5 DBMS, Big Data & Cloud Computing

1. Introduction

01. A view of a database that appears to an application program is known as
(a) Schema
(b) Subschema (external view)
(c) Virtual table
(d) None of these
[ISRO - 2007]

02. Which type of DBMS provides support for maintaining several versions of the same entity?
(a) Relational Data Base Management Systems
(b) Hierarchical
(c) Object Oriented Data Base Management Systems
(d) Network
[ISRO - 2011]

03. Which of the following is not provided as a service in cloud computing?
(a) Infrastructure as a service
(b) Architecture as a service
(c) Software as a service
(d) Platform as a service
[ISRO - 2013]

04. An aggregation associations is drawn using which symbol?
(a) A line which loops back on to the same table
(b) A small open diamond at the end of a line connecting two tables
(c) A small closed diamond at the end of a line connecting two tables
(d) A small closed triangle at the end of a line connecting two tables
[ISRO - 2014]

05. Goals for the design of the logical schema include
(a) Avoiding data inconsistency
(b) Being able to construct queries easily
(c) Being able to access data efficiency
(d) All of these
[ISRO - 2016]

06. What does the data dictionary identify?
(a) Field names
(b) Field formats
(c) Field Types
(d) All of these
[ISRO - 2017(May)]

07. Type IV JDBC driver is a driver
(a) Which is written in C++
(b) Which requires an intermediate layer
(c) Which communicates through Java sockets
(d) Which translates JDBC function calls into API not native to DBMS.
[ISRO - 2017(Dec)]

08. Which of the following related to snowflake schema is true?
(a) Each dimension is represented by a single dimensional table
(b) Maintenance efforts are less
(c) Dimension tables are normalized
(d) It is not an extension of star schema
[ISRO - 2017(Dec)]

09. Immunity of the external schemas (or application programs) to changes in the conceptual schema is referred to as:
(a) Physical Data Independence
(b) Logical Data Independence
(c) Both (a) and (b)
(d) None of the above
[ISRO - 2018]

KEY & Detailed Solutions				
01. (b)	02. (c)	03. (b)	04. (b)	05. (d)
06. (d)	07. (c)	08. (c)	09. (b)	

01. Ans:(b)

Sol: The external level is the user's view of the database. This level describes part of the database relevant to the user. Most of the users of the database are no

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concerned with all the information contained in the database.

A subschema expresses the external view. External schemas are also called sub schemas.

So option B is correct.

02. Ans: (c)

Sol: **Object Oriented Database Management Systems** allow object-oriented programmers to develop the product, store them as objects, and replicate or modify existing objects to make new objects within the OODBMS.

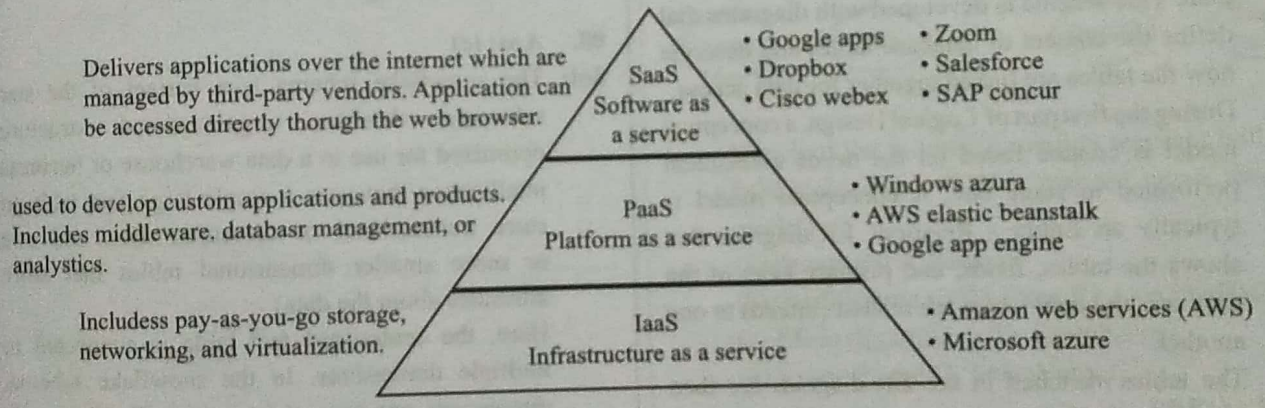
Network database management systems (Network DBMSs) are based on a network data model that allows each record to have multiple parents and multiple child records. A network database allows flexible relationship models between entities.

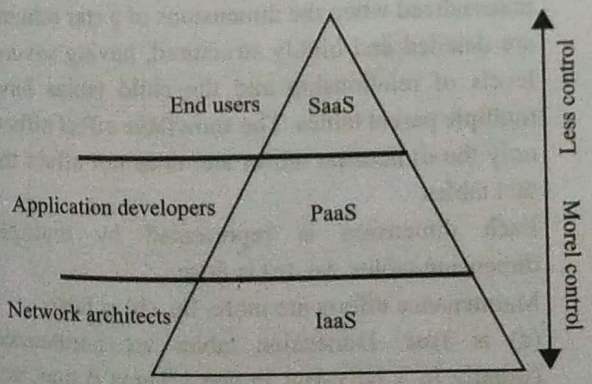
Hierarchical DBMS is a type of Network DBMS.

An **RDBMS** is a type of database management system (DBMS) that stores data in a row-based table structure which connects related data elements. An RDBMS includes functions that maintain the security, accuracy, integrity and consistency of the data.

03. Ans: (b)

Sol: Architecture as service is not part of the cloud computing stack.





04. Ans: (b)

Sol: Association is a relationship where all objects have their own lifecycle and there is no owner.

Aggregation is a specialized form of Association where all objects have their own lifecycle, but there is ownership and child objects can not belong to another parent object.

Composition is again a specialized form of Aggregation and we can call this as a "death" relationship. It is a strong type of Aggregation. Child object does not have its lifecycle and if the parent object is deleted, all child objects will also be deleted.

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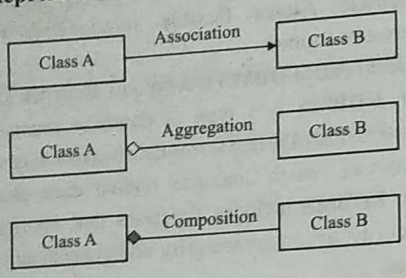
Representation:



owners feed pets, pets please owners (association)
a tail is a part of both dogs and cats (aggregation / composition)
a cat is a kind of pet (inheritance / generalization)

05. Ans: (d)

Sol: A database's logical schema is its overall logical plan. This schema is developed with diagrams that define the content of database tables and describe how the tables are linked together for data access.
During the first part of Logical Design, a conceptual model is created based on the needs assessment performed in stage one. A conceptual model is typically an Entity - Relation(ER)diagram that shows the tables, fields, and primary keys of the database and how tables are related (linked) to one another.
The tables sketched in the ER diagram are then normalized. The normalization process resolves any problems associated with the database design, so that data can be accessed quickly and efficiently.
Hence, Option(d) All of the above.

06. Ans: (d)

Sol: A data dictionary is a file or a set of files that contains a database's metadata. data dictionary contains a list of all files in the database, the number of records in each file and the names and types of each field also contains data ownership, data relationships to other objects and other data.

07. Ans: (c)

Sol: JDBC drivers implement the defined interfaces in the JDBC API, for interacting with your database server.
For example, using JDBC drivers, enable us to open database connections and to interact with it by sending SQL or database commands then receiving results with Java.
The Java.sql package that ships with JDK, contains various classes with their behaviors defined and their actual implementations are done in third-party drivers. Third party vendors implement the java.sql.Driver interface in their database driver.
Type 4 driver is a pure Java-based(i.e C++ is not used) driver which communicates directly (i.e no intermediate layer is required) with the vendor's database through socket connection.

08. Ans: (c)

Sol: The snowflake schema is a variant of the star schema(a database organizational structure optimized for use in a data warehouse or business intelligence that uses a single large fact table to store transactional or measured data, and one or more smaller dimensional tables that store attributes about the data)
Here, the centralized fact table is connected to multiple dimensions. In the snowflake schema, dimensions are present in a normalized form in multiple related tables. The snowflake structure materialized when the dimensions of a star schema are detailed and highly structured, having several levels of relationship and the child tables have multiple parent tables. The snowflake effect affects only the dimension tables and does not affect the fact tables.
Each dimension is represented by multiple dimension tables. So, (a) is false
Maintenance efforts are more. So, (b) is false
(c) is True. Dimension tables are normalized (usually in 3 NF), But in star schema it may not always be true).
It is an extension of the star schema. so, (d) is false

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09. **Ans: (b)**

Sol: Immunity here means if we make certain changes in the one level of database design it will not affect the other part of database design.

Physical data independence: if we make any change in the physical storage of schema that it will not affect our logical schema/ conceptual schema.

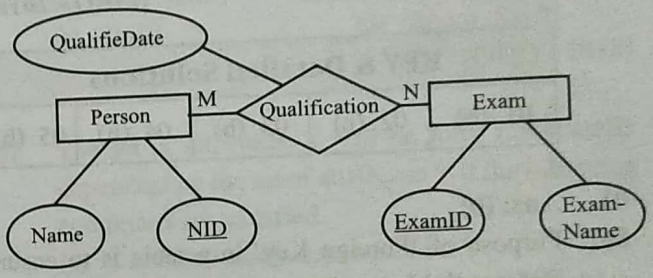
Logical data independence: if we make any change in the conceptual schema it will not affect external schema.

2. ER & Relational Model

01. Purpose of 'Foreign Key' in a table is to ensure
(a) Null Integrity
(b) Referential Integrity
(c) Domain Integrity
(d) Null & Domain Integrity

[ISRO - 2009]

02. Consider the following Entity Relationship Diagram (ERD)



Which of the following possible relations will not hold if the above ERD is mapped into a relation model?
(a) Person (NID, Name)
(b) Qualification (NID, ExamID, QualifiedDate)
(c) Exam (ExamID, NID, ExamName)
(d) Exam (ExamID, ExamName)

[ISRO - 2015]

03. Let R(a, b, c) and S(d, e,f) be two relations in which d is the foreign key of S that refers to the primary key of R
Consider the following four operations in R and S

I. Insert into R	II. Insert into S
III. Deletion from R	IV. Deletion from S

Which of the following can cause violation of the relational integrity constraint above?
(a) Both I and IV
(b) Both II and III
(c) All of these
(d) None of these

[ISRO - 2016]

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04. Which symbol denote derived attributes in ER Model?
(a) Double ellipse (b) Dashed ellipse
(c) Squared ellipse
(d) Ellipse with attribute name underlined
[ISRO - 2017(May)]

05. In E-R model, Y is the dominant entity and X is subordinate entity
(a) If X is deleted, then Y is also deleted
(b) If Y is deleted, then X is also deleted
(c) If Y is deleted, then X is not deleted
(d) None of the above **[ISRO - 2018]**

KEY & Detailed Solutions				
01. (b)	02. (c)	03. (b)	04. (b)	05. (b)

01. Ans: (b)

Sol: Purpose of 'Foreign Key' in a table is to ensure **Referential Integrity.**

Domain integrity specifies that all columns in a relational database must be declared upon a defined domain.

Example: Age must be a number,cannot be a character.

NULL integrity: Constraint that says attribute cannot have NULL value.

02. Ans: (c)

Sol: If we convert an ER diagram into a relational model then we can create a table for each entity.We get two tables

One for Entity Person-**Person(NID,Name)**

One for Entity Exam-**Exam(ExamID,ExamName)**

Now for relationship Qualification, we can not add QualifiedDate in any of the two tables formed so we need to create a new table using Primary Key from both the Entities Person and Exam.(M-N relation needs a separate table)

We obtain **Qualification(NID, ExamID, QualifiedDate),**

So option (c) is irrelevant,

03. Ans: (b)

Sol: **d is the foreign key of S that refers to the prima key of R**

Means,all the values present in column d of should be present in the primary key(a) colum R.

Insert into R cannot cause any violation.

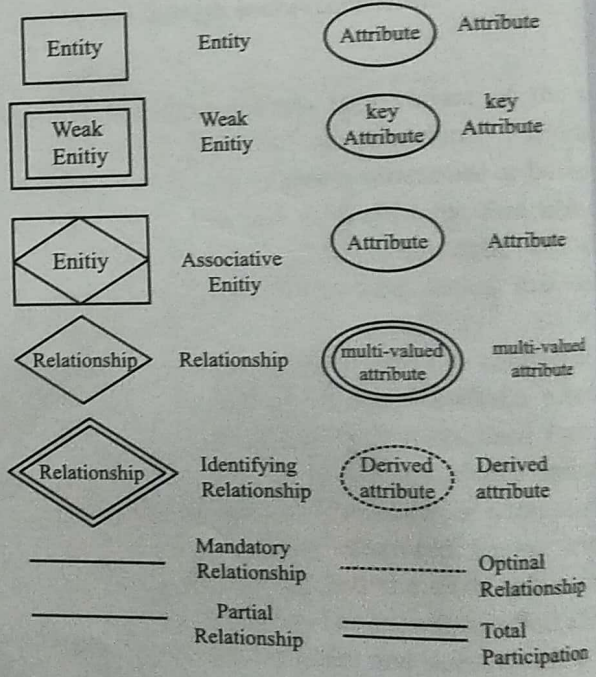
Insert into S can cause violation if any value (wh is not in a of R) is inserted into d of S,.

Delete from S cannot cause any violation.

Delete from R can cause violation if any tuple f R is deleted, the value 'a' gets deleted,which referenced by 'd' in S.

04. Ans: (b)

Sol:



05. Ans: (b)

Sol: Y is dominant entity: Strong entity and X Subordinate entity : Weak entity

If any changes happen in the dominant entity th they are also reflected in subordinate entity but n the vice versa.

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3. Functional Dependencies

01. Armstrong's inference rule doesn't determine
(a) Reflexivity (b) Augmentation
(c) Transitivity (d) Mutual dependency
[ISRO - 2007]

02. In functional dependency, Armstrong's inference rules refers to
(a) Reflexive, Augmentation and Decomposition
(b) Transitive, Augmentation and Reflexive
(c) Augmentation, Transitive, Reflexive and Decomposition
(d) Reflexive, Transitive and Decomposition
[ISRO - 2011]

03. Every time the attribute A appears, it is matched with the same value of attribute B but not the same value of attribute C. Which of the following is true?
(a) A -> (B, C)
(b) A -> B, A ->> C
(c) A -> B, C ->> A
(d) A->> B, B -> C
[ISRO - 2014]

04. Let x,y,z,a,b,c be the attributes of an entity set E. If {x}, {x,y}, {a,b}, {a.b,c}, {x,y,z} are superkeys then which of the following are the candidate keys?
(a) {x, y} and {a, b}
(b) {x} and {a, b}
(c) {x,y,z} and {a,b,c}
(d) {z} and {c}
[ISRO - 2014]

05. Let R = (A, B, C, D, E, F) be a relation scheme with the following dependencies C → F, E → A, EC → D, A → B. Which of the following is a key for R?
(a) CD (b) EC
(c) AE (d) AC
[ISRO - 2015]

06. Consider the following table in a relational database

Last Name	Rank	Room	Shift
Smith	Manager	234	Morning
Jones	Custodian	33	Afternoon
Smith	Custodian	33	Evening
Doe	Clerical	222	Morning

According to the data shown in the table, which of the following could be a candidate key of the table?
(a) {Last Name} (b) {Room}
(c) {Shift} (d) {Room, Shift}
[ISRO - 2018]

07. The set of attributes X will be fully functionally dependent on the set of attributes Y if the following conditions are satisfied.
(a) X is functionally dependent on Y
(b) X is not functionally dependent on any subset of Y
(c) Both (a) and (b)
(d) None of these
[ISRO - 2018]

KEY & Detailed Solutions			
01. (d)	02. (b)	03. (b)	04. (b)
05. (b)	06. (d)	07. (c)	

01. Ans: (d)

Sol: Armstrong inference rules refers to a set of inference rules used to infer all the functional dependencies on a relational database. It consists of the following axioms:

Axiom of Reflexivity:

This axiom states: if Y is a subset of X, then X determines Y

Axiom of Augmentation:

The axiom of augmentation, also known as a partial dependency, states if X determines Y, then XZ determines YZ, for any Z

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Axiom of Transitivity:
The axiom of transitivity says if X determines Y, and Y determines Z, then X must also determine Z. Armstrong's inference rule doesn't determine Mutual dependency
So, option (d) is correct.

02. Ans: (b)

Sol: We can derive additional functional dependencies from the initial set using inference rules. Armstrong's Axioms are the most basic inference rules. These are 3 rules:
Reflexivity: If Y is a subset of X, then $X \rightarrow Y$
Augmentation: If $X \rightarrow Y$, then $XZ \rightarrow YZ$
Transitivity: If $X \rightarrow Y$ and $Y \rightarrow Z$, then $X \rightarrow Z$
Additionally there are secondary rules derived from above 3 rules:
Union: If $X \rightarrow Y$ and $X \rightarrow Z$, then $X \rightarrow YZ$
Decomposition: If $X \rightarrow YZ$, then $X \rightarrow Y$ and $X \rightarrow Z$
Pseudotransitivity: If $X \rightarrow Y$ and $WY \rightarrow Z$, then $WX \rightarrow Z$
Composition: If $X \rightarrow Y$ and $Z \rightarrow W$, then $XZ \rightarrow YW$

03. Ans: (b)

Sol: Functional dependency is a relationship that exists when one attribute uniquely determines another attribute, therefore A→B.
Multivalued dependency occurs when there are more than one independent multivalued attribute in a table. If A->> C is a multivalued dependency, it means for A, attribute C has more than one value.
So, option (b) is correct.

04. Ans: (b)

Sol: A Candidate key is the minimal Superkey i.e. it is a minimal set of attributes required to identify a tuple. {x}, {a,b} are the candidate keys for the above schema as they do not contain any extraneous attribute.
(i.e no proper subset of these keys is a candidate key)
{x,y} has a proper subset {x} which is a candidate key, So {x,y} cannot be a candidate key but it can be a superkey.
{a,b,c} has a proper subset {a,b} which is a candidate key, So {a,b,c} cannot be a candidate key but it can be a superkey.
{x,y,z} has a proper subset {x} which is a candidate key, So {x,y,z} cannot be a candidate key but it can be a superkey.

05. Ans: (b)

Sol: $\{CD\}^+$ = out of {C,D}, C can derive F.
{C,D,F} cannot derive anything new.
$\{CD\}^+ = \{CDF\}$
$\{EC\}^+$ = out of {E,C} C can derive F, E can derive A, EC can derive D.
Out of {E,C,F,A,D}, A can derive B.
$\{EC\}^+ = \{ABCDEF\}$
So, EC can be key,as it can derive all the attributes
$\{AE\}^+$ = Out of {A,E}, A can derive B.
{A,B,E} cannot derive anything new.
$\{AE\}^+ = \{ABE\}$
$\{AC\}^+$ = out of {A, C} C can derive F, A can derive B.
{A,B,C,F} cannot derive anything new.
$\{AC\}^+ = \{ABCF\}$

06. Ans: (d)

Sol: **Candidate key**: must be able to uniquely determine every other attribute. i.e., whenever a candidate key value is repeated, all other values must repeat or the candidate key cannot be repeated.
Last Name cannot be key as smith is repeated twice and has different values of Rank attribute in different places.
Room cannot be key, as33 is repeated twice and has different values of Shift attribute in different places.

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Shift cannot be key,as morning is repeated twice and has different values of room attribute in different places.

Room + shift → Every tuple is now unique
So Option D is right.

07. Ans: (c)

Sol: The term full functional dependency (FFD) is used to indicate the minimum set of attributes in the determinant(i.e LHS of FD).

In other words, the set of attributes X will be fully functionally dependent on the set of attributes Y if the following conditions are satisfied:

1. X is functionally dependent on Y and
2. X is not functionally dependent on any proper subset of Y.

If X is functionally dependent on any proper subset of Y, that is called partial dependency.

4. Normalization

01. BCNF is not used for cases where a relation has
(a) Two (or more) candidate keys
(b) Two candidate keys and composite
(c) The candidate key overlap
(d) Two mutually exclusive foreign keys
[ISRO - 2007]

02. Which 'Normal Form' is based on the concept of 'full functional dependency' is
(a) First Normal Form
(b) Second Normal Form
(c) Third Normal Form
(d) Fourth Normal Form
[ISRO - 2011]

03. Consider the following dependencies and the BOOK table in a relational database design. Determine the normal form of the given relation.

ISBN → Title
ISBN → Publisher
Publisher → Address

(a) First Normal Form
(b) Second Normal Form
(c) Third Normal Form
(d) BCNF
[ISRO - 2013]

04. Consider the schema R (A, B, C, D) and the functional dependencies
A → B and C → D. If the decomposition is made as R_1 (A, B) and R_2 (C, D), then which of the following is TRUE?
(a) Preserves dependency but cannot perform lossless join
(b) Preserves dependency and performs lossless join
(c) Does not preserve dependency and cannot perform lossless join
(d) Does not preserve dependency but performs lossless join
[ISRO - 2014]

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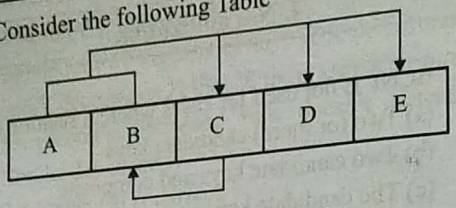
05. Consider the following Table



The table is in which normal form?
(a) First Normal Form
(b) Second Normal Form
(c) Third Normal Form but not BCNF
(d) Third Normal Form and BCNF

[ISRO - 2014]

06. Consider the following table: Faculty (facName, dept, office, rank, dateHired)

facName	dept	office	rank	date-Hired
Ravi	Art	A101	Professor	1975
Murali	Math	M201	Assistant	2000
Narayanana	Art	A101	Associate	1992
Lakshmi	Math	M201	Professor	1982
Mohan	CSC	C101	Professor	1980
Sreeni	Math	M203	Associate	1990
Tanuja	CSC	C101	Instructor	2001
Ganesh	CSC	C105	Associate	1995

(Assume that no faculty member within a single department has same name. Each faculty member has only one office identified in office). 3NF refers to third normal form and BNCF refers to Boyce-Codd normal form
Then Faculty is
(a) Not in 3NF, in BCNF
(b) In 3NF, not in BCNF
(c) In 3NF, in BCNF
(d) Not in 3NF, not in BCNF

[ISRO - 2017(Dec)]

07. For a database relation R(a, b, c, d) where the domains of a, b, c and d include only atomic values, only the following functional dependencies and those that can be inferred from them hold

$a \rightarrow c$
$b \rightarrow d$

The relation is in
(a) First normal form but not in second normal form
(b) Second normal form but not in third normal form
(c) Third normal form
(d) None of the above

[ISRO - 2018]

08. If every non-key attribute functionally dependent on the primary key, then the relation will be in
(a) First normal form (b) Second normal form
(c) Third normal form (d) Fourth normal form

[ISRO - 2020]

KEY & Detailed Solutions			
01. (d)	02. (b)	03. (b)	04. (a)
05. (c)	06. (b)	07. (a)	08. (a)

01. Ans: (d)

Sol: A relation is in BCNF if all attributes which are determinants(i.e LHS of FDs) are also candidate keys in every relation.

Transformation into BCNF deals with the problem of overlapping keys and there is no problem with two or more CK.

Referential Integrity may get affected in case of a relation having two mutually exclusive foreign keys, if we try to decompose into BCNF.

02. Ans: (b)

Sol: '2NF' is based on the concept of full functional dependency,It removes Partial dependencies.

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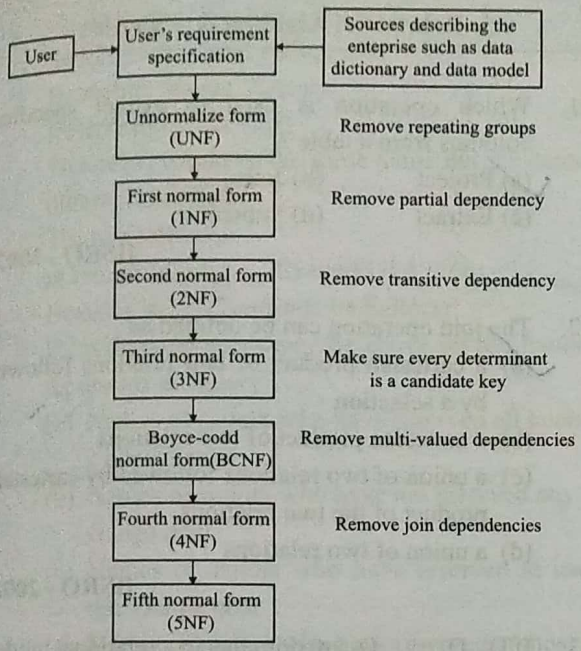

03. Ans: (b)

Sol: **ISBN → Title**

ISBN → Publisher

Publisher → Address

No multivalued attributes are mentioned, So relation is in 1 NF.

To satisfy 2NF, we should not have any partial dependency (A non key shouldn't be functionally dependent on proper subset of a Candidate Key)

Candidate key = ISBN

because,(ISBN)+ ={Title,Publisher,Address}

Since our Candidate Key is Single-attribute Key, There is no chance for partial dependency.

The relation is in the second normal form.

ISBN → Publisher

Publisher → Address These dependencies leads to Transitive dependency.

So the relation is in 2NF and not in 3NF.

04. Ans: (a)

Sol: **Dependency Preserving:**

In the Given Tables,

R1(A,B) holds the functional dependency A→B

R2(C,D) holds the functional dependency C→D,

So Decomposition is dependency preserving.

Lossless decomposition:

Decomposition of a relation R into R1 and R2 is a lossless-join decomposition if at least one of the following functional dependencies are in F+ (Closure of functional dependencies)

$R1 \cap R2 \rightarrow R1$ OR $R1 \cap R2 \rightarrow R2$

Given decomposition is not lossless as there is no common attribute on which two sub relations can be joined to get the original one.

05. Ans: (c)

Sol: The following dependencies exists:

$AB \rightarrow CDE$

$C \rightarrow B$

AB is a key.

A,B are prime attributes.

C is not a Super key Here. So violating BCNF.

But B is a prime attribute, So 3NF holds.

3NF is the strictest normal form.(1NF, 2NF also holds here)

So, relations is in Third Normal Form but not BCNF

06. Ans: (b)

Sol: Based on given instance of table, following FDs holds

facName, dept→office,rank, date-hired.

office→dept.

Here in facName, dept is the primary key.

The office is not a super key but dept is prime attribute, so 3NFbut not in BCNF.

07. Ans: (a)

Sol: $(ab)^+=\{a, b, c, d\}$

Candidate Key is ab.

a, b are prime attributes.

Since all a, b, c, d are atomic so the relation is in 1 NF.

Checking the FDs :

a→c (proper subset of candidate key derives Non-

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Prime, Partial dependency)
b→d (proper subset of candidate key derives Non-Prime, Partial dependency)
Since, there are partial dependencies, it is not in 2NF.
So the Answer is 1NF but not 2NF

08. Ans: (a)

Sol: If every non-key attribute **fully** functionally dependent on the primary key, then the relation will be in **2NF**
If every non-key attribute **only** dependent on the primary key, then the relation will be in 3NF
But, In the question they have mentioned,
If every non-key attribute functionally dependent on the primary key
still, There can be a possibility of **transitive dependency**
Consider the relation R(A,B,C) with following dependencies
A →B
B→C(It is allowed because primary key is not the only set that can determine non-key attributes)
A→C
Here A is the key, It can derive all the attributes.
Still, the non-prime attribute C is transitively dependent on A.
Since, Transitive dependency exists, relation cannot be in 3NF.
There can be a possibility of **partial dependency**
Consider the relation R(A,B,C,D) with following dependencies
AB →CD
B→D(It is allowed because primary key is not the only set that can determine non-key attributes)
Here AB is the key, It can derive all the attributes.
Still, the non-prime attribute D is partially dependent on B(proper subset of key AB).
Since, Partial dependency exists, relation cannot be in 2NF.
So, Answer is relation is 1NF.

5. Relational Algebra & Calculus

01. Which operation is used to extract specified columns from a table ?
(a) Project (b) Join
(c) Extract (d) Substitute
[ISRO - 2007]

02. The join operation can be defined as
(a) a cartesian product of two relations followed by a selection
(b) a cartesian product of two relations
(c) a union of two relations followed by cartesian product of the two relations
(d) a union of two relations
[ISRO - 2008]

03. If $D_1, D_2, \ldots, D_n$ are domains in a relational model, then the relation is a table, which is a subset of
(a) $D_1 \oplus D_2 \oplus \ldots \oplus D_n$ (b) $D_1 \times D_2 \times \ldots \times D_n$
(c) $D_1 \cup D_2 \cup \ldots \cup D_n$ (d) $D_1 \cap D_2 \cap \ldots \cap D_n$
[ISRO - 2015]

04. Consider Join of a relation R with a relation S. If R has m tuples and S has n tuples, then maximum and minimum sizes of the Join respectively are
(a) m + n and 0 (b) mn and 0
(c) m + n and |m – n| (d) mn and m + n
[ISRO - 2016]

05. Given the relations
Employee (name, salary, deptno) and
Department (deptno, deptname, address)
Which of the following queries cannot be expressed using the basic relational algebra operations (U, –, x, π, σ, p)?
(a) Department address of every employee
(b) Employees whose name is the same as their department name
(c) The sum of all employees' salaries
(d) All employees of a given department
[ISRO - 2016]

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06. Consider the following schema :
Sailors (sid, sname, rating, age)
Boats(bid, bname, colour)
Reserves(sid, bid, day)
Two boats can have the same name but the colour differentiates them.
The two relations
ρ(Tempsids, ($\pi_{sid, bid}$ Reserves)/(π_{bid} ($\sigma_{bname = 'Ganga'}$ Boats))), π_{sname} (Tempsids $\bowtie$ Sailors)
If / is division operation, the above set of relations represents the query
(a) Names of sailors who have reserved all boats c alled Ganga
(b) Names of sailors who have not reserved any Ganga boat
(c) Names of sailors who have reserved at least one Ganga boat
(d) Names of sailors who have reserved at most one Ganga boat

[ISRO - 2017(Dec)]

KEY & Detailed Solutions		
01. (a)	02. (a)	03. (b)
04. (b)	05. (c)	06. (a)

01. Ans: (a)

Sol: SELECT (σ)
The SELECT operation is used for selecting a subset of the tuples according to a given selection condition. Sigma(σ)Symbol denotes it. It is used as an expression to choose tuples which meet the selection condition. Select operator selects tuples that satisfy a given predicate.
$\sigma_p(r)$
σ is the predicate
r stands for relation which is the name of the table
p is propositional logic
σ_{topic} = "Database" (Tutorials)
Output: Selects tuples from Tutorials where topic = 'Database'.

Projection(π)
The projection method defines a relation that contains a vertical subset of Relation.
This helps to extract the values of specified attributes to eliminate duplicate values. π(pi) symbol is used to choose attributes from a relation.
This operator helps you to keep specific columns from a relation and discards the other columns.
$\Pi_{CustomerName, Status}$ (Customers)
Extract the specified columns.

Join Operations
Join operation is essentially a cartesian product followed by a selection criterion.
Join operation denoted by $\bowtie$.
JOIN operation also allows joining variously related tuples from different relations.

Types of JOIN:
Various forms of join operation are:
Inner Joins:
Theta join
EQUI join
Natural join
Outer join:
Left Outer Join
Right Outer Join
Full Outer Join

02. Ans: (a)

Sol: Join is a combination of a Cartesian product followed by a selection process. A Join operation pairs two tuples from different relations, if and only if a given join condition is satisfied.
Join operation denoted by $\bowtie$.
JOIN operation also allows joining variously related tuples from different relations.

Types of JOIN:
Various forms of join operation are:
Inner Joins:
Theta join
EQUI join
Natural join

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Outer Join:

Left Outer Join

Right Outer Join

Full Outer Join

03. Ans: (b)

Sol: Given sets $D_1, D_2, \ldots, D_n$

The Cartesian product $D_1XD_2X.....XD_n$ is the set of all (ordered) n–tuples $<d_1, d_2, d_3, \ldots\ldots d_n>$ such that $d_1 \in D_1, d_2 \in D_2 \ldots\ldots\ldots, d_n \in D_n$

Any mathematical relation on $D_1, D_2, \ldots, D_n$ is a subset of the Cartesian product $D_1XD_2X.....XD_n$

04. Ans: (b)

Sol: **Maximum tuples**-When the common attribute contain identical values (mn)

Minimum Tuples-When Both the relations have a common attribute but no tuple in both relations match. (0)

05. Ans: (c)

Sol: Employee (name, salary, deptno)

Department (deptno, deptname, address)

(a) Department address of every employee

$\pi_{address}(\sigma_{Employee.deptno=Department.deptno}$**(EmployeeX Department))**

(b) Employees whose name is the same as their department name

$\pi_{name}(\sigma_{name=deptname}(\sigma_{Employee.deptno=Department.deptno}$**(Employee X Department)))**

(c) The sum of all employees' salaries

It is possible in SQL,Relational algebra does not support Aggregate functions.

(d) All employees of a given department

$\pi_{name}(\sigma_{deptname='CS'}(\sigma_{Employee.deptno=Department.deptno}$**(Employee X Department)))**

06. Ans: (a)

Sol: Sailors (sid, sname, rating, age)

Boats(bid, bname, colour)

Reserves(sid, bid, day)

ρ(Tempsids, $(\pi_{sid,bid}$Reserves)/ $(\pi_{bid}(\sigma_{bname='Ganga'Boats}))$), π_{sname}(Tempside$\bowtie$Sailors)

$(\pi_{sid,bid}$**Reserves)/**$(\pi_{bid}(\sigma_{bname='Ganga'Boats}$**)**

According to Division operator, this gives sids of those who have reserved all boats called Ganga

ρ(Tempsids, $(\pi_{sid,bid}$Reserves)/ $(\pi_{bid}(\sigma_{bname='Ganga'Boats}))$)

Renames the output table of the previous query as Tempsids.

π_{sname}(Tempside$\bowtie$Sailors)

Joins the tables Tempsid, Sailors over the common attribute Sid and projects the sname.

So, the output is Names of sailors who have reserved all boats called Ganga

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6. Structured Query Language

01. Which commands are used to control access over objects in relational database?
(a) CASCADE & MVD
(b) GRANT & REVOKE
(c) QUE & QUIST
(d) None of these **[ISRO - 2007]**

02. Which of the following is aggregate function in SQL?
(a) Avg (b) Select
(c) Ordered by (d) distinct
[ISRO - 2007]

03. The 'command' used to change contents of one database using the contents of another database by linking them on a common key field is called
(a) Replace (b) Join
(c) Change (d) Update
[ISRO - 2009]

04. Consider the following relational schema:
Suppliers (sid: Integer, sname: string, saddress: string)
Parts (pid:integer, pname:string, pcolor:string)
Catalog (pid: integer, pid:integer, pcost:real)
What is the result of the following query?
(SELECT Catalog.pid from Suppliers, Catalog
WHERE Suppliers.sid = Catalog.pid)
MINUS
(SELECT Catalog.pid from Suppliers, Catalog
WHERE Suppliers.sname <> 'sachin' and Suppliers.sid = Catalog.sid)

(a) pid of Parts supplied by all except sachin
(b) pid of Parts supplied only by sachin
(c) pid of Parts available in catalog supplied by sachin
(d) pid of Parts available in catalogs supplied by all except sachin **[ISRO - 2013]**

05. The maximum length of an attribute of type text is
(a) 127 (b) 255
(c) 256 (d) It is variable
[ISRO - 2015]

06. Consider the following relational query on the above database:
SELECT S.sname
FROM Suppliers S
WHERE S.sid NOT IN (SELECT C.sid
FROM Catalog C
WHERE C.pid NOT IN (SELECT P.pid
FROM Parts P
WHERE P.color <> 'blue'))
Assume that relations corresponding to the above schema are not empty. Which of the following is the correct interpretation of the above query?

(a) Find the names of all suppliers who have supplied a non-blue part
(b) Find the names of all suppliers who have not supplied a non-blue part
(c) Find the names of all suppliers who have suppliers who have supplied only non-blue parts
(d) Find the names of all suppliers who have not supplied only non-blue parts
[ISRO - 2015]

07. Consider the following schema :
Emp (Empcode, Name, Sex, Salary, Deptt)
A simple SQL query is executed as follows :
SELECT Deptt FROM Emp
WHERE sex = 'M'
GROUP by Dept
Having avg (salary)>{select avg (Salary) from Emp}
The output will be
(a) Average salary of male employee is the average salary of the organization
(b) Average salary of male employee is less than the average salary of the organization

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(c) Average salary of male employee is equal to the average salary of the organization
(d) Average salary of male employees is more than the average salary of the organization.

[ISRO - 2015]

08. The relation **book (title, price)** contains the titles and prices of different books. Assuming that no two books have the same price, what does the following SQL query list?
[select title from book as B where (select count(*) from book as T where T. price > B.price) < 5]
(a) Titles of the four most expensive books
(b) Title of the fifth most inexpensive book
(c) Title of the fifth most expensive book
(d) Titles of the five most expensive books

[ISRO - 2016]

09. Trigger is
(a) Statement that enables to start any DBMS
(b) Statement that is executed by the user when debugging an application program
(c) The condition that the system test for the validity of the database user
(d) Statement that is executed automatically by the system as a side effect of a modification to the database

[ISRO - 2016]

10. Database table by name Overtime_allowance is given below :

Employee	Department	OT_Allowance
RAMA	Mechanical	5000
GOPI	Electrical	2000
SINDHU	Computer	4000
MAHESH	Civil	1500

What is the output of the following SQL query?
Select count(*) from ((select Employee, Department from Overtime_allowance) as S natural join (select Department, OT_Allowance from Overtime_allowance as T);
(a) 16 (b) 4
(c) 8 (d) None of the above

[ISRO - 2017(May)]

11. Consider the schema
Sailors (sid, sname, rating, age) with the following data

sid	sname	rating	age
22	Dustin	7	45
29	Borg	1	33
31	Pathy	8	55
32	Robert	8	25
58	Raghu	10	17
64	Herald	7	35
71	Vishnu	10	16
74	King	9	35
85	Archer	3	26
84	Bob	3	64
96	Flinch	3	17

For the query
SELECT S.rating, AVG(S.age) AS avgage FROM Sailors S
Where S.age >=18
GROUP BY S.rating
HAVING 1 < (SELECT COUNT(*) FROM Sailors S2 where S.rating = S2.rating)
The number of rows returned is
(a) 6 (b) 5 (c) 4 (d) 3

[ISRO - 2017(Dec)]

12. Consider the set of relations given below and the SQL query that follows:
Students : (Roll_number, Name, Date_of_birth)
Courses : (Course_number, Course_name, Instructor)
Grades: (Roll_number, Course_number, Grade)

```
SELECT DISTINCT Name
FROM Students, Courses, Grades
WHERE Students.Roll_number = Grades.Roll_number
      AND Courses. Instructor =Sriram
      AND Courses.Course_number = Grades. Course_number
      AND Grades.Grade = A
```


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Which of the following sets is computed by the above query?

(a) Names of Students who have got an A grade in all courses taught by Sriram

(b) Names of Students who have got an A grade in all courses

(c) Names of Students who have got an A grade in at least one of the courses taught by Sriram

(d) None of the above

[ISRO - 2018]

13. Given relations R(w,x) and S(y,z), the result of

```
SELECT DISTINCT w, x
FROM R, S
```

Is guaranteed to be same as R, if

(a) R has no duplicates and S is non-empty

(b) R and S have no duplicates

(c) S has no duplicates and R is non-empty

(d) R and S have the same number of tuples

[ISRO - 2018]

14. The SQL query

```
SELECT columns
FROM TableA
RIGHT OUTER JOINT Table B
ON A. column Name = B.columnName
WHERE A. columnName IS NULL
```

returns the following:

(a) All rows in TableB, which meets equality condition above and none from Table A which meets the condition

(b) All rows in TableA, which meets equality condition above and none from Table B, which meets the condition

(c) All rows in TableB, which meets equality condition

(d) All rows in TableA, which meets equality condition

[ISRO - 2020]

15. Properties of 'DELETE' and 'TRUNCATE' commands indicate that

(a) After the execution of 'TRUNCATE' operation, COMMIT and ROLLBACK statements cannot be performed to retrieve the lost data, while 'DELETE' allow it

(b) After the execution of 'DELETE' and 'TRUNCATE' operation retrieval is easily possible for the lost data

(c) After the execution of 'DELETE' operation, COMMIT and ROLLBACK statements can be performed to retrieve the lost data., while TRUNCATE do not allow it

(d) After the execution of 'DELETE' and 'TRUNCATE' operation no retrieval is possible for the lost data

[ISRO - 2020]

KEY & Detailed Solutions				
01. (b)	02. (a)	03. (b)	04. (b)	05. (d)
06. (*)	07. (d)	08. (d)	09. (d)	10. (b)
11. (d)	12. (c)	13. (a)	14. (*)	15. (a) & (c)

01. Ans: (b)

Sol: The Data Control Language (DCL) is a subset of the SQL that allows database administrators to configure security access to relational databases. It consists of only three commands: GRANT, REVOKE and DENY.

These SQL commands are mainly categorized into four categories as:

DDL – Data Definition Language
DQL – Data Query Language
DML – Data Manipulation Language
DCL – Data Control Language

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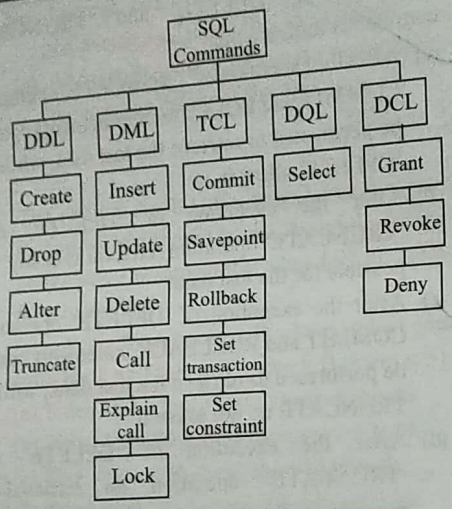

02. Ans:(a)

Sol: In database management an aggregate function is a function where the values of multiple rows are grouped together as input on certain criteria to form a single value of more significant meaning.

Various Aggregate Functions

1. Count()
2. Sum()
3. Avg()
4. Min()
5. Max()

03. Ans: (b)

Sol: The REPLACE() function replaces all occurrences of a substring within a string, with a new substring.

Note: The search is case-insensitive.

REPLACE(string, old_string, new_string)

Parameter	Description
string	The original string
old_string	The string to be replaced
new_string	The new replacement string

JOIN clause combines columns from one or more tables in a relational database. It creates a set that can be saved as a table or used as it is.

The **UPDATE** statement is used to modify the existing records in a table.

UPDATE Syntax:

UPDATE table_name SET column1 = value1, column2 = value2, … WHERE condition;

So, Changing contents of one database using the contents of another database by **linking them** is possible with **JOIN**

04. Ans: (b)

Sol: (SELECT Catalog.pid from Suppliers, Catalog WHERE Suppliers.sid = Catalog.sid)
MINUS
(SELECT Catalog.pid from Suppliers, Catalog WHERE Suppliers.sname <> 'Sachin' and Suppliers.sid = Catalog.sid)

Let us consider,

Query1 = (SELECT Catalog.pid from Suppliers, Catalog WHERE Suppliers.sid = Catalog.sid)

Query2 = (SELECT Catalog.pid from Suppliers, Catalog WHERE Suppliers.sname <> 'Sachin' and Suppliers.sid = Catalog.sid)

Here in the 1st query we are joining Catalog and Supplier and getting pids for all parts which are being supplied.

In the 2nd query we are doing the same as the 1st query but just removing all those rows where the Supplier name is not Sachin. i.e., this query returns pids for all parts which are not being supplied by Sachin.

In the resulting table we are subtracting 2nd table rows from 1st table and getting pids for those parts which are supplied only by Sachin.

Notice that, If a part is supplied by some other supplier along with Sachin, it will be selected by the second query and due to "minus" will be removed in the final output.

Thus option (c) is wrong and (b) is correct.

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05. Ans: (d)

Sol: It is variable.

TINYBLOB, TINYTEXT L + 1 bytes, where $L < 2^8$

BLOB, TEXT L + 2 bytes, where $L < 2^{16}$

MEDIUMBLOB, MEDIUMTEXT L + 3 bytes, where $L < 2^{24}$

LONGBLOB, LONGTEXT L + 4 bytes, where $L < 2^{32}$

Variable-length string types are stored using a length prefix plus data. The length prefix requires from one to four bytes depending on the data type, and the value of the prefix is L (the byte length of the string).

For example, storage for a MEDIUMTEXT value requires L bytes to store the value plus three bytes to store the length of the value.

06. Ans: None

Sol: **SELECT P.pid FROM Parts P WHERE P.color<>'blue'**

Select all non blue parts

SELECT C.sid FROM Catalog C WHERE C.pid NOT IN

Selects all suppliers who have not supplied any non-blue part (i.e have supplied a blue part)

SELECT S.sname FROM Suppliers S WHERE S.sid NOT IN

Selects suppliers who have not supplied any blue parts.

So, none of the options match.

07. Ans: (d)

Sol: **SELECT Dept FROM Emp**

WHERE sex = 'M'

Filters Male Employees

GROUP by Dept

All the Male employees are grouped with respect to Dept

{select avg (Salary) from Emp}

Calculates the average salary of the organization.

Having avg (salary)>{select avg (Salary) from Emp}

Compare Average salaries of Male employees of each department with Average salary of Organization.

Returns the depts whose Average salary of male employees is more than the average salary of the organization.

08. Ans: (d)

Sol: Select title from book as B

The outer query selects all titles from the book table.

(select count(*) from book as T where T. price > B.price)

For every selected book, the subquery returns the count of those books which are more expensive than the selected book.

WHERE (select count(*) from book as T where T. price > B.price) < 5

The where clause of the outer query will be true for 5 most expensive books.

count (*) will be 0 for the most expensive book

count(*) will be 1 for the second most expensive book.

count(*) will be 2 for the third most expensive book.

count(*) will be 3 for the fourth most expensive book.

count(*) will be 4 for the fifth most expensive book.

For count(*) > = 5 conditions fail.

So the output is

Titles of the five most expensive books

09. Ans: (d)

Sol: Triggers are the SQL statements that are automatically executed when there is any change in the database. The triggers are executed in response to certain events(INSERT, UPDATE or DELETE) in a particular table. These triggers help in maintaining the integrity of the data by changing

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the data of the database in a systematic fashion. So, Trigger is a Statement that is executed automatically by the system as a side effect of a modification to the database.

10. Ans: (b)

Sol: Given Table

Employee	Department	OT_allowance
RAMA	Mechanical	5000
GOPI	Electrical	2000
SINDHU	Computer	4000
MAHESH	Civil	1500

(select Employee, Department from Overtime_ allowance) as S

Employee	Department
RAMA	Mechanical
GOPI	Electrical
SINDHU	Computer
MAHESH	Civil

(select Department, OT_Allowance from Overtime_ allowance as T)

Department	OT_allowance
Mechanical	5000
Electrical	2000
Computer	4000
Civil	1500

Select count(*) from ((select Employee, Department from Overtime_allowance) as S natural join (select Department, OT_Allowance from Overtime_ allowance as T);

Now, we apply a natural join on S and R, it matches the common attribute Department in both the tables and outputs the common tuples. So, 4 tuples will be given as the output. (we get the initial table again)

11. Ans: (d)

Sol: SELECT S.rating, AVG(S.age) AS avgage FROM Sailors S Where S.age >=18 GROUP BY S.rating HAVING 1 < (SELECT COUNT(*) FROM Sailors S2 where S.rating = S2.rating)

SELECT S.rating, AVG(S.age) AS avgage FROM Sailors S Where S.age >=18 GROUP BY S.rating

Rating	Number of rows in each Group Count (*)	Sid	Sname	age
1	1	29	Borg	33
3	2	85	Archer	26
		84	Bob	64
7	2	22	Dustin	45
		64	Herald	35
8	2	31	Pathy	55
		32	Robert	25
9	1	74	King	35

Rating	Count(*) This column is not displayed in otuput	Average(age)
1	1	33
3	2	45
7	2	40
8	2	40
9	1	35

HAVING 1 < (SELECT COUNT(*) FROM Sailors S2 where S.rating = S2.rating)

Now, the having clause: The inner query selects the rows (from S2) where the rating is equal to the rating in the row returned by the outer query (table S) and then finally selects those rows where this count is greater than 1.

The final table returned is:

Rating	Average(age)
3	45
7	40
8	40

In the previous table, rows 9 and 1 have count (i.e. there is only 1 sailor with rating 9 and only 1 sailor with rating 1). Hence these two rows are filtered out by the having clause.

In other words, The query will find the average rating of the employee whose age is greater than or equal to 18 and rating is repeated at least one time

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12. Ans: (c)

Sol: Students: (Roll_number, Name, Date_of_birth)
Courses: (Course_number, Course_name, Instructor)
Grades: (Roll_number, Course_number, Grade)
SELECT DISTINCT Name FROM Students, Courses, Grades
WHERE Students.Roll_number = Grades.Roll_number
AND Courses. Instructor =Sriram
AND Courses.Course_number =Grades. Course_number
AND Grades.Grade = A

Students, Courses, Grades

This is equivalent to taking the cross product of the 3 tables based on the following conditions

WHERE Students.Roll_number = Grades.Roll_number

Tables Students and Grades are joined here such that Grade information of students can be retrieved.

AND Courses. Instructor =Sriram

the details of the courses taught by Sriram from courses table are retrieved

AND Courses.Course_number = Grades. Course_number

Tables Students ,Grades Courses are joined here such that Grade information of students in a **course** can be retrieved.

AND Grades.Grade = A

Filter the Names Where the Student got Grade A

SELECT DISTINCT Name FROM Students, Courses, Grades

After applying all the conditions in the query, the output is

Names of Students who have got an A grade in at least one of the courses taught by Sriram

13. Ans: (a)

Sol: This question is about SQL, in SQL Relations are MULTISET, not SET.

So,attributes R or S can have duplicate values.

If R has duplicates, those duplicates get eliminated in the final result, because keyword distinct is used. So, R can not have duplicates. If S is empty RXS becomes empty, so S must be non empty. So, option A is true.

Option (b) is False, S has no duplicates but If S is empty, Then R X S will be empty. So this is false.

Option (c) is False,S has no duplicates but If S is empty, Then R X S will be empty.

Option (d) is False. Assume that R has duplicates. Then the Distinct keyword will remove duplicates. So, result of query !=R, so This is false.

14. Ans: NONE

Sol: SELECT columns
FROM TableA
RIGHT OUTER JOIN TableB
ON A.columnName = B.columnName

Consider the below example

Where TableA is Customers
TableB is Orders
Column name considered for JOIN is CustomerID

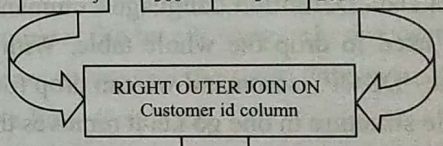
RIGHT OUTER JOIN

Customers

Customer Id	Name
1	Shree
2	Kalpana
3	Basavaraj

Orders

Order Id	Customer Id	Order date
100	1	2014-01-29 23:56:57.700
200	4	2014-01-30 23:56:57.700
300	3	2014-01-31 23:56:57.700



Result

Customer Id	Name	Order Id	Customer Id	Order date
1	Shree	1	1	2014-01-30 23:48:32.850
NULL	NULL	4	4	2014-01-31 23:48:32.853
3	Basavaraj	3	3	2014-01-01 23:48:32.853

Below query demonstrates how to get the Orders with a CustomerId, for which we don't have a mapping any record in the Customers Table:

SELECT O.* FROM Customers C RIGHT OUTER JOIN Orders O
ON O.CustomerId = C.CustomerId
WHERE C.CustomerId IS NULL

So the Query returns records of table B which are failed equality conditions of join.

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15. **Ans: (a) & (c)**

Sol: After the execution of 'TRUNCATE' operation, COMMIT and ROLLBACK statements cannot be performed to retrieve the lost data, while 'DELETE' allow it

After the execution of 'DELETE' operation, COMMIT and ROLLBACK statements can be performed to retrieve the lost data, while TRUNCATE does not allow it.

Both of the above statements are TRUE and equivalent to each other.

DELETE :

Basically, it is a Data Manipulation Language Command (DML). It is used to delete one or more tuples of a table. With the help of the "DELETE" command, we can either delete all the rows in one go or can delete rows one by one. i.e., we can use it as per the requirement or the condition using the Where clause. It is comparatively slower than the TRUNCATE command.

Here we can use the "ROLLBACK" command to restore the tuple because it does not auto-commit.

DROP :

It is a Data Definition Language Command (DDL). It is used to drop the whole table. With the help of the "DROP" command we can drop (delete) the whole structure in one go i.e. it removes the named elements of the schema. By using this command the existence of the whole table is finished or lost.

Here we can't restore the table by using the "ROLLBACK" command because it auto commits.

TRUNCATE :

It is also a Data Definition Language Command (DDL). It is used to delete all the rows of a relation (table) in one go. With the help of the "TRUNCATE" command, we can't delete the single row as here WHERE clause is not used. By using this command the existence of all the rows of the table is lost. It is comparatively faster than the delete command as it deletes all the rows fastly.

Here we can't restore the tuples of the table by using the "ROLLBACK" command.

7. Transactions & Concurrency Control

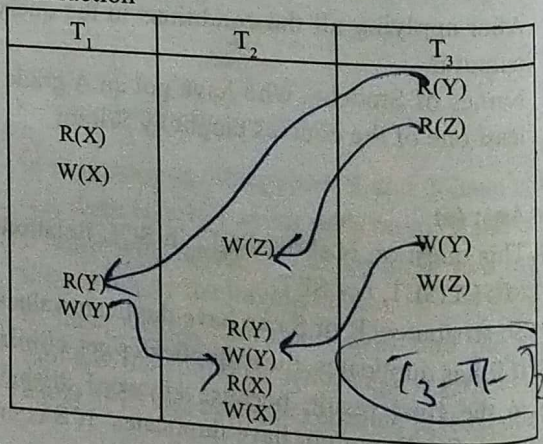
01. Which of the following is correct with respect Two phase commit protocol ?
(a) Ensures serializability
(b) Prevents Deadlock
(c) Detects Deadlock
(d) Recover from Deadlock **[ISRO - 200**

02. A locked database file can be
(a) Accessed by only one user
(b) Modified by users with the correct password
(c) Used to hide sensitive information
(d) Updated by more than one user **[ISRO - 200**

03. Which of the following scenarios may lead to a irrecoverable error in a database system?
(a) A transaction writes a data item after it is rea by an uncommitted transaction
(b) A transaction reads a data item after it is rea by an uncommitted transaction
(c) A transaction reads a data item after it is writte by a committed transaction
(d) A transaction reads a data item after it is writte by an uncommitted transaction **[ISRO - 200**

04. What is the equivalent serial schedule for th following transactions?

Transaction



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(a) T_1-T_2-T_3 (b) T_3-T_1-T_2
(c) T_2-T_1-T_3 (d) T_1-T_3-T_2

[ISRO - 2011]

05. Which of the following is the highest isolation level in transaction management?
(a) Serializable (b) Repeated Read
(c) Committed Read (d) Uncommitted Read

[ISRO - 2013]

06. Which of the following concurrency control protocol ensures both conflict serializability and free from deadlock?
(a) Time stamp ordering (b) 2 Phase locking
(c) Both (a) and (b) (d) None of the above

[ISRO - 2017(May)]

07. ACID properties of a transactions are
(a) Atomicity, consistency, isolation, database
(b) Atomicity, consistency, isolation, durability
(c) Atomicity, consistency, integrity, durability
(d) Atomicity, consistency, integrity, database

[ISRO - 2017(May)]

08. Let us assume that transaction T1 has arrived before transaction T2. Consider the schedule
S = r1(A); r2(B); w2(A); w1(B)
Which of the following is true?
(a) Allowed under basic timestamp protocol
(b) Not allowed under basic timestamp protocols because T1 is rolled back
(c) Not allowed under basic protocols because T2 is rolled back.
(d) None of these

[ISRO - 2018]

KEY & Detailed Solutions			
01. (a)	02. (a)	03. (d)	04. (b)
05. (a)	06. (a)	07. (b)	08. (b)

01. Ans: (a)

Sol: Two-Phase Locking

A transaction is said to follow the Two-Phase Locking protocol if Locking and Unlocking can be done in two phases.

Growing Phase: New locks on data items may be acquired but none can be released.

Shrinking Phase: Existing locks may be released but no new locks can be acquired.

Note: If lock conversion is allowed, then upgrading of lock (from S(a) to X(a)) is allowed in the Growing Phase and downgrading of lock (from X(a) to S(a)) must be done in the shrinking phase.

LockPoint: The Point at which the growing phase ends, i.e., when a transaction takes the final lock it needs to carry on its work.

2-PL ensures serializability.

Cascading Rollback, Deadlocks and Starvation are still possible.

02. Ans: (a)

Sol: File locking is a mechanism that restricts access to a computer file by allowing only one user or process access at any specific time. Otherwise there would be a Race Condition.

03. Ans: (d)

Sol: "A transaction reads a data item after it is written by an uncommitted transaction"

If the uncommitted transaction fails and the transaction reading from that uncommitted transaction commits, it is a dirty-read and irrecoverable.

So,(d) is the answer.

All other options are recoverable.

Option (a) can be recovered.

Option (b) is also fine as no write operation is involved.

Option (c) is a normal operation.

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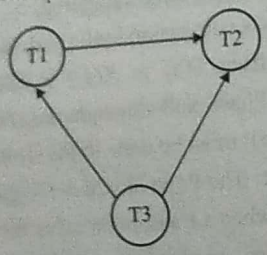
04. Ans: (b)

Sol: The precedence graph, after considering the all W-W,W-R,R-W Conflicts

$R_3(Y), W_1(Y)$ is a conflicting operation →directed edge from T_3 to T_1

$R_1(Z), W_2(Z)$ is a conflicting operation →directed edge from T_3 to T_2

$W_1(X), R_2(X)$ is a conflicting operation →directed edge from T_1 to T_2



So equivalent serial schedule of above transaction=T_3–T_1–T_2

05. Ans: (a)

Sol: **Dirty Read** – A Dirty read is the situation when a transaction reads a data that has not yet been committed. For example, Let's say transaction 1 updates a row and leaves it uncommitted, meanwhile, Transaction 2 reads the updated row. If transaction 1 rolls back the change, transaction 2 will have read data that is considered never to have existed.

Non Repeatable read-Non Repeatable read occurs when a transaction reads the same row twice, and gets a different value each time. F example, suppose transaction T1 reads data. D to concurrency, another transaction T2 upda the same data and commits. Now if transaction T rereads the same data, it will retrieve a differe value.

Phantom Read-Phantom Read occurs when t same queries are executed, but the rows retriev by the two are different. For example, suppo transaction T1 retrieves a set of rows that satis some search criteria. Now, Transaction T2 generate some new rows that match the search criteria fo transaction T1. If transaction T1 re-executes th statement that reads the rows, it gets a different se of rows this time.

Based on the above phenomena,

The SQL standard defines four isolation levels:

Isolation Level	Dirty reads	Non-repeatable reads	Phantom
Read Uncommitted	May occur	May occur	May occur
Read Committed	Don't occur	May occur	May occur
Repeatable Read	Don't occur	Don't occur	May occur
Serializable	Don't occur	Don't occur	Don't occur

06. Ans: (a)

Sol: In basic two phase locking ensures serializability still there is a chance for deadlock.

Timestamp ordering protocol ensures both conflict serializability and free from deadlock

Protocol	Serializable	Deadlock Free	Starvation	Recoverability
Basic 2PL	Yes	No	Yes	May not be recoverable
Strict 2PL	Yes	No	Yes	Strict schedules
Ringorous 2PL	Yes	Yes	Yes	May not be recoverable
Conservative 2PL	Yes	Yes	Yes	May not be recoverable
Graph based protocol	Yes	Yes	Yes	May not be recoverable
Timestamp ordering	Yes	Yes	Yes	May not be recoverable
Thomas write rule	Yes	Yes	Yes	Same as Timestamp ordering and some view serializable schedule are generated.

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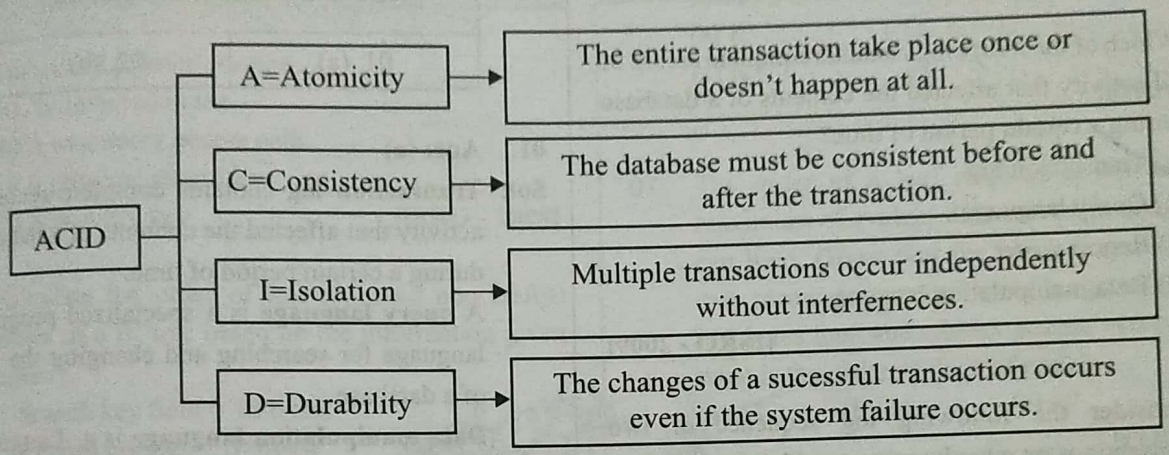
07. Ans: (b)

Sol:

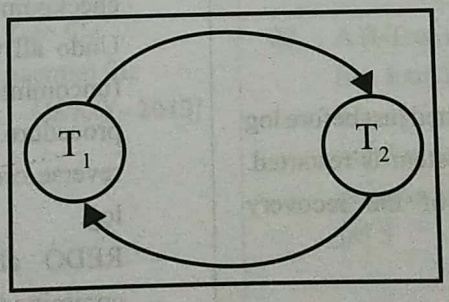


08. Ans: (b)

Sol: If a schedule is a conflict serializable schedule then it is allowed in basic timestamp protocol but the given schedule is not conflict serializable so it is not allowed in basic timestamp.

$r_1(A)$, $w_2(A)$ is a conflicting operation $\rightarrow$ directed edge from T_1 to T_2

$r_2(B)$, $w_1(B)$ is a conflicting operation $\rightarrow$ directed edge from T_2 to T_1



In Timestamp Ordering Protocol each conflicting operation has to be executed in timestamp order.

Here, transaction T1 has arrived before transaction T2. So the order is T1 followed by T2,but again there is a conflict operation r2(B) $\rightarrow$ w1(B), which is showing T2 is followed by T1 which is a violation hence T1 must be rolled back.

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8. Recovery Management System

01. Which of the following contains complete record of all activity that affected the contents of a database during a certain period of time?
(a) Transaction log
(b) Query language
(c) Report writer
(d) Data manipulation language
[ISRO - 2009]

02. Consider the following log sequence of two transactions on a bank account, with initial balance 12000, that transfer 2000 to a mortgage payment and, then apply a 5% interest
(i) T1 start
(ii) T1 B old = 12000 new = 10000
(iii) T1 M old = 0 new = 2000
(iv) T1 commit
(v) T2 start
(vi) T2 B old = 10000 new = 10500
(vii) T2 commit

Suppose the database system crashed just before log record 7 is written. When the system is restarted. Which one statement is true of the recovery procedure?

(a) We must redo log record 6 set B to 10500
(b) We must undo log record 6 to set B to 10000 and then redo log record 2 and 3
(c) We need not redo log records 2 and 3 because transaction T1 has committed
(d) We can apply redo and undo operations in arbitrary order because they are idempotent.
[ISRO - 2015]

KEY & Detailed Solutions

01. (a)	02. (b)

01. Ans: (a)

Sol: **Transaction log** contains complete record of activity that affected the contents of a database during a certain period of time.

A **query language** is a specialized programming language for searching and changing the content of a database

Data manipulation language is a Language that is used to update the content of the table.

02. Ans: (b)

Sol: Here we are not using checkpoints so, redo log records 2 and 3 and undo log record 6.

Consider the following steps:

Use two lists of transactions maintained by the system: the committed transactions since the last checkpoint and the active transactions

Undo all the write_item operations of the active (uncommitted) transaction, using the UNDO procedure. The operations should be undone in the reverse order in which they were written into the log.

REDO all the write_item operations of the committed transactions from the log, in the same order in which they were written into the log.

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9. Indexing

01. Embedded pointer provides
(a) An inverted index
(b) A secondary access path
(c) A physical record key
(d) A primary key **[ISRO - 2008]**

02. Calculate the order of leaf (p_{leaf})and non leaf(p) nodes of a B^+ tree based on the information given below
Search key field = 12 bytes
Record pointer = 10 bytes
Block pointer = 8 bytes
Block size = 1 KB
(a) $p_{leaf} = 51$ & $p = 46$ (b) $p_{leaf} = 47$ & $p = 52$
(c) $p_{leaf} = 46$ & $p = 51$ (d) $p_{leaf} = 52$ & $p = 47$
[ISRO - 2013]

03. The physical location of a record determined by a formula that transforms a file key into a record location is
(a) Hashed file (b) B-Tree file
(c) Indexed file (d) Sequential file
[ISRO - 2013]

04. Embedded pointer provides
(a) a secondary access path
(b) a physical record key
(c) an inverted index
(d) a prime key
[ISRO - 2013]

05. Given a block can hold either 3 records or 10 key pointers. A database contains n records, then how many blocks do we need to hold the data file and the dense index
(a) $\frac{13n}{30}$ (b) n/3
(c) n/10 (d) n/30
[ISRO - 2015]

06. If a node has K children is B tree, then the node contains exactly _____ keys.
(a) K^2 (b) K – 1
(c) K + 1 (d) $\sqrt{K}$
[ISRO - 2015]

07. The order of a leaf node in a B+ tree is the maximum of (value, data record pointer) pairs it can hold. Given that the block size is 1K bytes, data record pointer is 7 bytes long, the value field is 9 bytes long and a block pointer is 6 bytes long, what is the order of the leaf node?
(a) 63 (b) 64 (c) 67 (d) 68
[ISRO - 2016]

08. A clustering index is defined on the fields which are of type _____.
(a) Non-key and ordering
(b) Non-key and non-ordering
(c) Key and ordering
(d) Key and non-ordering
[ISRO - 2016]

09. A B-Tree used as an index for a large database table has four levels including the root node. If a new key is inserted in this index, then the maximum number of nodes that could be newly created in the process are
(a) 5 (b) 4 (c) 1 (d) 2
[ISRO - 2017(May)]

10. Consider a table that describes the customers :
Customers(custid, name, gender, rating)
The rating value is an integer in the rang 1 to 5 and only two values (male and female) are recorded for gender. Consider the query "how many male customers have a rating of 5"? The best indexing mechanism appropriate for the query is
(a) Linear hashing (b) Extendible hashing
(c) B+ tree (d) Bit-mapped index
[ISRO - 2017(Dec)]

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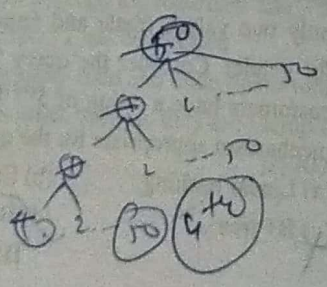
11. Consider the following query :
SELECT E.eno, COUNT(*)
FROM Employees E
GROUP BY E.eno
If an index on eno is available, the query can be answered by scanning only the index if
(a) the index is only hash and clustered
(b) the index is only B+ tree and clustered
(c) index can be hash or B+ tree and clustered or non-clustered
(d) index can be hash or B+ tree and clustered
[ISRO - 2017(Dec)]

12. In a file which contains 1 million records and the order of the tree is 100, then what is the maximum number of nodes to be accessed if B+ tree index is used?
(a) 5 (b) 4 (c) 3 (d) 10
[ISRO - 2018]

13. Which of the following is dense index?
(a) Primary index (b) Clusters index
(c) Secondary index (d) Secondary non key index
[ISRO - 2018]

KEY & Detailed Solutions				
01. (b)	02. (c)	03. (a)	04. (a)	05. (a)
06. (b)	07. (a)	08. (a)	09. (a)	10. (d)
11. (c)	12. (b)	13. (c)		



01. Ans: (b)

Sol: **Embedded Pointers** are Pointer Set in a data record. It provides a secondary access path.
An **Inverted index** is an index data structure that stores a mapping from content (such as words or numbers) to its locations in a document or a set of documents. In simple words, it is a hashmap-like data structure that directs you from a word to a document or a web page.
A Primary key, also called a primary keyword, is a key in a relational database that is unique for each record. It is a unique identifier, such as a driver license number.

02. Ans: (c)

Sol: Search key field**(K)** = 12 bytes
Record pointer**(R_p)** = 10 bytes
Block pointer**(B_p)** = 8 bytes
Block size**(B)** = 1 KB
p_{leaf} = order of the leaf node
p = order of the non-leaf node

Leaf node

$p_{leaf}(K+R_p) + B_P \le B$
$p_{leaf}(12+10) + 8 \le 1024$
$22p_{leaf}+8 \le 1024$
$p_{leaf} \le 1016/22$
$p_{leaf} \le 46.18$
$\mathbf{p_{leaf} = 46}$

Non-leaf node

$p(B_p)+(p-1) \le B$
$p(8)+(p-1)12 \le 1024$
$20p-12 \le 1024$
$p \le 1036/20$
$p \le 51.8$
$\mathbf{p = 51}$

03. Ans: (a)

Sol: The index (location) of where to put the record (or data) is determined by a formula (like xmod10) in the Hash data structure.

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For the rest you don't use any formula to determine the physical location of records.(we just use just traverse with the help of comparisons)

04. Ans: (a)

Sol: **Embedded Pointers** are Pointer Set in a data record. It provides a secondary access path.

An **inverted index** is an index data structure storing a mapping from content, such as words or numbers, to its locations in a document or a set of documents. In simple words, it is a hashmap-like data structure that directs you from a word to a document or a web page.

A primary key, also called a primary keyword, is a key in a relational database that is unique for each record. It is a unique identifier, such as a driver license number.

05. Ans: (a)

Sol: Total number of block required by data file = n/3

total number of records needed by key pointers = n/10. (#key pointers = no of keys)

total blocks = n/3 + n/10 =13n / 30

06. Ans: (b)

Sol: If a node has k children then it has k pointers so it must contain k–1 key values.

07. Ans: (a)

Sol: Disk Block size = 1024 bytes

Data Record Pointer size($\mathbf{R_p}$) = 7 bytes

Value = search key size(**K**) = 9 bytes

Disk Block ptr($\mathbf{B_p}$) = 6 bytes

Let the order of the leaves be n. A leaf node in B+ tree contains at most m record pointers, at most n values, and one disk block pointer.

$B_p + n(R_p + K) \leq BlockSize$

$\Rightarrow 1\times6+n(7+9)\leq1024$

$\Rightarrow n \leq 63.625$

So, 63 is the answer.

08. Ans: (a)

Sol: **Primary index** is on the ordered key field.

Secondary index is either on the key or non-key unordered field.

Clustered index is on the non-key ordered field.

Additional points for Clustered Indexing:

The number of entries in the index file are the unique values of the attribute on which indexing is done.

The pointer in the index file will give the base address of the block in which the value appears for the first time.

09. Ans: (a)

Sol: Suppose all nodes are completely full, meaning every node has n−1 keys.

The tree has 4 levels. If a new key is inserted then at every level there will be created a new node. and in worst case root node will also be broken into two parts. and we have 4 levels so, answer should be 5. Because tree will be increased with one more level.

If a B-Tree used as an index for a large database table has **K** levels including the root node.

If a new key is inserted in this index, then the maximum number of nodes that could be newly created in the process are **K+1**. Because,when we split the root node, 2 new nodes will be created and at rest of the (K−1) levels, 1 new node will be created.

10. Ans: (d)

Sol: Bitmap Indexing is used for huge databases, when the column is of low cardinality and these columns are most frequently used in the query.

Since we require only 2 bits 0 and 1 to record gender of customers we easily implement it using a bit-mapped index.

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11. Ans: (c)

Sol: Based on the indexing strategy,Search efficiency may be improved.

Scanning operation does not get affected by the Indexing strategy.

For executing the Query by scanning the index,the index can be a hash or B+ tree and clustered or non-clustered.

12. Ans: (b)

Sol: We need to find the maximum no. of nodes to be accessed so consider the minimum fill factor.

Here, order of B+tree= #ptrs per node=p=100

Minimum ptrs per node=$\lceil p/2 \rceil$=50

#Nodes in last level=106/50 = 2 * 104

#Nodes in Second last level= 2*104/50 =400

#Nodes in Third last level= 400/50 =8

#Nodes in Forth last level= 8/50 =1

The maximum no. of nodes to be accessed = #B+tree levels = 4

13. Ans: (c)

Sol: Dense Index

In a dense index, a record is created for every search key valued in the database, here all records have a record in the index that point to them. In other words, any index is called dense if every search-key value of attribute A in relation R also appears in the index.

Now secondary index is any index that is not primary. So secondary index must be dense index as the index is guaranteed not to be in the same order as the physical order of records. Secondary index can be either built over key or non-key attribute.

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