Database Management system 2019 year Question paper solution

BCA Fourth Semester (Tribhuwan University)

GROUP A

i) **Which of the following is the process of decomposing unsatisfactory relations by breaking up their attributes into smaller relations?**
a) Neutralization b) Breakdown c) Decomposition **d) Normalization**

ii) **Which of the following abstraction level hides the details of data types?**
a) View Level b) Physical Level C) Logical Level d) Abstract Level

iii) **In relation algebra, which of the following is used to select certain columns from relation.**
a) **Select** b) Project C) Certain d) Join

iv) **In ER diagram, which of the following relationship is used to recognize weak entity set?**
a) Non-Identifying Relationship b) Identifying Relationship C) Weak Relationship d) N-ary Relationship

v) **To use union, intersection operation between any two relations, they should be**
a) Union Compatible b) Intersection Compatible c) Both a and b d) derived relations

vi) **Two Schedules are said to be ------- if the order of any two conflicting oerations is the same in both schedules.**
a) Conflict Serialization b) Serial Schedule c) Conflict Equivalent d) Ordered Schedule

vii) **Which of the following are the types of ordered indices?**
a) Dense and Sparse b) Sparse and Granular c) Comact and close d) Dense and Complex

viii) **Which of the following is used together with the select clause in SQL to uniquely lit the values?**
a) Unique b) once c) Single d) Distinct

ix) **Which of the following SSQL Query is used to change the schema of an existing table in a database?**
a) Create b) Update c) Alter d) Drop

x) **……defines that an entity can be a member of at most one of the subclass of the specialization.**
a) Dis-Jointness b) Superclass c) Overlap d) Specific Subclass

GROUP B

2. What is DBMS? Describe the merits of using DBMS.

Database Management System (DBMS) is a software for storing and retrieving users' data while considering appropriate security measures. It consists of a group of programs which manipulate the database. The DBMS accepts the request for data from an application and instructs the operating system to provide the specific data. In large systems, a DBMS helps users and other third-party software to store and retrieve data.

DBMS allows users to create their own databases as per their requirement. The term "DBMS" includes the user of the database and other application programs. It provides an interface between the data and the software application.

Reducing Data Redundancy

The file based data management systems contained multiple files that were stored in many different locations in a system or even across multiple systems. Because of this, there were sometimes multiple copies of the same file which lead to data redundancy.

This is prevented in a database as there is a single database and any change in it is reflected immediately. Because of this, there is no chance of encountering duplicate data.

Sharing of Data

In a database, the users of the database can share the data among themselves. There are various levels of authorisation to access the data, and consequently the data can only be shared based on the correct authorisation protocols being followed.

Many remote users can also access the database simultaneously and share the data between themselves.

Data Integrity

Data integrity means that the data is accurate and consistent in the database. Data Integrity is very important as there are multiple databases in a DBMS. All of these databases contain data that is visible to multiple users. So it is necessary to ensure that the data is correct and consistent in all the databases and for all the users.

Data Security

Data Security is vital concept in a database. Only authorised users should be allowed to access the database and their identity should be authenticated using a username and password. Unauthorised users should not be allowed to access the database under any circumstances as it violates the integrity constraints.

Privacy

The privacy rule in a database means only the authorized users can access a database according to its privacy constraints. There are levels of database access and a user can only view the data he is allowed to. For example - In social networking sites, access constraints are different for different accounts a user may want to access.

Backup and Recovery

Database Management System automatically takes care of backup and recovery. The users don't need to backup data periodically because this is taken care of by the DBMS. Moreover, it also restores the database after a crash or system failure to its previous condition.

Data Consistency

Data consistency is ensured in a database because there is no data redundancy. All data appears consistently across the database and the data is same for all the users viewing the database. Moreover, any changes made to the database are immediately reflected to all the users and there is no data inconsistency.

3. What is Data Model? What is the difference between hierarchical and network data model? what are its types?

Data models define how the logical structure of a database is modeled. Data Models are fundamental entities to introduce abstraction in a DBMS. Data models define how data is connected to each other and how they are processed and stored inside the system.

The very first data model could be flat data-models, where all the data used are to be kept in the same plane. Earlier data models were not so scientific, hence they were prone to introduce lots of duplication and update anomalies.

Hierarchical model	Network model
Not possible to map many to many relationships. only one-to-many or one-to-one relationships can be exist.	possible to map many to many relationships
does not provide an independent stand alone query interface like SQL	uses CODASYL (Conference on Data Systems Languages)
Insertion anomaly (problem in insert operation) because cannot insert the information of a child who does not have parent.	Free from insertion anomaly.
Update anomaly because a child record may have multiple occurrences (exist at more than one place).	Free from update anomaly. because a record has single occurrence(exist at one place).
Deletion anomaly. because deletion of parent results in deletion of child Records.	free from deletion anomalies. Because information is stored in different tables.

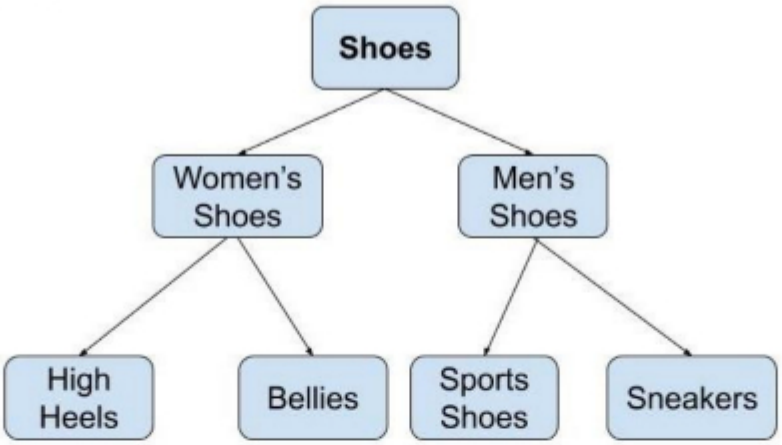
Some of the Data Models in DBMS are:

I. Hierarchical Model
II. Network Model
III. Entity-Relationship Model
IV. Relational Model
V. Object-Oriented Data Model
VI. Object-Relational Data Model
VII. Flat Data Model
VIII. Semi-Structured Data Model
IX. Associative Data Model
X. Context Data Model

Hierarchical Model

Hierarchical Model was the first DBMS model. This model organises the data in the hierarchical tree structure. The hierarchy starts from the root which has root data and then it expands in the form of a tree adding child node to the parent node. This model easily represents some of the real-world relationships

like food recipes, sitemap of a website etc. ***Example:*** We can represent the relationship between the shoes present on a shopping website in the following way:



Hierarchical Model

Features of a Hierarchical Model

1. ***One-to-many relationship:*** The data here is organised in a tree-like structure where the one-to-many relationship is between the datatypes. Also, there can be only one path from parent to any node. ***Example:*** In the above example, if we want to go to the node *sneakers* we only have one path to reach there i.e through men's shoes node.
2. ***Parent-Child Relationship:*** Each child node has a parent node but a parent node can have more than one child node. Multiple parents are not allowed.
3. ***Deletion Problem:*** If a parent node is deleted then the child node is automatically deleted.
4. ***Pointers:*** Pointers are used to link the parent node with the child node and are used to navigate between the stored data. *Example:* In the above example the '*shoes*' node points to the two other nodes '*women shoes*' node and '*men's shoes*' node.

Advantages of Hierarchical Model

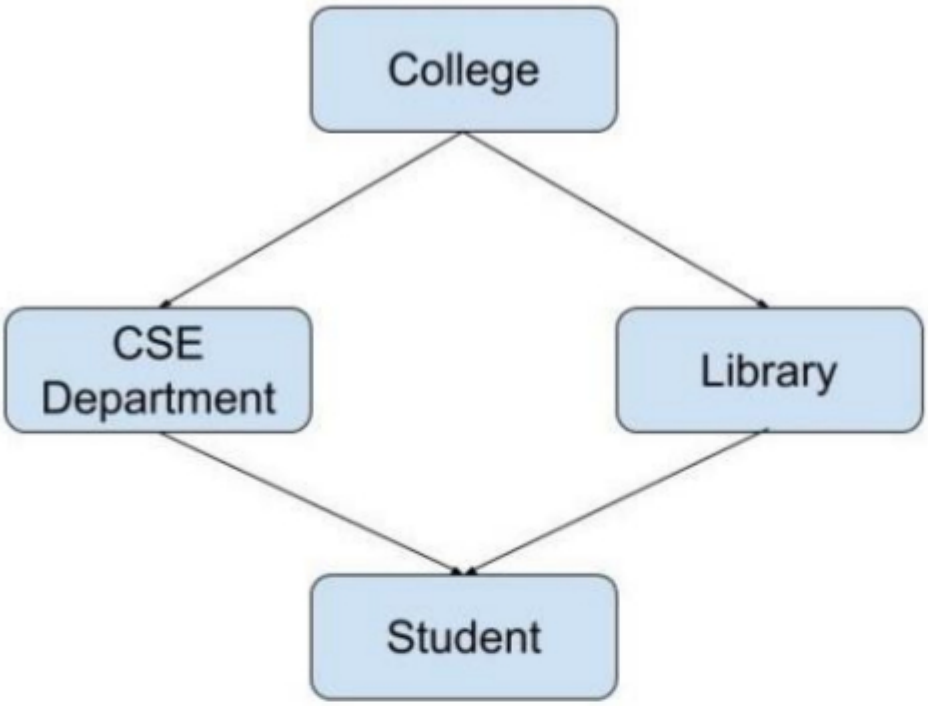
- It is very simple and fast to traverse through a tree-like structure.
- Any change in the parent node is automatically reflected in the child node so, the integrity of data is maintained.

Disadvantages of Hierarchical Model

- Complex relationships are not supported.
- As it does not support more than one parent of the child node so if we have some complex relationship where a child node needs to have two parent node then that can't be represented using this model.
- If a parent node is deleted then the child node is automatically deleted.

Network Model

This model is an extension of the hierarchical model. It was the most popular model before the relational model. This model is the same as the hierarchical model, the only difference is that a record can have more than one parent. It replaces the hierarchical tree with a graph. ***Example:*** In the example below we can see that node student has two parents i.e. CSE Department and Library. This was earlier not possible in the hierarchical model.



Network Model

Features of a Network Model

1. ***Ability to Merge more Relationships:*** In this model, as there are more relationships so data is more related. This model has the ability to manage one-to-one relationships as well as many-to-many relationships.
2. ***Many paths:*** As there are more relationships so there can be more than one path to the same record. This makes data access fast and simple.
3. ***Circular Linked List:*** The operations on the network model are done with the help of the circular linked list. The current position is maintained with the help of a program and this position navigates through the records according to the relationship.

Advantages of Network Model

- The data can be accessed faster as compared to the hierarchical model. This is because the data is more related in the network model and there can be more than one path to reach a particular node. So the data can be accessed in many ways.
- As there is a parent-child relationship so data integrity is present. Any change in parent record is reflected in the child record.

Disadvantages of Network Model

- As more and more relationships need to be handled the system might get complex. So, a user must be having detailed knowledge of the model to work with the model.
- Any change like updation, deletion, insertion is very complex.

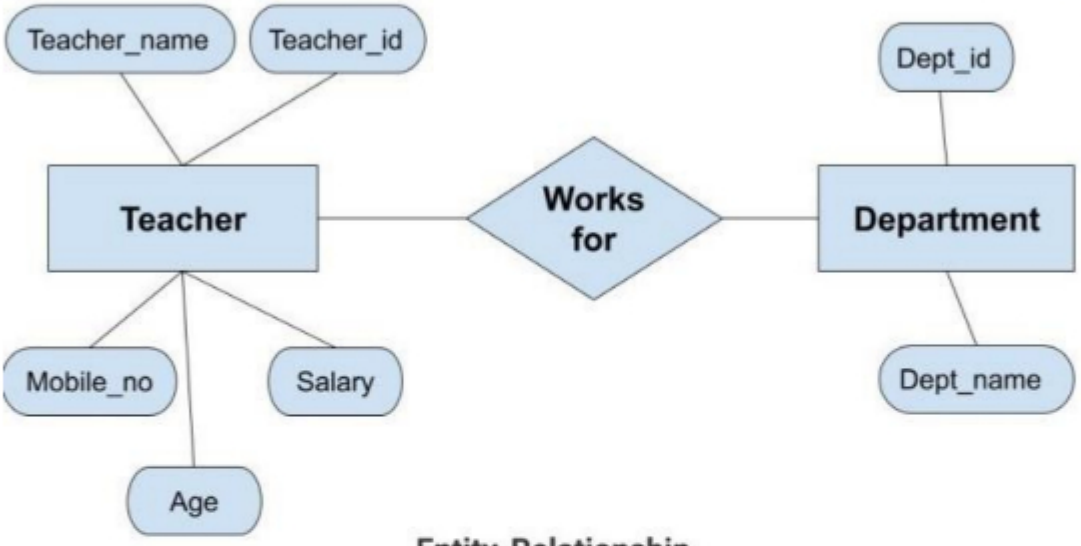
Entity-Relationship Model

Entity-Relationship Model or simply ER Model is a high-level data model diagram. In this model, we represent the real-world problem in the pictorial form to make it easy for the stakeholders to understand. It is also very easy for the developers to understand the system by just looking at the ER diagram. We use

the ER diagram as a visual tool to represent an ER Model. ER diagram has the following three components:

- ***Entities:*** Entity is a real-world thing. It can be a person, place, or even a concept. *Example:* Teachers, Students, Course, Building, Department, etc are some of the entities of a School Management System.
- ***Attributes:*** An entity contains a real-world property called attribute. This is the characteristics of that attribute. *Example:* The entity teacher has the property like teacher id, salary, age, etc.
- ***Relationship:*** Relationship tells how two attributes are related. *Example:* Teacher works for a department.

Example:



Entity-Relationship Model

In the above diagram, the entities are Teacher and Department. The attributes of ***Teacher*** entity are Teacher_Name, Teacher_id, Age, Salary, Mobile_Number. The attributes of entity ***Department*** entity are Dept_id, Dept_name. The two entities are connected using the relationship. Here, each teacher works for a department.

Features of ER Model

- ***Graphical Representation for Better Understanding:*** It is very easy and simple to understand so it can be used by the developers to communicate with the stakeholders.
- ***ER Diagram:*** ER diagram is used as a visual tool for representing the model.
- ***Database Design:*** This model helps the database designers to build the database and is widely used in database design.

Advantages of ER Model

- ***Simple:*** Conceptually ER Model is very easy to build. If we know the relationship between the attributes and the entities we can easily build the ER Diagram for the model.
- ***Effective Communication Tool***: This model is used widely by the database designers for communicating their ideas.
- ***Easy Conversion to any Model***: This model maps well to the relational model and can be easily converted relational model by converting the ER model to the table. This model can also be converted to any other model like network model, hierarchical model etc.

Disadvatages of ER Model

- ***No industry standard for notation:*** There is no industry standard for developing an ER model. So one developer might use notations which are not understood by other developers.
- ***Hidden information:*** Some information might be lost or hidden in the ER model. As it is a high-level view so there are chances that some details of information might be hidden.

Relational Model

Relational Model is the most widely used model. In this model, the data is maintained in the form of a two-dimensional table. All the information is stored in the form of row and columns. The basic structure of a relational model is tables. So, the tables are also called *relations* in the relational model. ***Example:*** In this example, we have an Employee table.

Emp_id	Emp_name	Job_name	Salary	Mobile_no	Dep_id	Project_id
AfterA001	John	Engineer	100000	9111037890	2	99
AfterA002	Adam	Analyst	50000	9587569214	3	100
AfterA003	Kande	Manager	890000	7895212355	2	65

EMPLOYEE TABLE

Features of Relational Model

- ***Tuples***: Each row in the table is called tuple. A row contains all the information about any instance of the object. In the above example, each row has all the information about any specific individual like the first row has information about John.
- ***Attribute or field:*** Attributes are the property which defines the table or relation. The values of the attribute should be from the same domain. In the above example, we have different attributes of the *employee* like Salary, Mobile_no, etc.

Advnatages of Relational Model

- ***Simple:*** This model is more simple as compared to the network and hierarchical model.
- ***Scalable:*** This model can be easily scaled as we can add as many rows and columns we want.
- ***Structural Independence:*** We can make changes in database structure without changing the way to access the data. When we can make changes to the database structure without affecting the capability to DBMS to access the data we can say that structural independence has been achieved.

Disadvantages of Relatinal Model

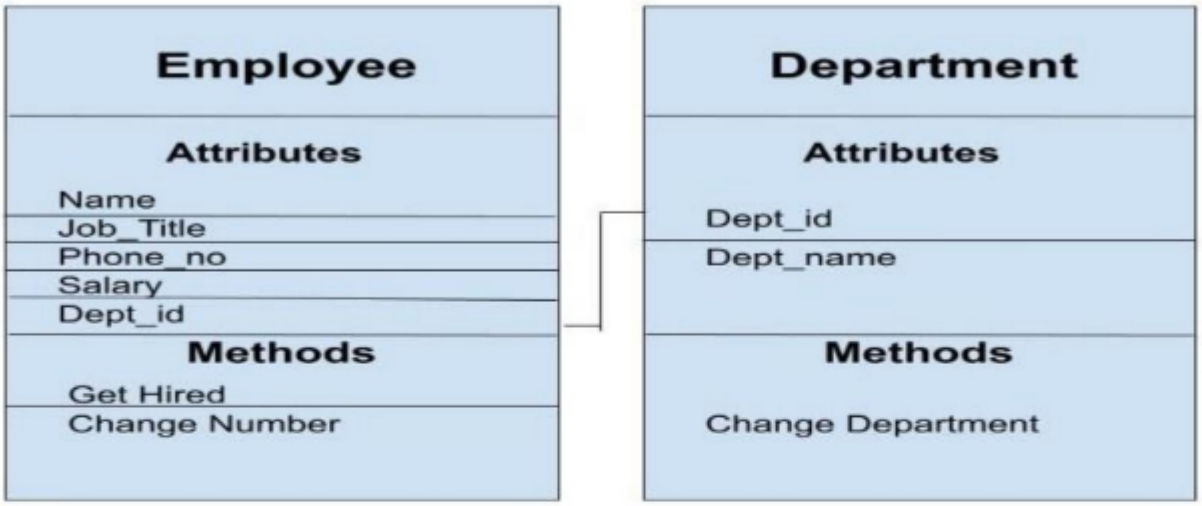
- ***Hardware Overheads:*** For hiding the complexities and making things easier for the user this model requires more powerful hardware computers and data storage devices.
- ***Bad Design:*** As the relational model is very easy to design and use. So the users don't need to know how the data is stored in order to access it. This ease of design can lead to the development of a poor database which would slow down if the database grows.

But all these disadvantages are minor as compared to the advantages of the relational model. These problems can be avoided with the help of proper implementation and organisation.

Object-Oriented Data Model

The real-world problems are more closely represented through the object-oriented data model. In this model, both the data and relationship are present in a single structure known as an object. We can store

audio, video, images, etc in the database which was not possible in the relational model(although you can store audio and video in relational database, it is adviced not to store in the relational database). In this model, two are more objects are connected through links. We use this link to relate one object to other objects. This can be understood by the example given below.



Object_Oriented_Model

In the above example, we have two objects Employee and Department. All the data and relationships of each object are contained as a single unit. The attributes like Name, Job_title of the employee and the methods which will be performed by that object are stored as a single object. The two objects are connected through a common attribute i.e the Department_id and the communication between these two will be done with the help of this common id.

Object-Relational Model

As the name suggests it is a combination of both the relational model and the object-oriented model. This model was built to fill the gap between object-oriented model and the relational model. We can have many advanced features like we can make complex data types according to our requirements using the existing data types. The problem with this model is that this can get complex and difficult to handle. So, proper understanding of this model is required.

Flat Data Model

It is a simple model in which the database is represented as a table consisting of rows and columns. To access any data, the computer has to read the entire table. This makes the modes slow and inefficient.

Semi-Structured Model

Semi-structured model is an evolved form of the relational model. We cannot differentiate between data and schema in this model. ***Example:*** Web-Based data sources which we can't differentiate between the schema and data of the website. In this model, some entities may have missing attributes while others may have an extra attribute. This model gives flexibility in storing the data. It also gives flexibility to the attributes. ***Example:*** If we are storing any value in any attribute then that value can be either atomic value or a collection of values.

Associative Data Model

Associative Data Model is a model in which the data is divided into two parts. Everything which has independent existence is called as an *entity* and the relationship among these entities are called *association*. The data divided into two parts are called items and links.

- ***Item***: Items contain the name and the identifier(some numeric value).

- ***Links:*** Links contain the identifier, source, verb and subject.

Example: Let us say we have a statement "The world cup is being hosted by London from 30 May 2020". In this data two links need to be stored:

1. The world cup is being hosted by London. The source here is 'the world cup', the verb 'is being' and the target is 'London'.
2. ...from 30 May 2020. The source here is the previous link, the verb is 'from' and the target is '30 May 2020'.

This is represented using the table as follows:

Items

Identifiers	Name
89	The world cup
95	Is being hosted
40	By London
44	from
10	30 May 2020

Links

Identifiers	Source	Verb	Target
70	89	95	40
75	70	44	10

ASSOCIATIVE MODEL

Context Data Model

Context Data Model is a collection of several models. This consists of models like network model, relational models etc. Using this model we can do various types of tasks which are not possible using any model alone.

4. why indexing is essential in database? Differentiate dense index from sparse index with suitable example.

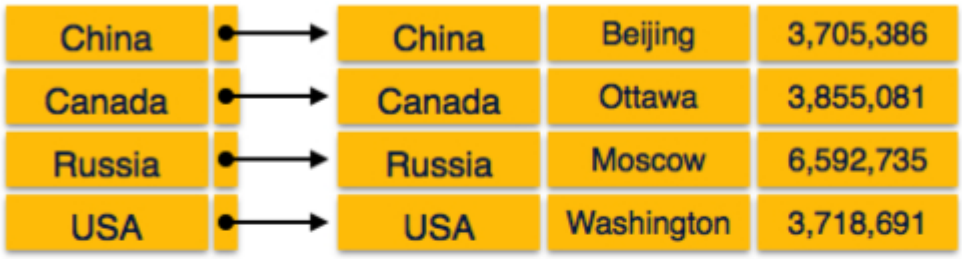
A database index is a data structure that improves the speed of data retrieval operations on a database table at the cost of additional writes and storage space to maintain the index data structure. Indices are used to quickly locate data without having to search every row in a database table every time a database table is accessed.

An index is a specific structure that organizes a reference to your data that makes it easier to look up. When accessing data, Postgres will either use some form of an index if it exists or a sequential scan.

Sequential scan – is when it searches over all of the data before returning the results.

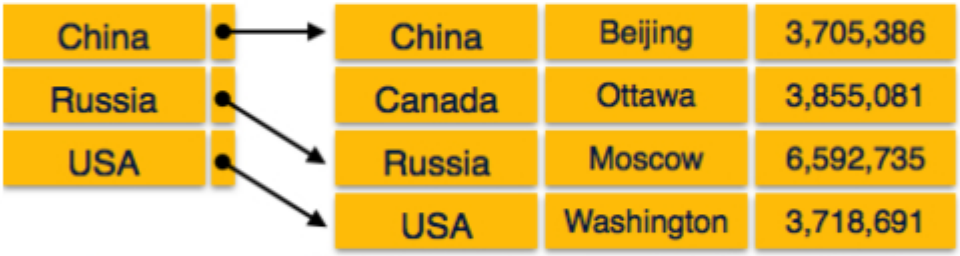
Dense Index

In the dense index, there is an index record for every search key value in the database. This makes searching faster but requires more space to store index records itself. Index records contain search key value and a pointer to the actual record on the disk.



Sparse Index

In the sparse index, index records are not created for every search key. An index record here contains a search key and an actual pointer to the data on the disk. To search a record, we first proceed by index record and reach at the actual location of the data. If the data we are looking for is not where we directly reach by following the index, then the system starts the sequential search until the desired data is found.



5.Discuss about materialized and pipelined evaluation of query expression in query optimization

- In the query processing system, we use two methods for evaluating an expression carrying multiple operations. These methods are:

a. Materialization

In this method, the given expression evaluates one relational operation at a time. Also, each operation is evaluated in an appropriate sequence or order. After evaluating all the operations, the outputs are materialized in a temporary relation for their subsequent uses. It leads the materialization method to a disadvantage. The disadvantage is that it needs to construct those

temporary relations for materializing the results of the evaluated operations, respectively. These temporary relations are written on the disks unless they are small in size.

b. Pipelining

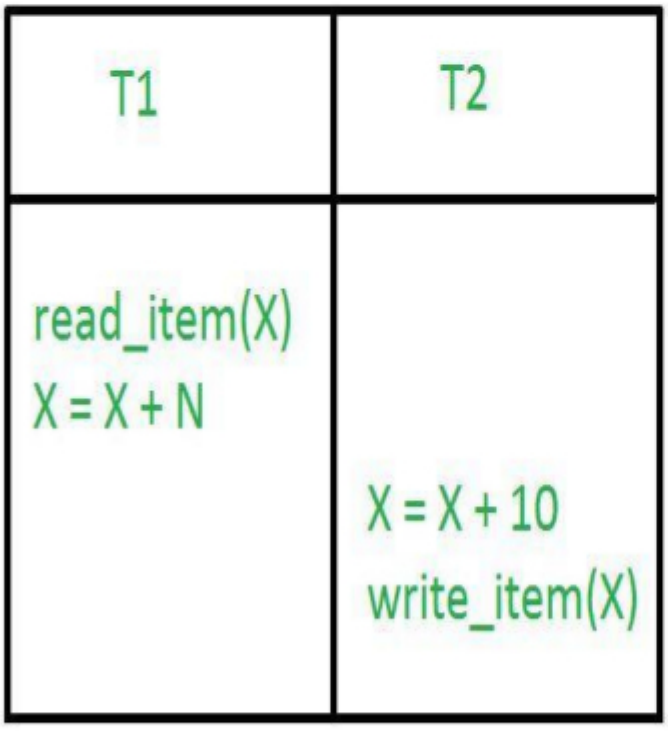
Pipelining is an alternate method or approach to the materialization method. In pipelining, it enables us to evaluate each relational operation of the expression simultaneously in a pipeline. In this approach, after evaluating one operation, its output is passed on to the next operation, and the chain continues till all the relational operations are evaluated thoroughly. Thus, there is no requirement of storing a temporary relation in pipelining. Such an advantage of pipelining makes it a better approach as compared to the approach used in the materialization method. Even the costs of both approaches can have subsequent differences in-between. But both approaches perform the best role in different cases. Thus, both ways are feasible at their place.

6.Explain with examples, how lost update and dirty read problems can occur in sentence of transactions?

Lost Update Problem:

In the lost update problem, update done to a data item by a transaction is lost as it is overwritten by the update done by another transaction.

Example:



In the above example, transaction 1 changes the value of X but it gets overwritten by the update done by transaction 2 on X. Therefore, the update done by transaction 1 is lost.

Dirty Read Problems (W-R Conflict)

The dirty read problem occurs *when one transaction updates an item of the database, and somehow the transaction fails, and before the data gets rollback, the updated database item is accessed by another transaction. There comes the Read-Write Conflict between both transactions.*

For example:

Consider two transactions T_X and T_Y in the below diagram performing read/write operations on account A where the available balance in account A is $300:

Time	T_x	T_y
t_1	READ (A)	—
t_2	A = A + 50	—
t_3	WRITE (A)	—
t_4	—	READ (A)
t_5	SERVER DOWN ROLLBACK	—

DIRTY READ PROBLEM

- At time t1, transaction T_X reads the value of account A, i.e., $300.
- At time t2, transaction T_X adds $50 to account A that becomes $350.
- At time t3, transaction T_X writes the updated value in account A, i.e., $350.
- Then at time t4, transaction T_Y reads account A that will be read as $350.
- Then at time t5, transaction T_X rollbacks due to server problem, and the value changes back to $300 (as initially).
- But the value for account A remains $350 for transaction T_Y as committed, which is the dirty read and therefore known as the Dirty Read Problem.

7. How timestaimp ordering protocol is used to ensure concurrency control?

- Timestamp Ordering Protocol

- The Timestamp Ordering Protocol is used to order the transactions based on their Timestamps. The order of transaction is nothing but the ascending order of the transaction creation.
- The priority of the older transaction is higher that's why it executes first. To determine the timestamp of the transaction, this protocol uses system time or logical counter.
- The lock-based protocol is used to manage the order between conflicting pairs among transactions at the execution time. But Timestamp based protocols start working as soon as a transaction is created.
- Let's assume there are two transactions T1 and T2. Suppose the transaction T1 has entered the system at 007 times and transaction T2 has entered the system at 009 times. T1 has the higher priority, so it executes first as it is entered the system first.
- The timestamp ordering protocol also maintains the timestamp of last 'read' and 'write' operation on a data.

Basic Timestamp ordering protocol works as follows:

1. Check the following condition whenever a transaction Ti issues a Read (X) operation:
   - If W_TS(X) >TS(Ti) then the operation is rejected.
   - If W_TS(X) <= TS(Ti) then the operation is executed.
   - Timestamps of all the data items are updated.
2. Check the following condition whenever a transaction Ti issues a Write(X) operation:
   - If TS(Ti) < R_TS(X) then the operation is rejected.
   - If TS(Ti) < W_TS(X) then the operation is rejected and Ti is rolled back otherwise the operation is executed.

Where,

TS(TI) denotes the timestamp of the transaction Ti.

R_TS(X) denotes the Read time-stamp of data-item X.

W_TS(X) denotes the Write time-stamp of data-item X.

Advantages and Disadvantages of TO protocol:

- TO protocol ensures serializability since the precedence graph is as follows:

Image: Precedence Graph for TS ordering

- TS protocol ensures freedom from deadlock that means no transaction ever waits.
- But the schedule may not be recoverable and may not even be cascade- free.

8. What is the advantage and Disadvantage of using stored procedure? How can you create and execute stored procedure?

A **Stored Procedure** is a type of code in SQL that can be stored for later use and can be used many times. So, whenever you need to execute the query, instead of calling it you can just call the stored procedure. You can also pass parameters to a stored procedure, so that the stored procedure can act based on the parameter values that is passed.

Syntax :

Syntax :

```
CREATE PROCEDURE procedure_name
AS
sql_statement
GO;
```

To execute a stored procedure –

```
EXEC procedure_name;
```

Example :

```
CREATE PROCEDURE SelectAllGeeks
AS
SELECT *
FROM Geeks
GO;
```

Advantages :

The main advantages of stored procedure are given below:

1. **Better Performance –**
   The procedure calls are quick and efficient as stored procedures are compiled once and stored in executable form.Hence the response is quick. The executable code is automatically cached, hence lowers the memory requirements.
2. **Higher Productivity –**
   Since the same piece of code is used again and again so, it results in higher productivity.
3. **Ease of Use –**
   To create a stored procedure, one can use any Java Integrated Development Environment (IDE). Then, they can be deployed on any tier of network architecture.
4. **Scalability –**
   Stored procedures increase scalability by isolating application processing on the server.
5. **Maintainability –**
   Maintaining a procedure on a server is much easier then maintaining copies on various client machines, this is because scripts are in one location.

6. **Security –**
   Access to the Oracle data can be restricted by allowing users to manipulate the data only through stored procedures that execute with their definer's privileges.

Disadvantages :
The main disadvantages of stored procedures are given below:

1. **Testing –**
   Testing of a logic which is encapsulated inside a stored procedure is very difficult. Any data errors in handling stored procedures are not generated until runtime.
2. **Debugging –**
   Depending on the database technology, debugging stored procedures will either be very difficult or not possible at all. Some relational databases such as SQL Server have some debugging capabilities.
3. **Versioning –**
   Version control is not supported by the stored procedure.
4. **Cost –**
   An extra developer in the form of DBA is required to access the SQL and write a better stored procedure. This will automatically incur added cost.
5. **Portability –**
   Complex stored procedures will not always port to upgraded versions of the same database. This is specially true in case of moving from one database type(Oracle) to another database type(MS SQL Server).

Advantages	Disadvantages
• It is faster. • It is pre-compiled. • It reduces network traffic. • It is reusable. • It's security is high	• It is difficult to debug. • Need expert developer, since difficult to write code. • It is database dependent. • It is non-portable. • It is expensive.

GROUP C

9. Design an ER diagram for Hospital System. Use your assumption for the selection attributes, entities and relationships. Show the use of total and partial participation along with the appropriate cardinalities,

10 Discuss the importance of normalization in DBMS, Describe 1NF, 2NF. And 3NF with examples.

Normalization is the process of minimizing **redundancy** from a relation or set of relations. Redundancy in relation may cause insertion, deletion and updation anomalies. So, it helps to minimize the redundancy in relations. **Normal forms** are used to eliminate or reduce redundancy in database tables.

1. First Normal Form –

If a relation contain composite or multi-valued attribute, it violates first normal form or a relation is in first normal form if it does not contain any composite or multi-valued attribute. A relation is in first normal form if every attribute in that relation is **singled valued attribute**.

- **Example 1** – Relation STUDENT in table 1 is not in 1NF because of multi-valued attribute STUD_PHONE. Its decomposition into 1NF has been shown in table 2.

STUD_NO	STUD_NAME	STUD_PHONE	STUD_STATE	STUD_COUNTRY
1	RAM	9716271721, 9871717178	HARYANA	INDIA
2	RAM	9898297281	PUNJAB	INDIA
3	SURESH		PUNJAB	INDIA

Table 1

Conversion to first normal form

STUD_NO	STUD_NAME	STUD_PHONE	STUD_STATE	STUD_COUNTRY
1	RAM	9716271721	HARYANA	INDIA
1	RAM	9871717178	HARYANA	INDIA
2	RAM	9898297281	PUNJAB	INDIA
3	SURESH		PUNJAB	INDIA

Table 2

- **Example 2 –**

```
ID   Name   Courses
-----------------
1    A      c1, c2
2    E      c3
3    M      C2, c3
```

In the above table Course is a multi valued attribute so it is not in 1NF.

Below Table is in 1NF as there is no multi valued attribute

ID	Name	Course
1	A	c1
1	A	c2
2	E	c3
3	M	c2
3	M	c3

2. Second Normal Form –

To be in second normal form, a relation must be in first normal form and relation must not contain any partial dependency. A relation is in 2NF if it has **No Partial Dependency,** i.e., no non-prime attribute (attributes which are not part of any candidate key) is dependent on any proper subset of any candidate key of the table.

Partial Dependency – If the proper subset of candidate key determines non-prime attribute, it is called partial dependency.

- **Example 1 –** Consider table-3 as following below.

STUD_NO	COURSE_NO	COURSE_FEE
1	C1	1000
2	C2	1500
1	C4	2000
4	C3	1000
4	C1	1000
2	C5	2000

{Note that, there are many courses having the same course fee. }

Here,
COURSE_FEE cannot alone decide the value of COURSE_NO or STUD_NO;
COURSE_FEE together with STUD_NO cannot decide the value of COURSE_NO;
COURSE_FEE together with COURSE_NO cannot decide the value of STUD_NO;
Hence,
COURSE_FEE would be a non-prime attribute, as it does not belong to the one only candidate key {STUD_NO, COURSE_NO} ;
But, COURSE_NO -> COURSE_FEE , i.e., COURSE_FEE is dependent on COURSE_NO, which is a

proper subset of the candidate key. Non-prime attribute COURSE_FEE is dependent on a proper subset of the candidate key, which is a partial dependency and so this relation is not in 2NF.

To convert the above relation to 2NF,
we need to split the table into two tables such as :
Table 1: STUD_NO, COURSE_NO
Table 2: COURSE_NO, COURSE_FEE

Table 1 **Table 2**

STUD_NO	COURSE_NO	COURSE_NO	COURSE_FEE
1	C1	C1	1000
2	C2	C2	1500
1	C4	C3	1000
4	C3	C4	2000
4	C1	C5	2000
2	C5		

NOTE: 2NF tries to reduce the redundant data getting stored in memory. For instance, if there are 100 students taking C1 course, we dont need to store its Fee as 1000 for all the 100 records, instead once we can store it in the second table as the course fee for C1 is 1000.

- **Example 2 –** Consider following functional dependencies in relation R (A, B, C, D)

```
AB -> C  [A and B together determine C]
BC -> D  [B and C together determine D]
```

In the above relation, AB is the only candidate key and there is no partial dependency, i.e., any proper subset of AB doesn't determine any non-prime attribute.

3. Third Normal Form –

A relation is in third normal form, if there is **no transitive dependency** for non-prime attributes as well as it is in second normal form.
A relation is in 3NF if **at least one of the following condition holds** in every non-trivial function dependency X –> Y

1. X is a super key.
2. Y is a prime attribute (each element of Y is part of some candidate key).

STUD_NO	STUD_NAME	STUD_STATE	STUD_COUNTRY	STUD_AGE
1	RAM	HARYANA	INDIA	20
2	RAM	PUNJAB	INDIA	19
3	SURESH	PUNJAB	INDIA	21

Table 4

Transitive dependency – If A->B and B->C are two FDs then A->C is called transitive dependency.

3. **Example 1** – In relation STUDENT given in Table 4,

FD set: {STUD_NO -> STUD_NAME, STUD_NO -> STUD_STATE, STUD_STATE -> STUD_COUNTRY, STUD_NO -> STUD_AGE}
Candidate Key: {STUD_NO}

For this relation in table 4, STUD_NO -> STUD_STATE and STUD_STATE -> STUD_COUNTRY are true. So STUD_COUNTRY is transitively dependent on STUD_NO. It violates the third normal form. To convert it in third normal form, we will decompose the relation STUDENT (STUD_NO, STUD_NAME, STUD_PHONE, STUD_STATE, STUD_COUNTRY_STUD_AGE) as:
STUDENT (STUD_NO, STUD_NAME, STUD_PHONE, STUD_STATE, STUD_AGE)
STATE_COUNTRY (STATE, COUNTRY)

- **Example 2 –** Consider relation R(A, B, C, D, E)
  A -> BC,
  CD -> E,
  B -> D,
  E -> A
  All possible candidate keys in above relation are {A, E, CD, BC} All attribute are on right sides of all functional dependencies are prime.

11. Consider a database system with following schemes;
Restaurant (Rname,Rlocation,Fname)
Cook (Cname, Cspeciality)
Worksat (Cname,Rname,Workinghrs,Shift)
Food (Fname,Cname,Catagory)

Now write SQL statements and relational algebra statements for following Queries:

a) **Select the name and location of al restaurants.**
b) **Find the working hours of cool named "Sita".**
c) **Select name of the foods cooked by "Ramesh".**
d) **Use join to select name of restaurants where food of category "breakfast" is available.**
e) **Find the name of cooks who work as "KFC".**