COMPUTER SCIENCE

Database Management System

FD's & Normalization

Lecture_01

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01 Introduction of RDBMS

02 Functional Dependency

DBMS

Lecture schedule

DBMS GATE Syllabus

7-9 Marks.

- Functional dependencies and Normalization.] 3-4M.
- Transaction and Concurrency control.] 1-3M.
- SQL
- Relational Algebra & TRC] 2-3M
- File Organization and Indexing] 1-2M
- ER model and Integrity constraints.] 1-2M.

Functional Dependency (FD's)

- [x] FD concepts
- [x] FD types
- [x] Armstrong's axioms/Inference rules
- [x] Attribute closure
- [x] Keys Concept
  - Super key
  - Candidate key
  - Primary key
  - Alternative / secondary key
- [ ] Finding multiple candidate keys
- [ ] Membership set

- Closure of FD set
- Equality between 2 FD sets.
- Minimal cover (Canonical cover).
- Lossy and Lossless Join Decomposition.
- Dependency preserving Decomposition.

Normalization

- Need of Normalization ? / Problem with Unnormalized Data

Normal Forms

- 1 NF
- 2 NF
- 3 NF
- BCNF

Multi-Valued Dependencies

NF Decomposition

- 2NF Decomposition
- 3NF Decomposition
- BCNF Decomposition

Transaction & Concurrency Control

- Transaction concept
- ACID Properties
- Schedules (serial & non serial schedule)
- Serializable schedule
  - conflict Serializable
  - View serializable
- Testing method for conflict serializability
- Conflict equivalent schedule
- Problem due to concurrent execution
- Recoverable, cascadeless, strict recoverable schedule.

- Implementation of concurrency control
  - Lock based protocol.
- 2 Phase locking protocol (Basic 2PL, Strict 2PL, Rigorous 2PL, Conservative 2PL)
- Time stamp based protocol
  - Thomas Write rule
  - Deadlock Avoidance (Wait - die & Wound - wait)

Query Language

- Introduction of Relational Algebra (RA)

Operations

- Section (σ)
- Projection (π)
- Union (∪)
- Set Difference (–)
- Cross Product (×)
- Rename (ρ)
- Intersection (∩)
- Division (/)
- Join & its type.

- TRC (Tuple Relational Calculus) & DRC(Domain Relational Calculus)
- SQL & its clauses
  - Aggregate operators
  - Set operators
  - Nested Query
  - Correlated nested query
- Null value concept

File Organization & Indexing

- Spanned and unspanned organization
- Sparse & Dense Index
- Indexing type (Primary, Clustered, Secondary index)
- Multi level indexing
- B Tree
- Insertion & Deletion in B tree
- B^+ Tree

ER Model & Integrity Constraints.

- Introduction of ER Model
- Attributes and its type
- Relationship set
- Participation constraints
- Cardinality Ratio
- Strong and weak entity set
- Specialization & Generalization
- Foreign key concept and its constraint
- Conversion of ER model to Relations (Tables).

Books:

Henry F. Korth (Transaction, ER)

Navathe (FD & N.F)

Raghu Ramakrishnan (Query, ER)

Jeffrey D. Ullman (Indexing

Basic

Generic Pall

@ CC With Enjoying (Chamkar Concept)

(b) CC [Crystal clear]

(c) C [clear]

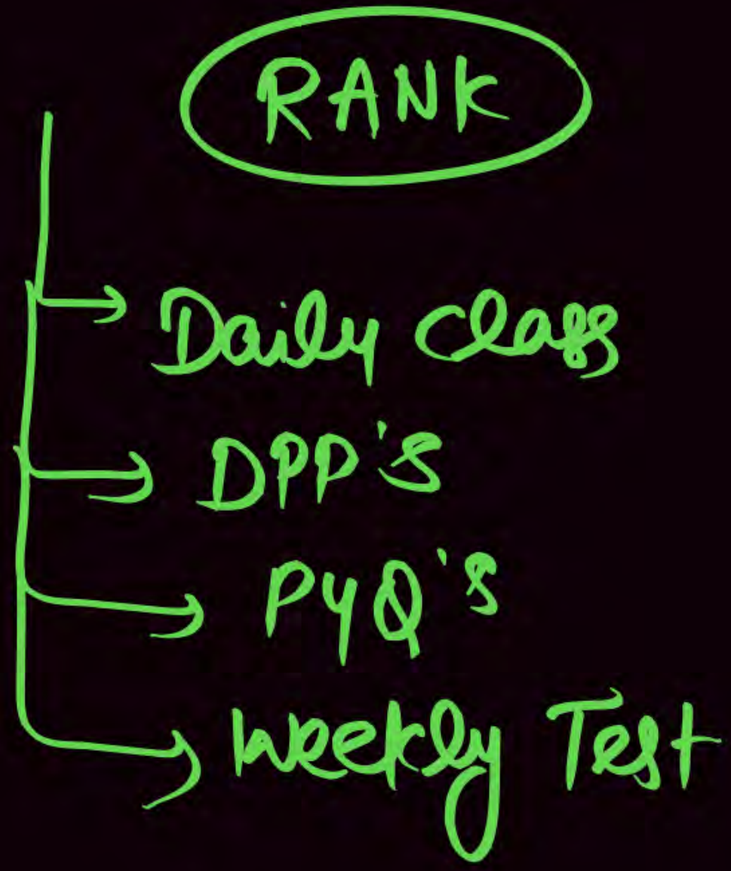
(d) Doubt

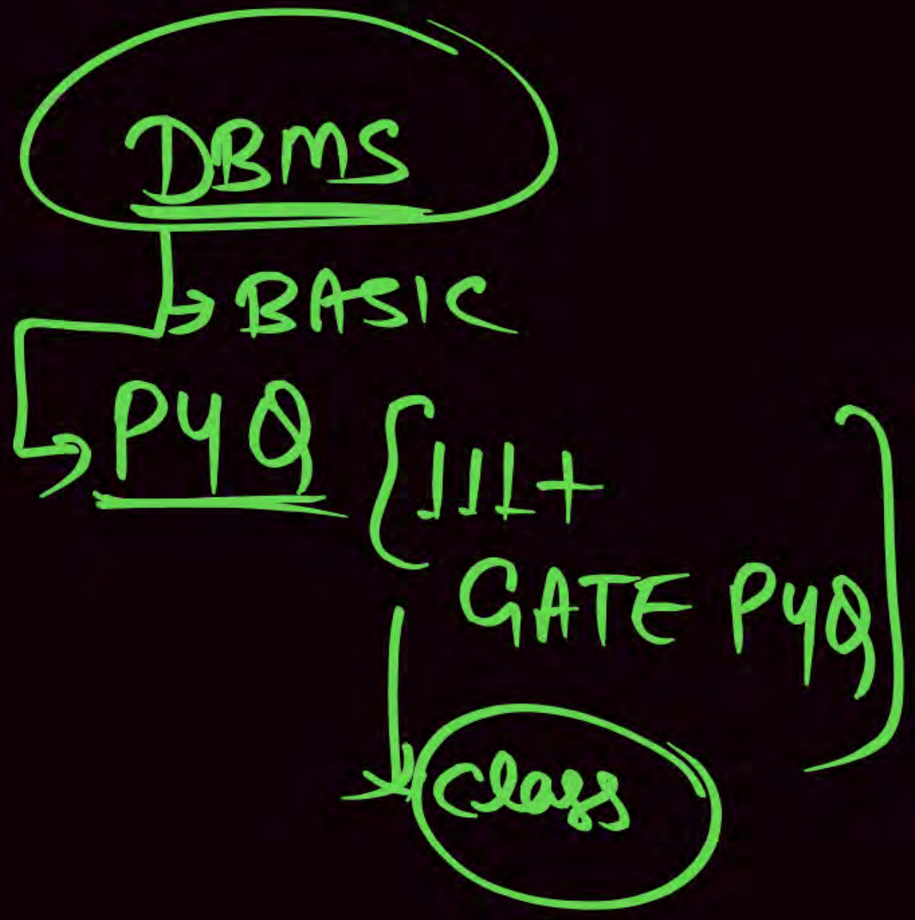
Pre Req

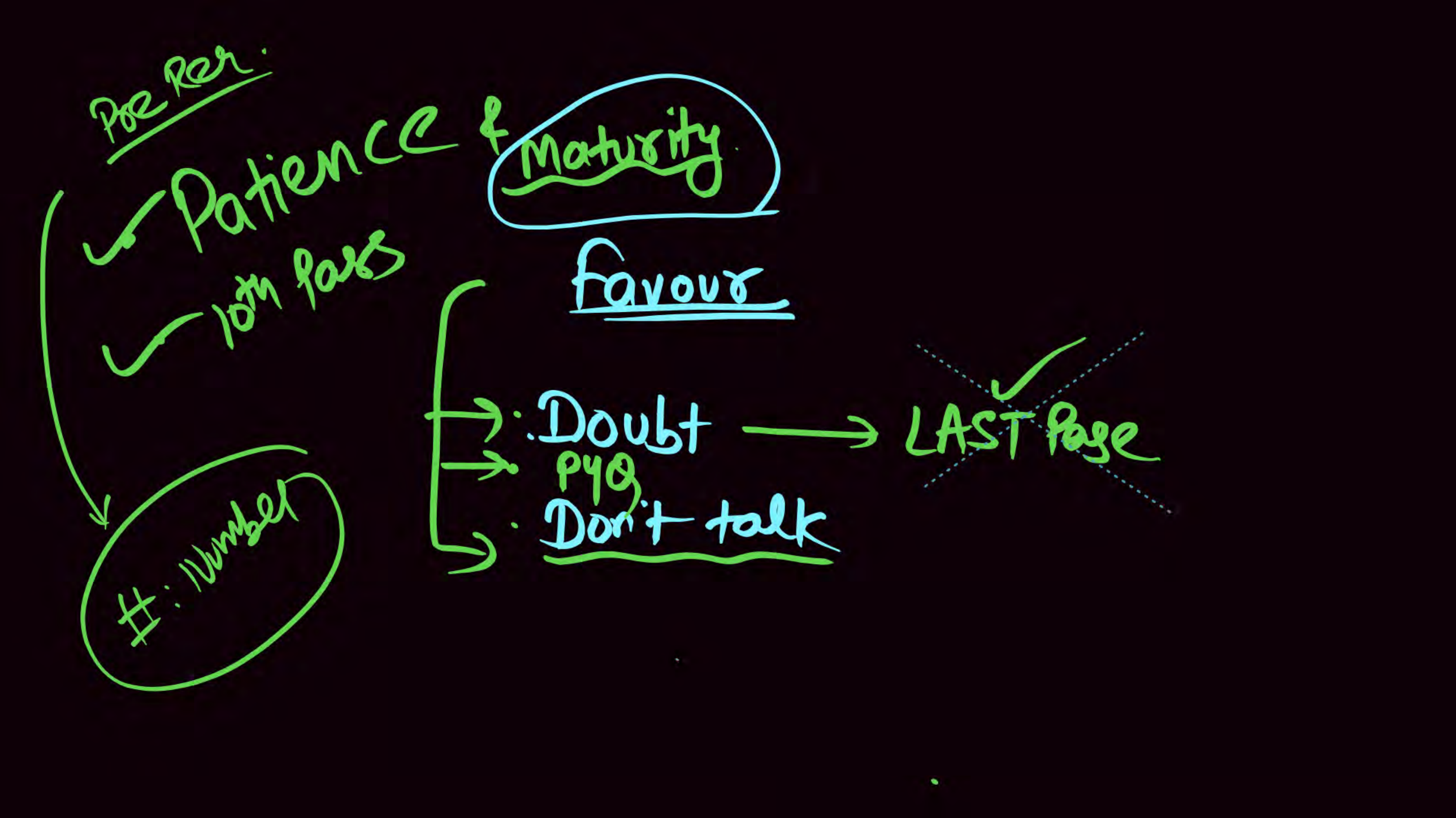
10th Pass

Vijay Sir PW

Telegram


RANK
Daily class
DPP's
PYQ's
Weekly Test


DBMS
BASIC
PYQ
IIIT+
GATE PYQ
class


Poe Rer:
Patience & Maturity
10th pass
#: Number
favour
Doubt
PYQ
Don't talk
LAST Page

DBMS [Database Management System]

DATA (Facts) (Raw Material)

↓

Information (Meaningful Data)
Pre Processed Data

↓

Database (Collection of Logically Related DATA
OR Collection of similar Records)

↓

DBMS [Set of Programs [S/W] used to Access & Update the Data in a efficient Manner]

RDBMS : Relational Database MS

Relation → Table

- Row [Tuple / Record]
- Column [Field / Attribute]

STUDENT

RollNO	Name	Branch	Gender	CGPA
1	A	CS	M	9
2	B	IT	F	10
3	C	CS	M	9
4	D	IT	F	10
5	E	CS	M	9
6	F	IT	F	10

[Degree]
↳ Arity : # of Attribute
[5]

Cardinality : # of Tuple / Record
(6)

Relational Schema: Table Abstraction / Heading of table

STUDENT (Roll No, Name, Branch, Gender, CGPA)

Relation Instance: Set of Records at Particular Moments.

1	A	CS	M	9
2	B	IT	F	10
3	C	CS	M	9
4	D	IT	F	10
5	E	CS	M	10
6	F	IT	F	10

Functional Dependency (FD)

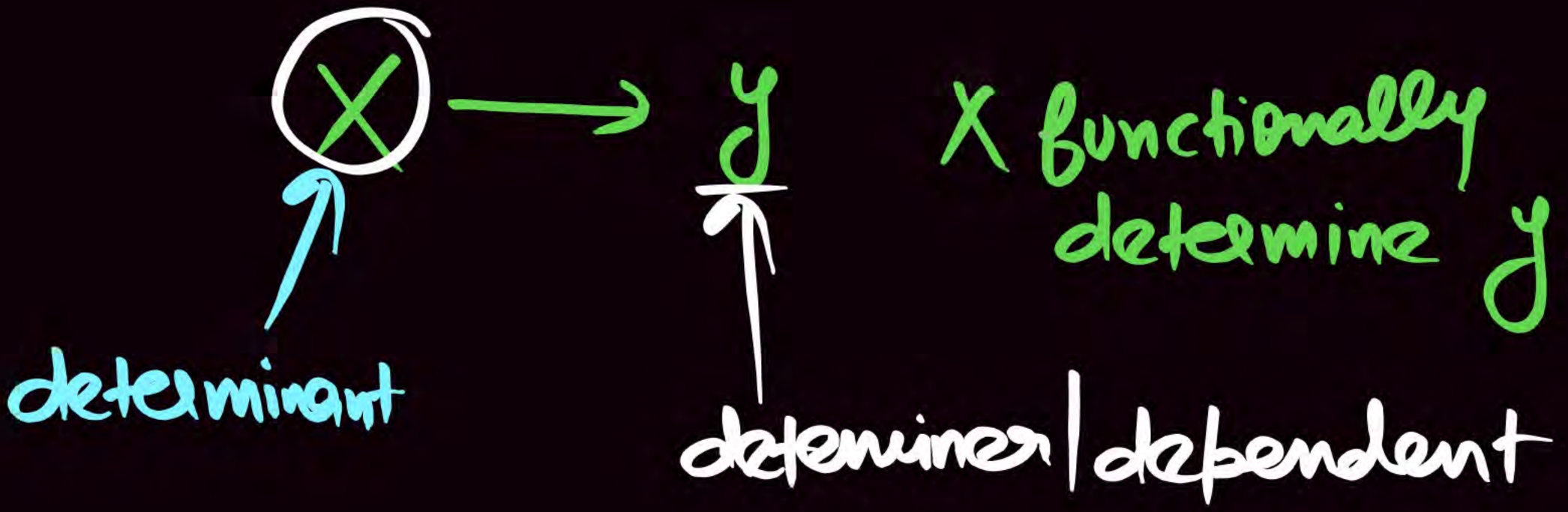
Roll No :

11 → Abhay

22 → Prince

29 → Rajeev.

56 → Neha


X
y
X functionally determine y.
determinant
determiner | dependent

Functional Dependency (FD) $X \rightarrow y$

Let R be the Relation Schema, X & y be the attribute Set of Relation R, t_1 & t_2 Any Two Tuple Such that

$X \rightarrow y$

If $t_1.X = t_2.X$ then $t_1.y = t_2.y$ Must be Same.

Functional Dependency (FD) $X \rightarrow y$

In $X \rightarrow y$ Whenever X Value Repeat then Corresponding y Value Must be Same.

Functional Dependency (FD) $X \rightarrow Y$

Type of FD

1. Trivial FD
2. Non Trivial FD
3. Semi Non Trivial FD

Functional Dependency (FD) $X \to Y$

① Trivial FD → Always Valid

$X \to Y$ is Trivial FD

iff $X \supseteq Y$.

(R.H.S (Right Hand Side) Attribute Must be Part or equal of L.H.S Attribute.

$AB \to A$
$AB \to B$
$AB \to AB$
Sid Sname → Sid
Sid Sname → Sname
Sid Sname → Sid Sname

Functional Dependency (FD) $X \to Y$

Non Trivial FD

$X \to Y$ is Non Trivial FD

IFF $X \cap Y = \phi$ && $X \to Y$ Must Satisfy FD Defination.

$A \to B$

Sid → marks

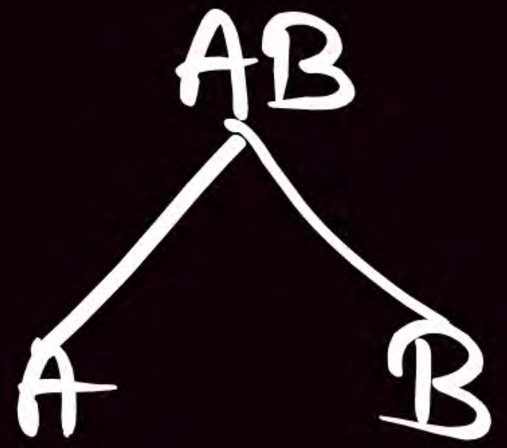
Sid → Sname

③ Semi Non Trivial FD

$X \to Y$ is Semi Non Trivial FD

iff $X \not\supset Y$ && $X \cap Y \neq \phi$

eg $AB \to BC$



Q.

X	Y	Z
3	3	7
3	1	7
1	3	7
1	1	7
1	3	7

Identify Non Trivial FD which is satisfied by the Instance?

Non Trivial

$X \to Z$
$Y \to Z$
$XY \to Z$

Ans

✗ $X \to Y$
✓ $X \to Z$
✗ $X \to YZ$

✗ $Y \to X$
✓ $Y \to Z$
✗ $Y \to XZ$

✗ $XZ \to X$
$XZ \to Y$
✗ $Z \to XY$

✓ $XY \to Z$
✗ $YZ \to X$
✗ $XZ \to Y$

Q.2

Consider the following relation:

A	B	C	TUPLE#
10	b1	c1	1
10	b2	c2	2
11	b4	c1	3
12	b3	c4	4
13	b1	c1	5
14	b3	c4	6

Given the extension (state), which of the following dependencies May hold in the above relation? If the dependency cannot hold, explain why by Specifying the tuples that cause the violation.

I. $A \rightarrow B$, II. $B \rightarrow C$, III. $C \rightarrow B$, IV. $B \rightarrow A$, V. $C \rightarrow A$

Q.3

A	B	C
1	1	1
1	2	1
2	1	2
2	1	3
1	3	3

Q.4

P	Q	R
6	6	7
6	7	7
7	3	4
8	3	4

Q.5

A	B	C
7	5	6
7	7	6
7	5	7
7	7	7
9	5	6

Q.6

A	B	C
2	2	4
2	3	4
3	2	4
3	3	4
3	2	4

Q.7

Given the following relation instance.

X	Y	Z
4	4	4
4	7	4
7	4	7
7	4	9
4	9	9

The number of non trivial FD's are satisfied by the instance ____

Q. 8

Given the following relation instance. [2000: 2 Marks]

X	Y	Z
1	4	2
1	5	3
1	6	3
3	2	2

Which of the following functional dependencies are satisfied by the instance?

A $XY \rightarrow Z$ and $Z \rightarrow Y$

B $YZ \rightarrow X$ and $Y \rightarrow Z$

C $YZ \rightarrow X$ and $X \rightarrow Z$

D $XZ \rightarrow Y$ and $Y \rightarrow X$

Q.9

From the following instance of a relation scheme R (A, B, C), we can conclude that: [2002: 2 Marks]

A	B	C
1	1	1
1	1	0
2	3	2
2	3	2

(A) A functionally determines B and B functionally determines C

(B) A functionally determines B and B does not functionally determines C

(C) B does not functionally determines C

(D) A does not functionally determines B and B does not functionally determines C

Q.10

Consider the relation X(P, Q, R, S, T, U) with the following set of functional dependencies [2015: 1 Marks]

F = {

$\{P, R\} \rightarrow \{S, T\}$

$\{P, S, U\} \rightarrow \{Q, R\}$

}

Which of the following is the trivial functional dependency in F^+ is closure of F?

A $\{P, R\} \rightarrow \{S, T\}$

B $\{P, R\} \rightarrow \{R, T\}$

C $\{P, S\} \rightarrow \{S\}$

D $\{P, S, U\} \rightarrow \{Q\}$

Armstrong's Axioms/Inference Rules

- Axioms, or rules of inference, provide a simpler technique for reasoning about functional dependencies
- In the rules that follow, we use Greek letters (α, β, γ,....) for sets of attributes.
- We can use the following three rules to find logically implied functional dependencies.
- By applying these rules repeatedly, we can find all of F+, given F. This collection of rules called Armstrong's Axioms in honor of the person who first proposed it.
  - Reflexivity Rule: If α is a set of attributes and $\beta \subseteq \alpha$, then $\alpha \rightarrow \beta$ holds.
  - Augmentation rule: If $\alpha \rightarrow \beta$ holds and γ is a set of attributes, then $\gamma\alpha \rightarrow \gamma\beta$ holds.
  - Transitivity Rule: If $\alpha \rightarrow \beta$ holds and $\beta \rightarrow \gamma$, then $\alpha \rightarrow \gamma$ holds.

Additional Rules

- If $\alpha \rightarrow \beta$ holds and $\alpha \rightarrow \gamma$ holds, then $\alpha \rightarrow \beta\gamma$ holds (union)
- If $\alpha \rightarrow \beta\gamma$ holds, then $\alpha \rightarrow \beta$ holds and $\alpha \rightarrow \gamma$ holds (decomposition)
- If $\alpha \rightarrow \beta$ holds and $\gamma\beta \rightarrow \delta$ holds, then $\alpha\gamma \rightarrow \delta$ holds (Pseudo transitivity)

The above rules can be inferred from Armstrong's Axioms.

Armstrong's Axioms/Inference Rules

Inference rules that can be used to infer new dependencies from a given set of dependencies

- IR1 (reflexive rule) : If $X \supseteq Y$, then $X \rightarrow Y$.
- IR2 (augmentation rule)[2]: $\{X \rightarrow Y\} \models XZ \rightarrow YZ$.
- IR3 (transitive rule): $\{X \rightarrow Y, Y \rightarrow Z\} \models X \rightarrow Z$.
- IR4 (decomposition, or projective, rule): $\{X \rightarrow YZ] \models X \rightarrow Y$.
- IR5 (union, or additive, rule): $\{X \rightarrow Y, X \rightarrow Z] \models X \rightarrow YZ$.
- IR6 (pseudotransitive rule): $\{X \rightarrow Y, WY \rightarrow Z| \models WX \rightarrow Z$.

Any Doubt ?

THANK YOU!