defined
4. Reserved words should not be defined as identifiers
5. Identifier name should not exceed 30 characters
6. **Reserve Words:**

The words which are already existed in PL/SQL are known as reserved words and these words will have special syntactic meaning and so it cannot be redefined.

1. **Character set:**

PL/SQL programs are written as lines of text using a specific set of characters. The PL/SQL character set includes:

1. The upper and lower case letters
2. The numerals 0..9
3. Tabs, spaces and carriage returns
4. The special symbols
5. **Delimiters:**

Delimiters are simple or compound symbols that have special meaning in PL/SQL.

|  |  |
| --- | --- |
| **Symbol** | **Meaning** |
| + | Addition |
| - | Subtraction |
| \* | Multiplication |
| / | Division |
| = | Comparison operator |
| @ | Remote access indicator |
| ; | Semi-colon |
| <> | Not Equals to  |
| || | Concatenation |
| - - | Single line comment indicator |
| := | Assignment operator |

1. **Literals**

A literal is an explicit numeric, character, string or Boolean value that is not represented by an identifier.

1. Character Literals
2. Numeric Literals
3. **Character Literals:**

Character literals include all the printable characters in the PL/SQL character set: letters, numerals, spaces and special symbols. Character and Date literals must be enclosed in string quotes.

1. **Numeric literals:**

Numeric literals are of two types: Integer and Real. An integer literal is an optionally signed whole number without a decimal point.

**Eg:** 23,4545,-343,0,-23

**A real literal** is an optional signed whole or fractional number with a decimal point.

**Eg:** 6.453,34.23,-23.34

1. **Lexical Unit:**

A line of PL/SQL text contains groups of characters known as lexical units, which can be classified as follows:

1. Delimiters
2. Identifiers
3. Literals
4. Comments

**Structure of PL/SQL Block**

PL/SQL is a block-structured language. This means that programs can be divided into logical blocks. A PL/SQL block consists of up to four sections. They are

1. **Documentation Section:**

The documentation section comprises a set of comment lines giving **the name of program, author name, date on which the program is created and other details, which the programmer would like to refer at a later stage.** The comment can begin with **double minus symbols.**

1. **Declarative Section**

The declarative section of a PL/SQL block starts with the **keyword DECLARE**. This section is used to declare any place holders like **variables, constants, records and cursors,** which are used to manipulate data in the executable section.

1. **Executable Section**

The executable section of a PL/SQL block **starts with thekeyword BEGIN** and **ends with END**. This is the section where the program logic is written to perform any task. The programmatic constructs like loops, conditional statement and SQL statements from the part of the executable section

1. **Exception Handling Section**

The exception section of a PL/SQL block starts with the **keyword EXCEPTION.** Any errors in the program can be handled in this section, so that the PL/SQL blocks terminates gracefully. If the PL/SQL block contains exceptions that cannot be handled, the block terminates immediately with errors.

**Syntax:**

**DECLARE**

 **Variable Declarations;**

 **[Exception Declaration];**

 **[Cursor Declarations];**

 **BEGIN**

 **Executable statements**

 **EXCEPTION**

 **Exception Handlers**

 **END;**

**Control Structures**

The control structures or statements are of two types. They are

1. Conditional statements
2. Iterative Statements
3. **Conditional Statements**

The conditional statements are used to control the flow of execution of statements of a program. The conditional statements are –

1. simple if
2. if.. then else
3. if.. then elsif
4. Case Expression
5. **Simple if**

This conditional statement is used to execute the statements only when the condition is true otherwise it skips the if statement

**Syntax:**if (expression) then

 statement1;

 statement2;

 end if;

1. **if.. then else**

This conditional statement is used to execute the true statements only when the condition is true otherwise it executes the false statements.

**Syntax:**if (expression) then

 statement1;

 statement2;

 else

 statement1;

 statement2;

 end if;

1. **if.. then elsif:**

This conditional statement is also called as branching statement or ladder statement. This conditional statement is used to execute the statements based on its respective condition

**Syntax:** if(expression1) then

 statement1;

 statement2;

 elsif(expression2) then

 statement1;

 statement2;

 elsif(expression3) then

 statement1;

 statement2;

 end if;

1. **Case Expressions**

A case expression selects a result and returns it. To select the result, the **CASE** expression uses a selector, an expression whose value is used to select one of several alternatives. The selector is followed by one or more WHEN clauses, which are checked sequentially. The value of the selector determines which clause is executed. If the value of the selector equals the value of a WHEN-clause expression, that WHEN clause is executed.

**Syn:**CASE <expression>

 WHEN search\_condition1 then result1

 WHEN search\_condition2 then result2

 ….

 WHEN search\_condition\_N then result

 Else

 resultN+1

 END;

**Loops**

Executing a statement or group of statements for a repeated number of times, it is called as a loop. Oracle contains different types of loops. They are -

1. For .. loop
2. while .. loop
3. Loop .. end loop
4. **for .. loop:**

In this loop a statement or group of statements can be executed for a repeated number of times only when the condition is true otherwise it terminates the loop.

 **Syntax:** for <index> in [reverse] startingvalue ..stopingvalue loop

 statement1;

 statement2;

 end loop ;

1. **While ..loop:**

It is also called as a conditional loop. In this loop a statement or group of statements can be executed for a repeated number of times only when the condition is true otherwise the loop will be terminated.

 **Syntax**:

initial value;

 while(expression) loop

 statement1;

 statement2;

 changingvalue;

 end loop;

1. **Loop .. End loop**

It is also called as a conditional loop. In this loop a statement or group of statements can be executed first and then the condition will be verified. In this loop the statements can be executed for repeated number of times only when the condition is false otherwise the loop will be terminated.

 **Syntax:**initialvalue;

 loop

 statement1;

 statement2;

 changing value;

 exit when <expression>

 end loop;

**Unconditional Statements**

1. **Goto:** The PL/SQL goto statement is a sequential control structure available in Oracle. The goto statement immediately transfers program control unconditionally to a named statement label or block label. The statement or label name must be unique in the block.

**Syn:**Goto<<label\_name>>;

Where label\_name is the name of the label identifying the target statement

**Eg:**

DECLARE

 A NUMBER(3):=10;

 B NUMBER(3):=5;

BEGIN

 DBMS\_OUTPUT.PUT\_LINE(‘SUM=’||TO\_CHAR(A+B));

 GOTO RES;

 DBMS\_OUTPUT.PUT\_LINE(‘SUB=’||TO\_CHAR(A-B));

DBMS\_OUTPUT.PUT\_LINE(‘PROD=’||TO\_CHAR(A\*B));

 <<RES>>

 DBMS\_OUTPUT.PUT\_LINE(‘DIV=’||A/B);

END;

**OUTPUT:**

SUM=15

DIV=2

1. **Null Statement:**

Generally when you write a statement in the program, you want it to do something but in some cases you want to tell PL/SQL to do nothing and in such cases, NULL statement can be used. The NULL statement does nothing other than pass control to the next statement.

**Exceptions**

Exceptions are designed for run time error handling, rather than compile time error handling. Exceptions and exception handlers are the method by which the program reacts and deals with run time errors. When an error occurs, an exception is raised. When an exception occurs, the control is passed the exception handler, which is a separate section in the program. Error handling is separate from the rest of the program. This ensures that all errors are trapped. When error handling is separated from the rest of the program it helps in understanding the program logic better. Detecting and handling of the error is accomplished. Exceptions are of 2 types. They are

* 1. Pre-defined Exceptions
	2. User-defined Exceptions

**Pre-defined Exception**

A pre-defined exception is already defined by Oracle. A few of the pre-defined exceptions are

|  |  |
| --- | --- |
| **Pre-Defined Exception** | **Description** |
| **No\_Data\_Found** | This exception can be raised when a query/select statement will never return any rows from the table |
| **Value\_Error** | This exception can be raised when we try to insert a value in more than the specified width. |
| **Zero\_Divide** | This exception can be raised when we try to divide a number by zero |
| **Too\_many\_rows** | This exception can be raised when a query returns more than one row |
| **Dup\_val\_on\_Index** | This exception can be raised when we try to store duplicate values in a database column that is constrained by a unique index |
| **Invalid\_Number** | This exception can be raised when the conversion of character string to a number fails because the character string does not represent a valid number.  |
| **Cursor\_already\_open** | Trying to open an already open cursor. A cursor must be closed before it can be reopened. A cursor for loop automatically opens the cursor to which it refers. Hence, a cursor cannot be opened inside the loop. |
| **Program\_error** | PL/SQL has an internal problem |
| **Not\_Logged\_on** | The PL/SQL program issues a database call without being connected by Oracle. |
| **Storage\_Error** | PL/SQL runs out of memory or memory is corrupted. |

**User-defined Exceptions:**

A user-defined exception is an error that is defined by the program. The error that it signifies need not necessarily be an oracle error. Pre-defined exceptions correspond to common SQL errors.

User-defined exceptions are declared in the declarative section of the PL/SQL block. They have a type and can be declared as follows:

**Syn:** User\_Exception **Exception**

**CURSORS**

Oracle allocates an area of memory known as context area for the processing of SQL statements. The context area contains information necessary to complete the processing, including the number of rows processed by the statement, a pointer to the parsed representation of the statement.

A cursor is a handle or pointer to the context area. Through the cursor, a PL/SQL program can control the context the context area and what happens to it as the statement is processed. The cursors are classified into 2 types. They are –

* 1. Implicit cursors
	2. Explicit cursors

**Implicit Cursors:**

* PL/SQL implicitly declares cursors for all SQL data manipulation statements, including queries that return one rows. For queries that return more than one row, we should use explicit cursors to access the rows individually.
* Implicit cursor attributes can be used to access information about the most recently executed SQL statement. The most recently executed SQL statement is referred as SQLCURSOR.
* An implicit cursor need not be created. An implicit cursor should not be created, opened or closed. Here everything will be look after by the SELECT statement (Query) itself.

**Explicit Cursors:**

An explicit cursor is one in which the cursor name is explicitly assigned to the select statement. An explicit cursor allows the user to perform transactions on multiple rows at a time. Here the user has to create the cursor and it should be controlled by the user itself.

**CURSOR:** This procedure is used to create a cursor.

 **Syntax:** Cursor <cur\_name> is [select]

Once a cursor is created, it has to be controlled by using the following commands. They are -

1. Open
2. Fetch
3. Close

**Open:** This command is used to open the cursor which was created.

 **Syn: Open <cursor\_name>**

**Fetch:** This command is used to fetch the data to a variable from a cursor.

 **Syn: Fetch cursor\_name into var**

**Close:** This command is used to close the cursor which was opened.

 **Syn: close <cur\_name>**

**Attributes:**

The cursor can be controlled by using the following attributes. They are -

1. %notfound
2. %found
3. %rowcount
4. %isopen

**%NOT FOUND:**

This attribute allows the user to find whether a cursor contains rows or not. if a cursor contains rows then %notfound attribute returns true otherwise it return false

**%FOUND:**

This attribute allows the user to find whether a cursor contains rows or not if a cursor contains rows then it returns true otherwise it returns false.

**%ROWCOUNT:**

This attribute finds to how many rows a transaction is performed.

**%ISOPEN:**

This attribute allows the user to find whether a cursor is opened or not. If a cursor is open it returns true otherwise it returns false.

**TRIGGERS**

A database trigger is a stored procedure that is fired when an insert, update or delete statement is issued against the associated table. Database triggers can be used for the following purposes.

1. To generate data automatically
2. To enforce complex integrity constraints
3. To customize complex security authorizations
4. To maintain replicate tables
5. To audit data modifications

**Parts of trigger:**

A database trigger has three parts namely a trigger statement, a trigger body and a trigger restriction.

**Syntax:**

Create or replace trigger trig\_name [before/after] [insert/update/delete] on <tname>[for each row/ for each statement] [when clause]

 DECLARE

 variable declarations;

 BEGIN

 statement1;

 statement2;

 END;

**Trigger statement:**

The trigger statement specifies the DML statements like update, delete and insert and it fires the trigger body. It also specifies the table to which the trigger is associated.

**Trigger body:**

It is a PL/SQL block that is executed when a triggering statement is issued.

**Trigger restriction:**

Restrictions on a trigger can be achieved using the WHEN clause. When clause is evaluated for each row that is affected by the trigger

**Types of triggers**

 1. before

 2. after

 3. for each row

 4. for each statement

**Before / after option**

The before/after options can be used to specify when the trigger body should be fired with respect to the triggering statement. If the user includes a before option, then, oracle fires the trigger before executing the triggering statement. On the other hand, if after is used, then oracle fires the trigger after executing the triggering statement.

**For each row/ statement**

The for each row/ statement option when included in the **'create trigger'** syntax specifies that the trigger fires once per row. By default, a database trigger fires for each statement.

Using a combination of the above options, we can assign 12 triggers to a database table. Only one trigger of each type can be assigned to a table.

 1. Before update row/ statement

 2. Before delete row/ statement

 3. Before insert row/ statement

 4. After insert row / statement

 5. After update row / statement

 6. After delete row / statement

To raise uses defined error message we can use the command called 'raise\_application\_error'.

**Syntax**: raise\_application\_error(error\_no,'err\_msg')

The error\_number ranges from -20000 to -20999 and the error\_msg can be a string.

**Procedures**

A procedure is a sub-program that performs a specific action it is called as a procedure. A procedure will never return a value to a calling procedure.

A procedure has **two parts**, namely, **specifications** and **body**. The procedure specification begins with the keyword **procedure** and ends with the **procedure name** or **parameter list**. The procedure body begins with the keyword **“is”** and ends with the keyword **end**. It can also include **declarative, executable** and **exceptional parts** within the keywords are and end.

**Syntax:**

Create or replace procedure proc\_name [parameter list] is

 Local declarations;

Begin

 Executable statements;

[Exception]

End;

**The parameter list** can hold any of the following modes, **namely, in out and inout.** These parameter modes can be used within any sub program.

1. **In Parameter:**

The **in parameter mode** is used to pass values to the subprogram when invoked. It acts like a constant and therefore it cannot be assigned a value.

1. **Out Parameter:**

The **out parameter mode** is used to return values to the caller of a subprogram. Since the initial value for an out parameter is undefined, its value can be assigned to another variable.

1. **In out Parameter:**

The **in out parameter** is used to pass initial values to the sub program when invoked and it also returns updated values to the caller. An **in out parameter** acts like an initialized variable and therefore can be assigned to other variables or to itself.

**Note:** Once the procedure is created it can be called or executed by using the keyword **“Exec” followed by procedure name**

**Syn:** Exec proc\_Name(arg1,arg2)

**Functions**

A function is a sub program that computes a value. **A block of statements which performs a particular task is called as a function.** A function will always returns a value to a calling function.

**Syntax:**

**Create or replace function fun\_name(arguments) return datatype is**

 **Local declarations**

**Begin**

 **Executable statements**

**[Exception]**

 **Exception Handlers
End;**

**Packages**

A package is a database object, which is an encapsulation of related PL/SQL types, subprograms, cursors, exceptions, variables and constants. It consists of two parts, a specification and a body. In the package specification we can declare types, variables, constants, exceptions, cursors and subprograms. A package body implements cursors, subprograms defined in the package specification.

Packages can be created by using the following commands.

1. Create package command
2. Create package body command

**Package Specification**

The package specification contains public objects and types. It can also include subprograms. The specification contains the package resources required for our application.

If a package specification declares only types, **constants, variables** and **exceptions**, then we need not include package body, because all the information required for the usage of types, constants, variables and exceptions are specified in the specification. Only subprograms and cursors have an underlying implementation or definition and hence have to include package body.

**Syn: Create or replace package <pack\_name> is**

 **Begin**

Procedure declarations;

 Function declarations;

 **End [pack\_name];**

**Package body:**

The package body contains the definition of every cursor and subprogram declared in the package specification and implements them. Private declarations can also be included in a package body.

The initialization part of the package body is optional, it may consists of statements that initialize some of the variables previously declared in the package. The initialization part of a package plays a minor role, because neither can a package can be called nor parameters be passed to the package. Therefore, the initialization part of a package is run only once.

**Syn:**

 **Create package body <pack\_name> as**

 **Begin**

 Procedure definitions;

 Function definitions;

 **End;**

**Calling Packaged subprograms:**

To reference the types, objects and subprograms declared in a package specification the following notation is used.

**Syntax:**

 Package\_name.type\_name;

 Package\_name.object\_name;

 Package\_name.subprogram\_name;