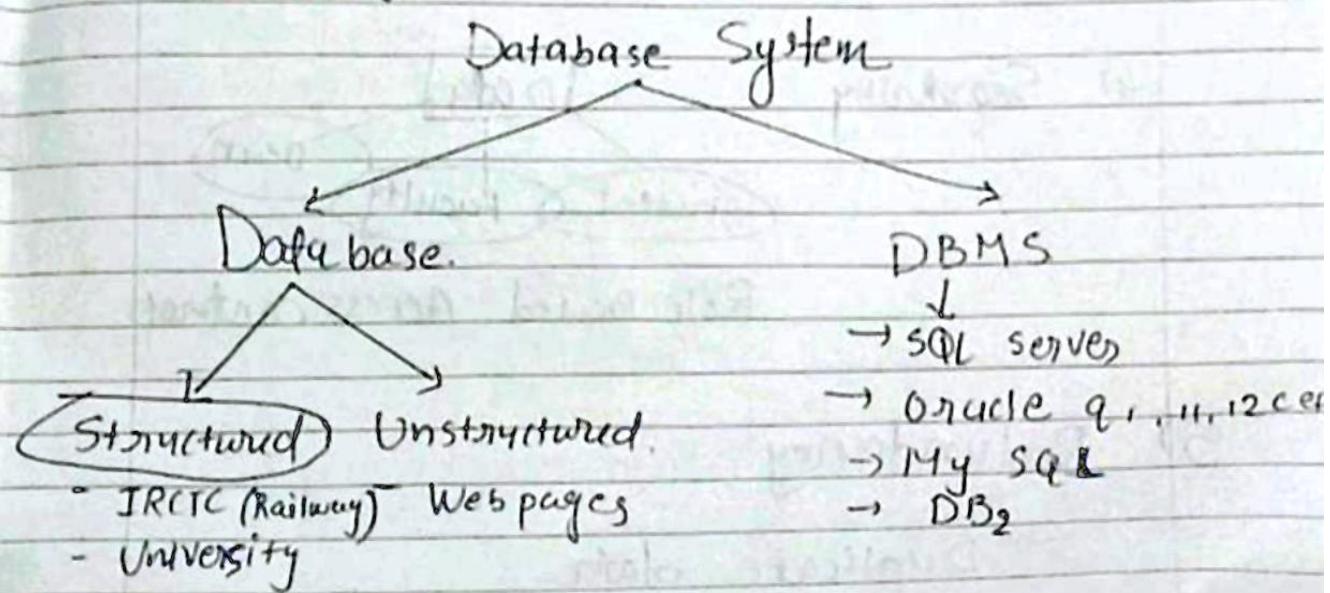


Database Management System (DBMS)

- Basic Intro.
- ER Model
- Basics of keys
- Normalization
- Transaction control and concurrency
- SQL and Relational algebra
- Indexing



Database : Database is a collection of related data

DBMS :

~~Lec 3~~ \Rightarrow Disadvantage of 'File System'

~~★~~ "File system" vs DBMS"

1) 1 KB data search

25 GB arrive this much data

} disadvantage of File system

2) Attributes

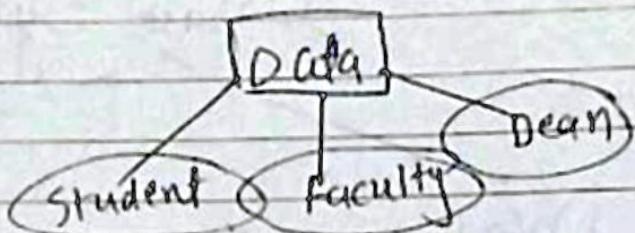
No require in DBMS. } Independent.

3) Concurrency

too much transaction at one time

WR
R &
RW
RWW

4) Security



Role Based Access control.

5) Redundancy.

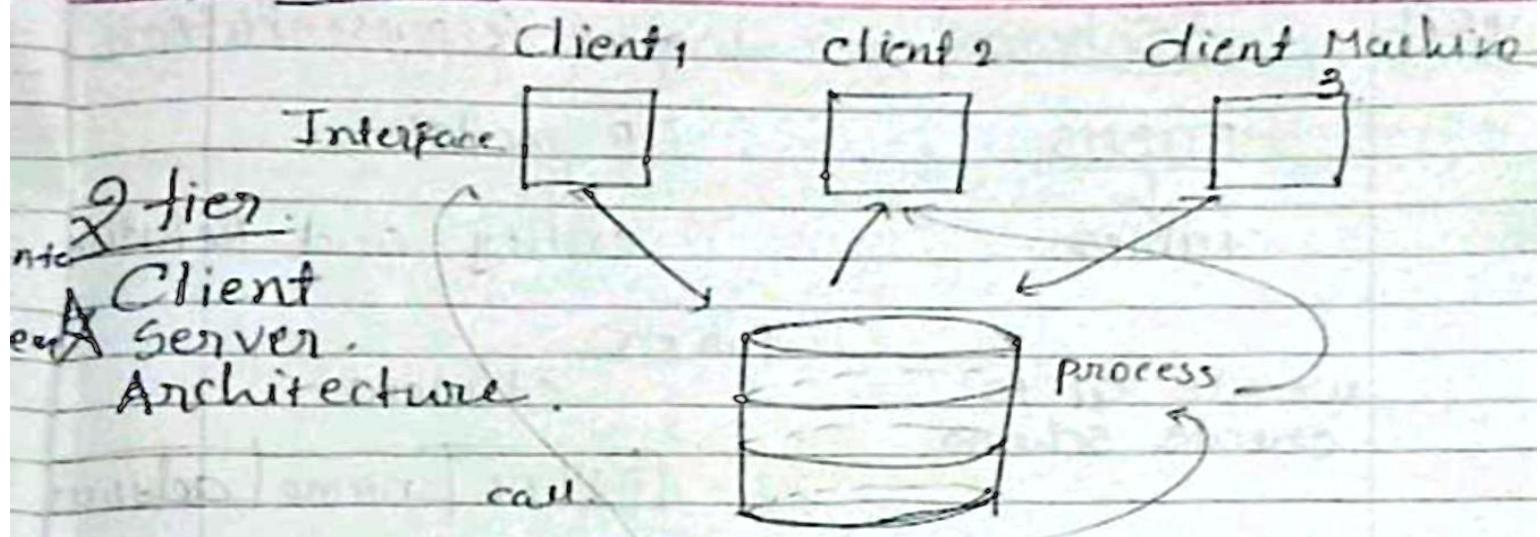
→ Duplicate data

In DBMS. \rightarrow Not problem of Redundance

~~Lec 4~~ 2 tier and 3 tier Arc

tier means \rightarrow layer

A 2 tier.



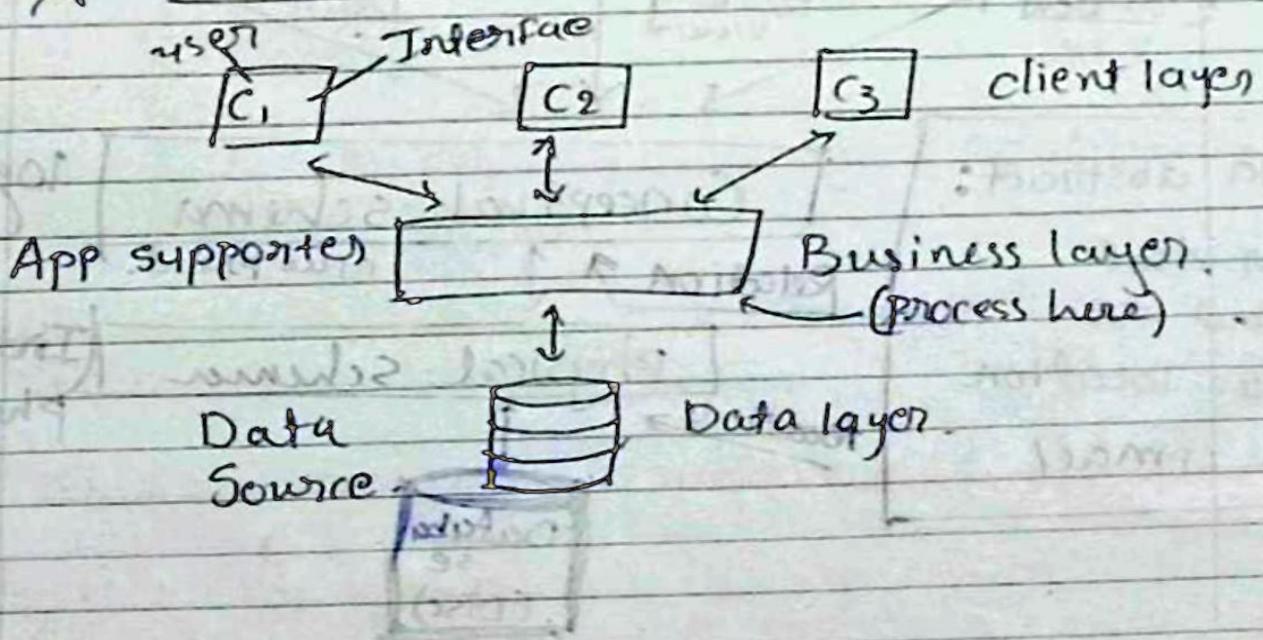
* disadvantage \rightarrow Database Server.

- Scalability
- Security.

* Advantage

- Maintenance.

A 3 tier Architecture.



Schema means structure.

Lec 9

'Schema' → logical Representation

RDBMS
↓
tables.

ER model

↓
entity and Relation

we use SQL to
create schema.

for ex

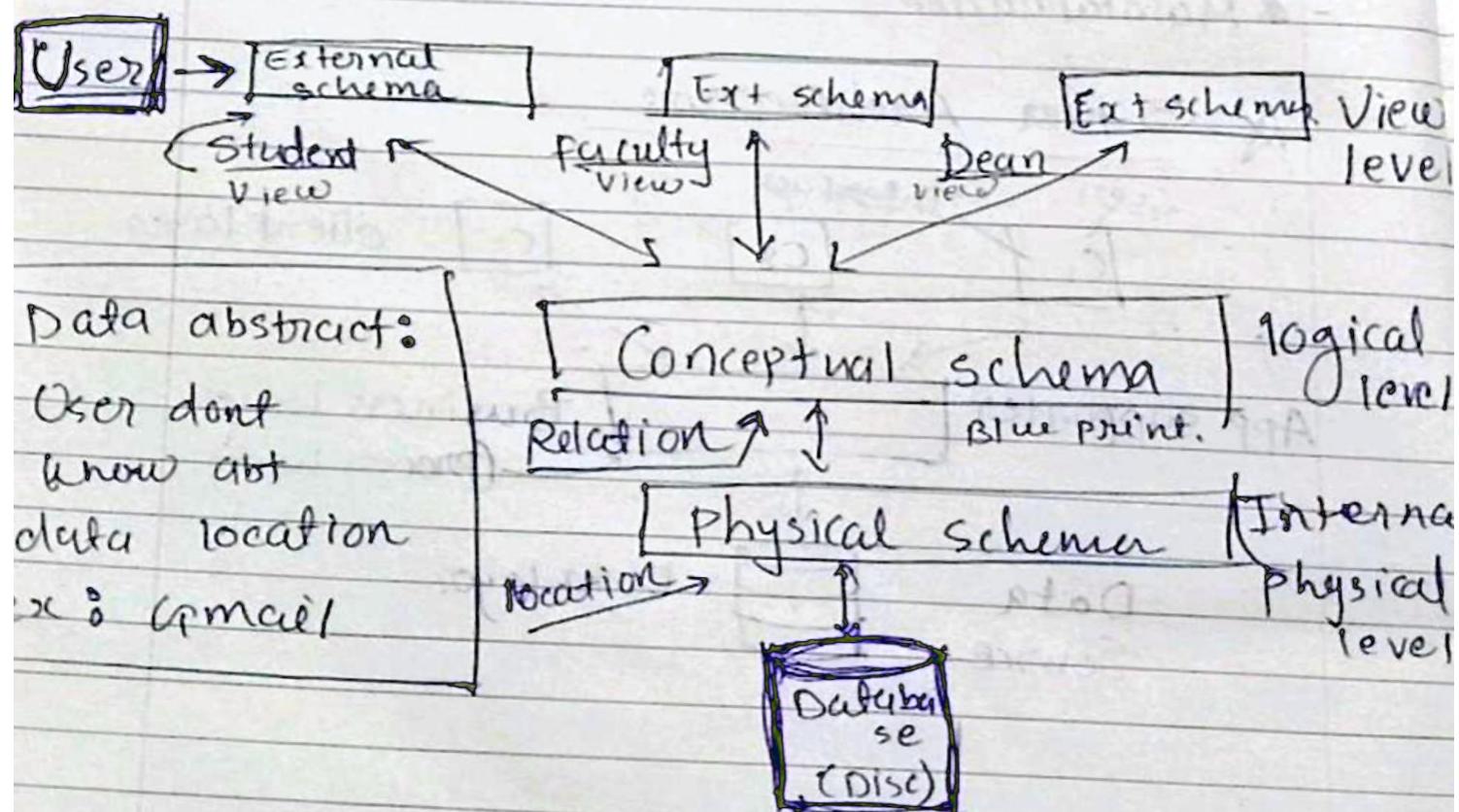
student

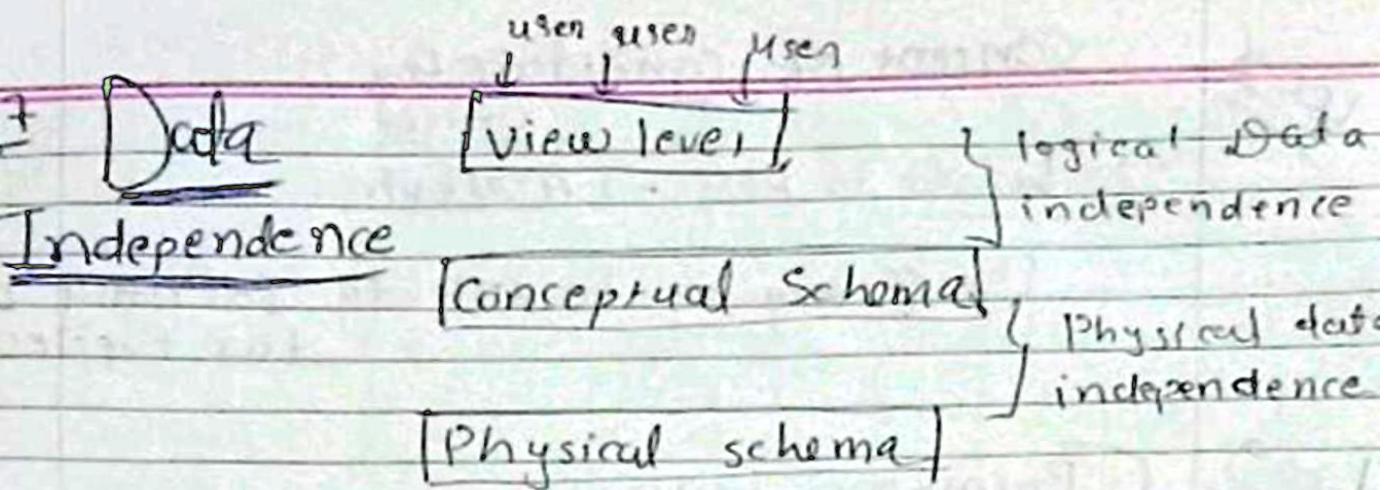
[Roll no | name | address]

Schema can be a single table Or it
can have more than one table

Lec 6

3 Schema architecture.





| DB |

if any user + change in data, It does not affect in the view of main data

Name	age	mobile

← added by user 1.

View for User 2.

- Don't need to change Application frequently.
- Location does not affect conceptual schema.
(physical schema)

- ① Storage structure
- ② DS chang
- ③ Index

- Change does not affect conceptual schema.

lec 6

Concept of Candidate key

unique

→ What is key → Attribute:

Use of key → to uniquely identify a
two tuples.

lec 9

Primary key.

- Unique + Not null

Candidate key.

- Unique

All
candidate
key.

Phone num

Aadhar no.

PAN

roll no } primary key.

Reg no }

cc 10

Foreign key

It is an attribute or set of attributes
of another table course
Add constraint KK
foreign key (roll no)
Reference student (roll no)

Concept of F.K.

Foreign key maintenance Referential Integrity.

P1K.

Roll no	name	address	Courseid	Course Name	F.K.P Roll no.
1	A	Delhi	G	DBMS	1
2	B	Mumbai	C ₂	IVW	2
3	A	Chd			
4	D	Chd			

Student (~~referenced
public base table~~)

course (Referencing
table)

Referenced table

- 1) Insert - No violation
- 2) Delete - May cause violation.

Solution :- { On delete cascade.
On delete set null.
On delete no action }

- 3) Updation → may cause violation

Referencing table.

- 1) Insert - May cause violation
- 2) Delete - No violation
- 3) Updation - May cause violation

lec 12

Lec-12

Let $R_1(a, b, c)$ and, $R_2(x, y, z)$ be two relations in which 'a' is foreign key in R_1 that refers to primary key of R_2 . Consider four options.

- (a) Insert into R_1 ~~(c) Delete from R_1~~
~~(b)~~ " " R_2 d) " " R_2

Base table		
$\frac{a}{1}$	R_1	$\frac{x}{1}$
$\frac{2}{2}$	b / c	y / z
$\frac{3}{3}$		

Which is correct regarding referential integrity?

- ~~not right~~ 1) Option a and b cause violation R_2 ins. violation
~~✓~~ 2) Option b " c " "
 3) " c and d " " R_2 violation problem
 4) " d and a " "

Lec-13 Concept of Superkey

Roll no	name	age	candidate key Roll no Name
			Super key age

\Rightarrow Super key : ~~name~~. A superkey is a combination of all possible attributes which can uniquely identify two tuples in a table.

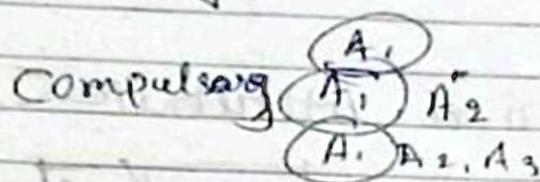
\Rightarrow Super set of any candidate key is super key

→ If $R(A_1, A_2, A_3, A_4, \dots, A_n)$ then how many super keys are possible

A_1 is candidate key

A_1, A_2 are candidate keys.

⇒ possibility $\{2^{n-1}\}$ (because A_1 is CK)



$$2^{n-1} + 2^{n-1} = 2^{n-2}$$

One key fix
two minus.

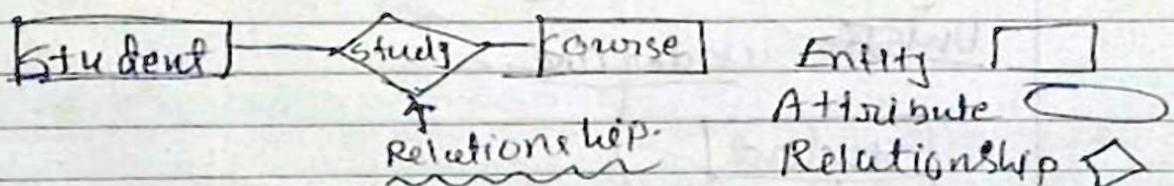
$\{A_1 A_2, A_3 A_4\}$

$$2^{n-2} + 2^{n-2}$$

$$\{2^{n-2} + 2^{n-2} - 2^{n-4}\}$$

lec 14

ER Model

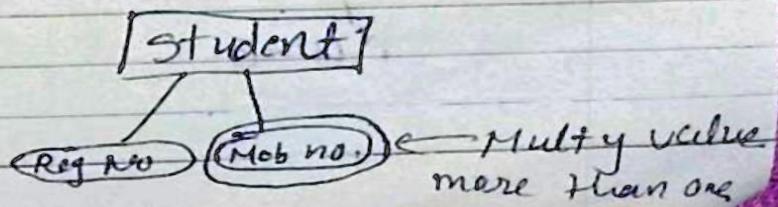
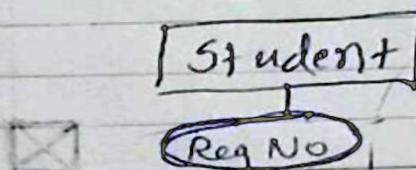


Entity → Physical existence.

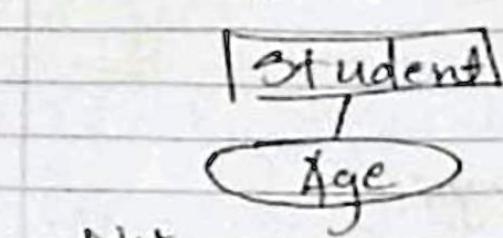
lec 15

Types of Attributes.

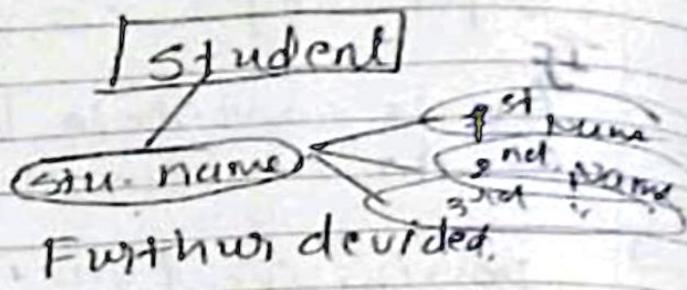
1) Single vs Multivalued Attributes



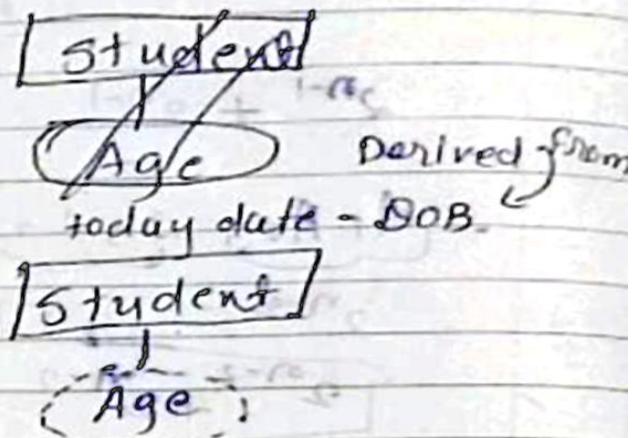
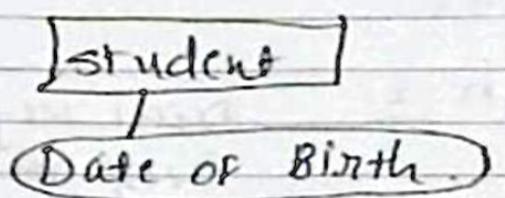
6) Simple vs composite Attribute.



Not further divided.

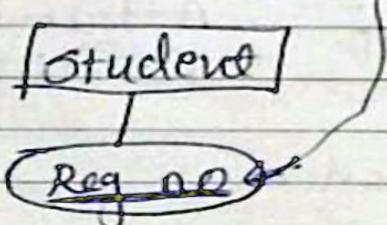


7) Stored vs derived Attribute

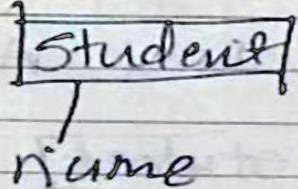


8) ** Key vs Non key Attribute

Unique underline.



9) Required vs Optional Attribute



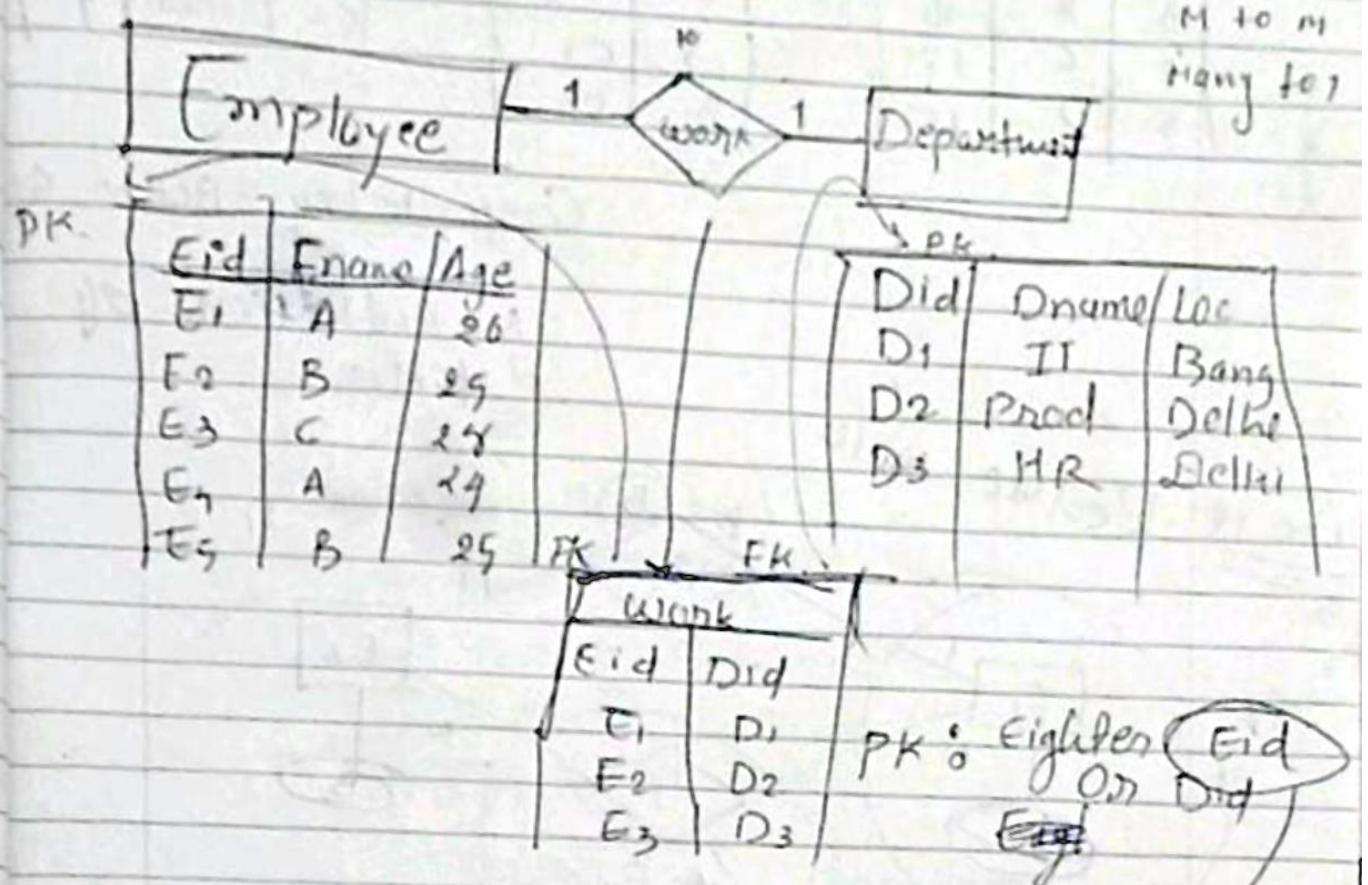
d) Complex Attribute

(Composite Multivalued)

lec-16

One to One Relationship

1 to Many
1 to 1
M to M
Many to 1

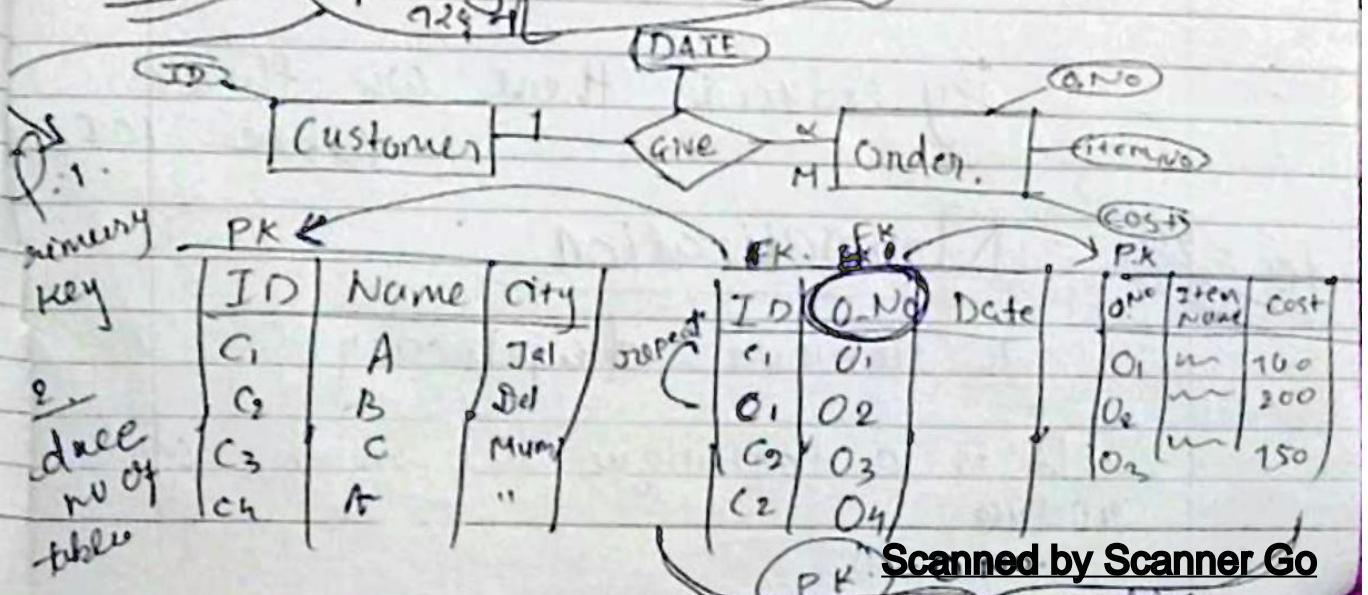


One to many

lex-17

Many primary key

Primary key
not null



Many to m

Lec 18

PK

Roll No.	Name	Age
1	A	16
2	B	17
3	A	16
4	C	17
5	D	15

PK

FK

SK

Roll No.	c_id
1	C1
2	C2
1	C2
2	C1
3	C3

PK

PK

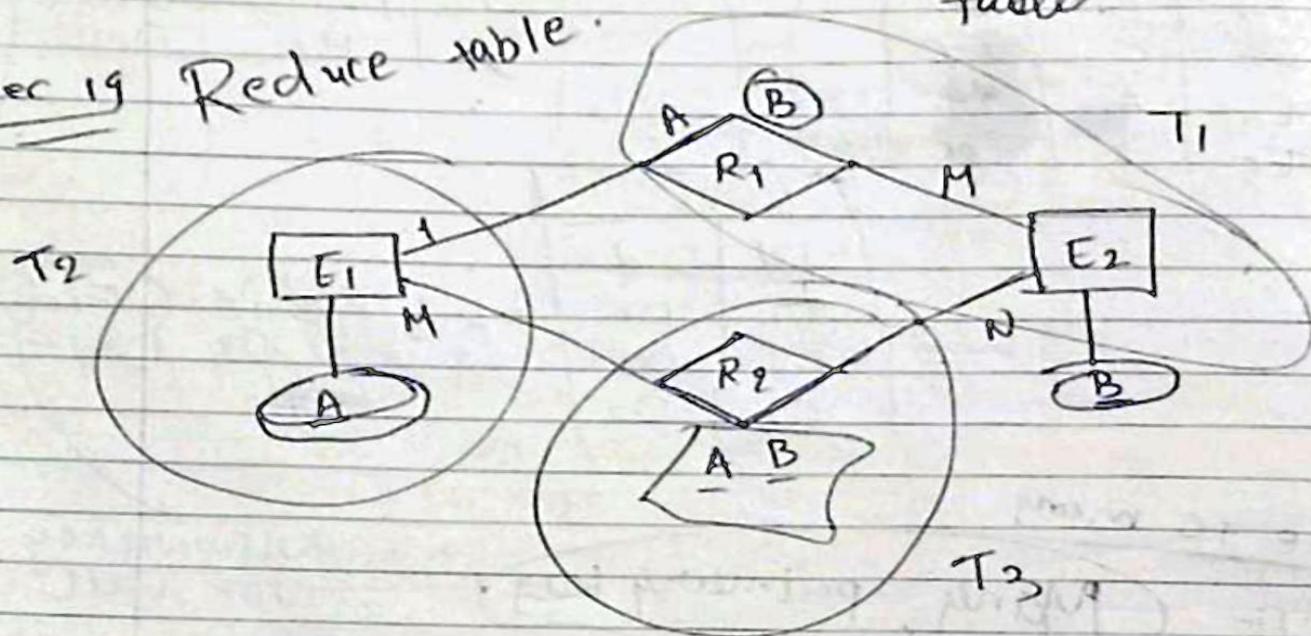
PK

c_id	name	cored
C1	Maths	4
C2	Phy	4
C3	Chem	4
C4	Hindi	4

Composite key = Roll no. c

No Reduction of tables

Lec 19 Reduce table.



By reducing there are three table i.e

Lec = 20

Normalization

to remove duplicacy

It is a technique to remove by reduce.

Reducing from a table

STD	Sname	Age
1	RAM	20
2	Varun	25
1	RAM	20

Row level duplicacy

STD	Sname	Cid	Cname	FID	Fname	Sal
1	RAM	C1	DBMS	F1	John	30000
2	Ravi	C2	JAVA	F2	Bob	40000
3	Nitin	C1	DBMS	F1	John	30000
4	Amrit Pal	C1	DBMS	F1	John	30.000
5	Varun	C10	MBBS	?	?	?

column level Duplicacy

- If New data
- Insert data
- Cannot insert data
- Insertion Anomaly
- Deletion Anomaly
- Updation Anomaly

Anomaly & Anomaly is problem occur at Special occasion

→ Delete from student where SID=1.

→ whole row delete.

→ ~~all~~ all information will be deleted.

Update student

Set Sname = "Amrit Pal"

Where SID = 2

Change salary for

F1 from 30k to
40K → ~~40000~~

If you change 30,000 to 40,000 →
at one place ... There will be
change in all pieces.

40000
40000
40000
40000

If you divide table in multiple tables

SID	Sname	ErID	CNAME
-----	-------	------	-------

EID	Fname	Surname
-----	-------	---------

Lec 21 First normal Form in DBMS

First normal Form

→ Table should not contain any multi-valued Attribute.

Roll no	Name	Course
1	Sai	C/C++
2	Harsh	Java
3	Omkar	C/DBMS

Format 1

Roll no	Name	Course	→ What will be primary key
1	Sai	C	↓
1	Sai	C++	
2	Harsh	Java	
3	Omkar	C	
3	Omkar	DBMS	Roll no Course

Composite primary

Format 2

Roll no	Name	Course 1	Course 2	→ Primary key
1	Sai	C	C++		
2	Harsh	Java	NULL		
3	Omkar	C	DBMS		Roll

5 mat	Roll no	Name	Roll no	Course
3	1	Sai	1	C
2	2	Harish	2	C++
1	3	Omkar	3	Java
				C
				DBMS

Base Table

PK : Roll no course
 FK : Roll no.

sd presentation.

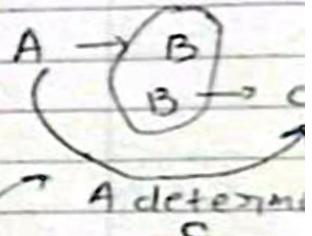
Lec 2.2

Closure Method → To find candidate key

→ find Candidate key

R(ABCD)
relation

CK = {A}



functional dependency

$$A^+ = BCDA$$

$$(AB)^+ = ABCD$$

Closure of A
what A can determine.

$$\begin{aligned} B^+ &= BCD \\ C^+ &= CD \\ D^+ &= D \end{aligned}$$

$$\overline{AB} = CK \times$$

Superkey

$\{A, B, C, D\}$ R(ABCD)

$$FD \{A \rightarrow B, B \rightarrow C, C \rightarrow D, D \rightarrow A\}$$

candi. key + Any thin
= Superkey

$$A^+ = ABCD$$

$$B^+ = BCD$$

$$C^+ = CDAB$$

$$D^+ = DAB$$

* Prime Attribute.

Used in Making of cand. key

$$= \{\emptyset\}$$

$R(A B C D E)$

$F D = \{ A \rightarrow B, B C \rightarrow D, E \rightarrow C, D \rightarrow A \}$

$E = \cdot B D C A E$

Note: IF E is not on the right side
 $\Rightarrow E$ is left $\rightarrow E$ in Right

$$E' = EC$$

$$\underbrace{A E}_{\text{candidate key}} = \underbrace{A B E C D}_{\text{right}}$$

candidate key = $\{ A E \} \checkmark, \{ B E \} \checkmark, \{ D E \} \checkmark$

Eighter A or E present at
Right Hand side.

$$\{ A E \}$$

\downarrow Replace

$$D E' = D E A B C$$

Prime Attribute : A B D E

Non Prime : C

CC 93

Functional Dependency

Determinant $(X) \rightarrow (Y)$ \rightarrow Dependent Attribute
 X determines Y
 Y is determined by X

3.id \rightarrow Sname

1 Ranjith

2 Ranjith

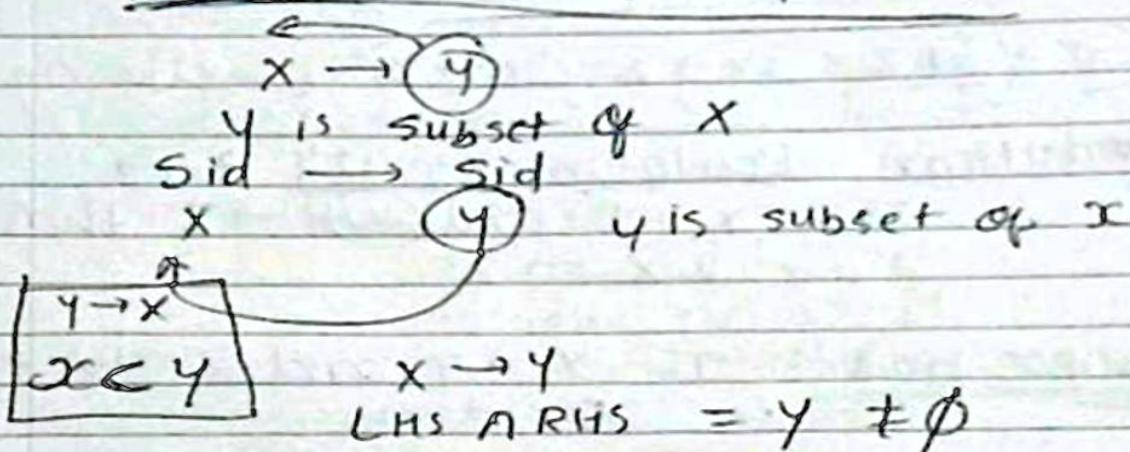
Ranjit \neq two same

Ranjith

<u>Valid ✓</u>	<u>Valid ✓</u>
$\text{sid} \rightarrow \text{sname}$	$\text{Sid} \rightarrow \text{sname}$
1 Ranjit	1 Ranjit
1 Ranjit	2 Ranjtt

<u>Valid ✓</u>	<u>sid sname X invalid</u>
$\text{Sid} \rightarrow \text{sname}$	$\text{sid sname X invalid}$
1 Ranxit	1 Ranxit
2 Varun	2 Varun

→ Trivial Functional Dependency (FD)



$\text{sid sname} \rightarrow \text{sid}$.

⇒ Non-trivial

$x \rightarrow y$

$\text{sid} \rightarrow \text{sname}$

$\text{sid} \rightarrow \text{semester}$

$\text{sid} \rightarrow \text{phoneno}$

$x \cap y = \emptyset$

Properties of FD

- Reflexivity: If y is subset of x then $x \rightarrow y$ [self-evident.]
- for ex. $\text{sid} \rightarrow \text{sid}$.

- (1) • Augmentation: If $x \rightarrow y$ then $xz \rightarrow yz$
ex. sid phone \rightarrow sid sname ph
- (2) • Transitive: If $x \rightarrow y$, and, $y \rightarrow z$ then $x \rightarrow z$
- (3) • Union: If $x \rightarrow (y_1)$ and $x \rightarrow (y_2)$ then

$$x \rightarrow (y_1 \cup y_2)$$
- (4) • Decomposition: If $x \rightarrow yz$ then

$$x \rightarrow (y) \quad y \rightarrow (z)$$

$$x \rightarrow y \quad y \rightarrow z \quad \leftarrow \text{Wrong}$$
- (5) • Pseudotransitivity: If $x \rightarrow y$ and $wy \rightarrow z$ then

$$wx \rightarrow z$$
- (6) • Composition: If $x \rightarrow y$ and $z \rightarrow w$ then

$$xz \rightarrow yw$$

Lec: 24

Second Normal Form

- Table or relation must be in 1st Normal Form.
- All the non prime attributes should be fully functional dependent on candidate key.

LHS : is a proper subset of any c
RHS : Non prime

Customer ID	Store ID	Location
1	1	Delhi
1	3	Mumbai
2	1	Delhi
3	1	Bangalore
4	3	Mumbai

el:25 3rd Normal Form

- Table or relation must be in 2nd Normal form.
 - There should be no transitive dependency in the table

Roll no	State	city
1	Punjab	Mohali
2	Haryana	Ambala
3	Punjab	Mohali
4	Haryana	Ambala
5	Bihar	

$\Rightarrow \{R_0\} \text{ no}\}$

Roll no → State
 time state → city
 non prime non prime

1

$$PA = \{R_{011} n\}$$

$$NPA = \{ \text{Static, city} \}$$

Roll no → State and state → city
prime non prime non prime non

Roll no → city

Transitive dependency

Ex: 1 $R(ABCD)$

Non Valid

FD: $AB \rightarrow C, C \rightarrow D$

CK: AB

PA: A, B

NPA: C, D

Not should be

X. { Non prime \rightarrow Non prime }

$AB' = AB, C, D$

\Rightarrow It should not be in 3rd Normal Form

Ex: 2 $R(ABCD)$

Valid FD: $AB \rightarrow CD, D \rightarrow A$

CK: A, B, DB

PA = { A, B, D }

NPA = { C }

Note:

{ A is ~~not~~ RHS of
we can make 1
 $(AB)' = APSCD$ by ~~in~~ D }

* For each FD

= LHS must be a CK or SK OR

OR RHS is a prime Attribute.

CK \rightarrow non prime
 $AB \rightarrow CD, D \rightarrow A$ prime
 valid valid prime Attr.

Table is in
3rd normal
form

LHS of all FD is CK or SK
 OR RHS is Prime Attribute

Q 30

$R(A B C D E F)$, Check the highest normal form?

FD: $S A B \rightarrow C, C \rightarrow D E, E \rightarrow F, F \rightarrow A$

steps.

Step 1: Find all CK in relation.

$$\begin{array}{l} \text{Reps of } A \\ \text{Rep of } C \\ \text{Rep of } F \end{array} \quad \begin{array}{l} (A B)^+ = A B C D E F \quad A^+ = A \times \\ (C B)^+ = F B A C D E \quad C^+ = C \times \\ (E B)^+ = E B F A C D E \quad E^+ = E \times \end{array}$$

Note: Check whether A or B individually candidate key or not.

$$CK: \{A B, F B, E B, C B\}$$

Step 2: Write all prime Attributes

$$PA: \{A, B, C, E, F\}$$

Step 3: NPA: {D}

Not in BCNF $\{AB \rightarrow C, C \rightarrow DE, E \rightarrow F, F \rightarrow A\}$

LHS of all FD's should be CK or SK

Redundancy	AB \rightarrow C	C \rightarrow DF	E \rightarrow F	F \rightarrow A	BCNF
BCNF	✓	X	X	X	2NF, 3NF
3NF	✗	C \rightarrow D, C \rightarrow F D \rightarrow F	✓	✓	3NF
2NF	✓	C \rightarrow BC C \rightarrow DE	✓	✓	2NF, 3NF
NF	✓	D \rightarrow NP E \rightarrow F F \rightarrow A	✓	✓	1NF, 2NF, 3NF

By default in 1st Normal Form

Lec 26

BCNF : Boyce Codd Normal Form

in
BCNF

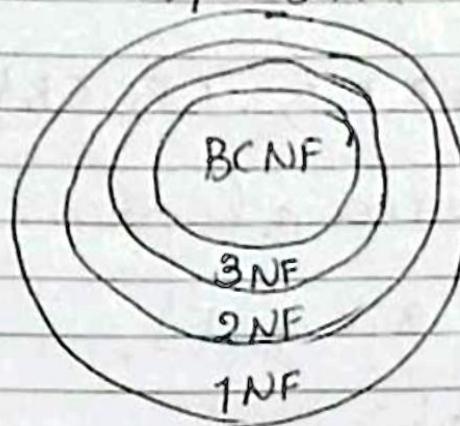
student 3NF

Rollno	Name	Voter id	age	ref: Roll, Voter
1	Ravi	K0123	20	
2	Varun	M034	21	
3	Ravi	K78G	23	
4	Rahul	D236	21	FD { Roll \rightarrow N Roll \rightarrow Vo VoterId \rightarrow N VoterId \rightarrow Vo }

Note: LHS of each dependency should be

CK on SK

BCNF



Lec 27

Lossless and Lossy Join Decomposition

R

	A	B	C	
1	1	2	1	$\rightarrow R_1(AB)$
2	2	2	2	$\rightarrow R_2(BC)$
3	3	3	2	

R_1

R_2

A	B
1	2
2	2
3	3

B	C
2	1
2	2
3	2

Ques Find the value of c if the value of A = 1.

↓
Here we need to join R₁ and R₂.

Select R₂ ∙ C from R₂ Natural join R₁,
where R₁ · A = 'A'.

	R ₁	R ₂		
	A	B	B	C
Cross product	1	2	2	1 ✓
	1	2	2	2 ✓
	—	2	3	2
	2	2	2	1 ✓
	2	2	2	2 ✓
	—	2	3	2
	3	3	2	1
	3	3	2	2
	3	3	3	2 ✓

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

Increment in rows.

Lossy Join Decomposition
Duplicacy in Database.

Ques Common Attribute should be CK or SK
either R₁ or R₂ or both.

We should common tuple is
take

A = R₂(A B) And R₂(A C)

same tuple in output
LOSSLESS

$$1) R_1 \cup R_2 \equiv R$$

$$AB \cup AC =$$

$$ABC \equiv ABC$$

$$2) R_1 \cap R_2 \neq \emptyset$$

$$\begin{matrix} AB \cap AC \\ A \end{matrix} \neq \emptyset$$

3) $R_1 \subset CK$ or $R_2 \subset CK$ or Both.

Lec 28

All normal Form with Real life

1st NF

- * NO Multivalued attribute.
- * ONLY single valued

	Roll no	course
1		C, C++
2		C++, Java.

Unvalid.

2nd NF

- * In 1st NF
- * No Partial Dependency
- * Only full "

NOT in 2NF
if p+ps true

LHS is proper subset
of CK.

RHS is non prim

Valid $\begin{array}{c} AB \\ \text{non Unique} \end{array} \rightarrow C \leftarrow \text{non unique.}$

Non Valid $B \rightarrow C$
 $A \rightarrow C$

3rd Normal Form

- * In 2nd NF
- * No Transitive dependency
- * No non-prime should determine non prime.

LHS is CK, PK, SK

RHS is prime

$$X \rightarrow Y$$

PK Non
prime ✓ Valid

$$X \rightarrow Y \rightarrow Z$$

PK Non prime Non prime Invalid.
 \underbrace{X \rightarrow Z}

BCNF

- * In 3rd NF
- * LHS must be CK or SK

$$X \rightarrow Y$$

\curvearrowleft

4th NF

- * In BCNF + NO Multivalued Dependency

$$X \not\rightarrow\!\!\! \rightarrow Y$$

Varun → 3 phone no. Invalid.
→ 3 Email

5th NF

- * In 4th NF +
- * Lossless Decomposition

Lec 26 For the following functional dependencies find the correct minimal cover.

Ques $\{A \rightarrow B, C \rightarrow B, D \rightarrow ABC, AC \rightarrow D^2\}$

Step - 1 RHS is must be single attribute

$$A \rightarrow B, C \rightarrow B, \underbrace{D \rightarrow A}, \underbrace{D \rightarrow B}, \underbrace{D \rightarrow C}$$

Step - 2

$$\begin{array}{c} A^+ \\ \downarrow \\ A^+ = A \\ A \rightarrow B, C \rightarrow B, D \rightarrow A, D \rightarrow B, D \rightarrow C \end{array} \quad \begin{array}{c} C^+ \\ \downarrow \\ C^+ = C \\ A^+ = A, C^+ = C, D^+ = D, B, C \end{array} \quad \begin{array}{c} D^+ \\ \downarrow \\ D^+ = DABC \\ D \rightarrow E, AC \rightarrow D \end{array}$$

(+) 11013
21571

Remove
\$29

$D \rightarrow B$ Redundant

$$\{A \rightarrow B, C \rightarrow B, D \rightarrow A, D \rightarrow C, AC \rightarrow D\}$$

Step - 3 LHS ps but be single Attribute

$$A \rightarrow B, C \rightarrow B, D \rightarrow A, D \rightarrow C,$$

Note { IF $\overbrace{AC \rightarrow D}^+$
 $C^+ = C$ if we get A in C^+ then we
 $A^+ = AB$ reduce and write $C \rightarrow D$.
Here we can't take it

Ans $A \rightarrow B, C \rightarrow B, D \rightarrow AC, AC \rightarrow D$

Q28 R(ABCDEF). Check the highest Normal Form.

FD: $\{AB \rightarrow C, C \rightarrow DE, E \rightarrow F, F \rightarrow A\}$

Step 1 Find all ck in the relation R.

$$\begin{array}{ll} AB^+ = ABCDEF & FB = FBACDE \\ C^+ \rightarrow CDEFA & EB = EBFACD \\ A^+ = A, B^+ = B & CB^+ = CBDEFA \end{array}$$

$$CK = \{ \begin{array}{l} AB \\ FB \\ EB \\ CB \end{array} \}$$

Prime Attribute : $\{A, B, C, E, F\}$
Non prime : $\{D\}$

For check BCNF \Rightarrow LHS of all is ck.

$$\{ AB \rightarrow C \quad C \rightarrow DE \quad E \rightarrow F \quad F \rightarrow A \}$$

✓ X

Not in BCNF

For 3NF : Non transitive

$$\begin{array}{cccc} AB \rightarrow C & C \rightarrow DE & E \rightarrow F & F \rightarrow A \\ \checkmark & \text{Non prime} & \checkmark & \text{X} \end{array}$$

Not in 3NF X

For 2NF :

$$\begin{array}{ccccc} B \rightarrow C & C \rightarrow DE & E \rightarrow F & F \rightarrow A \\ \checkmark & \text{X} & \checkmark & \checkmark \\ \text{proper subset of BC} & \text{non prime} & \text{X} \end{array}$$

It is in the 1NF
By default.

Lec 31

Q. Which of the following statement is true?

A) A relation is in 3NF then it is always in BCNF.

B) A relation is in 2NF then it is not in 1NF

✓ Relation is in BCNF " is 2NF.

D) A relation is in 2NF then it contains partial dependency.

Q. Relation R has eight attributes ABCDEFGH.

$F = \{ CH \rightarrow G, A \rightarrow BC, B \rightarrow FH, E \rightarrow A, F \rightarrow H \}$

How many CK in R? A) 3 B) 4 C) 5 D) 6

$CH \Rightarrow CHG$

Right side all D right

$A = ABCFHEG$

$D^+ = D$

1) $AD^+ = ADBCFHEG$

2) $ED^+ = EDABCFCFG$

3) $FD = FDEGA BCCEH$

4) $BD = \dots$

Lec 32

Schema: \downarrow Registration (Roll no., courses)

Non-trivial FD's Roll no \rightarrow courses

LHS & RHS = 0

valid case

$BCNF \Rightarrow \text{LHS CK, SK, PK} \rightarrow \checkmark BCNF$