COMPUTER SCIENCE

Database Management System

Introduction of RDBMS, FD's and Keys Concept, Finding Multiple Candidate Key

Lecture_01

Vijay Agarwal sir

DBMS

Lecture schedule

DBMS GATE Syllabus

(7 - 9 marks)

8 marks

- Functional dependency and Normalization.
- Transaction and Concurrency control.
- Relational Algebra, TRC and SQL
- File Organization and Indexing
- ER model and Integrity constraints.

Functional Dependency (FD's)

(2-4M)

- FD concepts
- FD types
- Attribute closure
- Keys Concept
  - Super key
  - Candidate key
  - Primary key
  - Alternative / secondary key
- Finding multiple candidate keys
- Membership set

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

Normalization

- Need of Normalization ?

  Normal Forms

  - 1 NF
  - 2 NF
  - 3 NF
  - BCNF

& Decomposition

Transaction & Concurrency Control

(2 M)

- 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)

Query Language

(2-3M)

- Introduction of Relational Algebra (RA)

Operations

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

RA SQL TRC

- TRC (Tuple Relational Calculus)
- SQL & its clauses
  - Aggregate operators
  - Set operators
- Nested Query

File Organization & Indexing

(1-2 M)

- Spanned and unspanned organization
- Sparse & Dense Index
- Indexing type (primary, clustered, secondary index)
- Multi level indexing
- 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

8 to 11 AM

Foreign key concept and its constraint

Conversion of ER model to Relations (Tables).

Books:

Henry F. Korth

Navathe

Raghu Ramakrishnan

: Crystal Clear

DBMS

- Data → Raw material | Facts

- Database (Collection of Logically Related Data)

- DBMS

RDBMS → Relation → Table

Row → Tuple | Record

Column → field | Attribute

Domain

Degree of Relation → # of Attributes

STUDENT

Sid	Name	Marks	Branch
S_1	A	9	CS
S_2	B	10	IT
S_3	C	9	CS
S_4	D	10	CS
S_5	E	9	IT
S_6	F	10	IT

Arity : # of Attributes [4]

Cardinality : # of Tuples [6]

Relational Schema: Table Heading

STUDENT(Sid, Name, Marks, Branch)

Relational Instance: Set of Records

$X \rightarrow y$

FD : (Functional Dependency)

$R(X, Y)$ $\quad X \rightarrow y$

X	y
1	5
2	6
3	7
4	8
2	5
4	9

(i) ✗

X	y
1	5
2	6
3	5
4	6
5	7

(ii) ✓

X	y
1	6
2	6
3	6
4	6
5	6

(iii) ✓

X	y
x_1	y_1
x_2	y_2
x_3	y_3
x_4	y_5
x_5	y_7
x_2	y_2
x_3	y_3

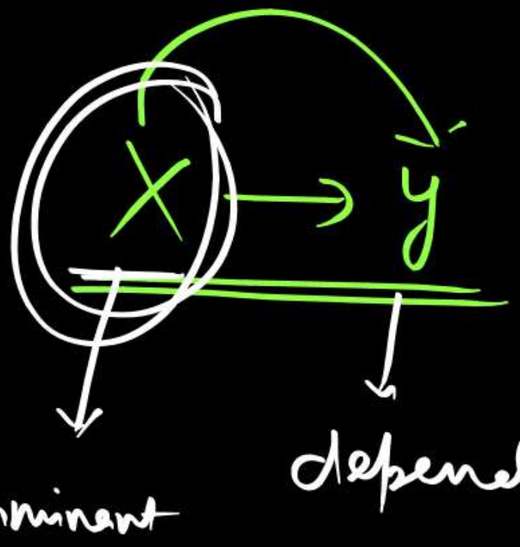
(iv) ✓

X	y
x_1	y_1
x_2	y_2
x_3	y_5
x_4	y_1

(v) ✓

X	y
1	5
2	6
3	7
4	8
5	9
1	5
4	8
5	9

(vi) ✓



$X \rightarrow y$

1 → Abhay

24 → Prashant

56 → Vijay Agarwal

$R(X, Y)$

FD

$X \rightarrow Y$

Relation Schema R in which X & Y be the attribute set of R. t_1 & t_2 Any Two Tuple Such that

X	Y

$X \rightarrow Y$

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

Note: In $X \rightarrow Y$ Whenever X Value Repeat, Corresponding Y Value Must be Same.

Type of FD

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

1. Trivial FD

(Always Valid)

$X \to y$ is Trivial FD

iff $X \supseteq y$ (R.H.S Attribute equal or Part of L.H.S Attribute.

$AB \to A$

$AB \to B$

$AB \to AB$

RollnoName $\to$ RollNo

RollNoName $\to$ Name

RollNoName $\to$ RollNoName

② Non Trivial FD

$X \to Y$ is Non Trivial

Iff $X \cap Y = \phi$ && must satisfy FD Defination

$A \to B$

$A \to C$

Sid → Branch

Sid → Grade

③ Semi Non Trivial FD

$X \cap Y \neq \phi$

$X \not\supseteq Y$

$AB \to BC$

Q.1

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

Q) Which - - Non Trivial FD Satisfied by the Instance

$A \to C$

$B \to C$

$AB \to C$

Ans

$A \to B$ ✗

$A \to C$ ✓

$A \to BC$ ✗

$B \to A$ ✗

$B \to C$ ✓

$B \to AC$ ✗

$C \to A$ ✗

$C \to B$ ✗

$C \to AB$ ✗

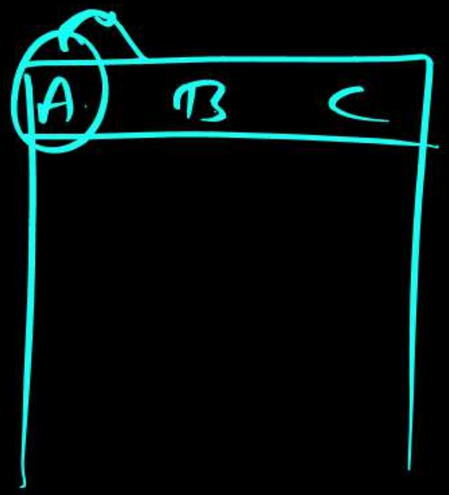
$AB \to C$ ✓

$BC \to A$ ✗

$AC \to B$ ✗

R (A B C)

Non Trivial FD Case



$A \rightarrow B$
$A \rightarrow C$
$A \rightarrow BC$

$B \rightarrow A$
$B \rightarrow C$
$B \rightarrow AC$

$C \rightarrow A$
$C \rightarrow B$
$C \rightarrow AB$

$AB \rightarrow C$
$BC \rightarrow A$
$AC \rightarrow B$

Q.2

Given the following relation instance.

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

Ans 1

$\times x \to y$ $\times y \to x$

$\times x \to z$ $\times y \to z$

$\times x \to yz$ $\times y \to xz$

$\times z \to x$ $\times xy \to z$

$\times z \to y$ $yz \to x$

$\times z \to xy$ $\times xz \to y$

The number of non trivial FD's are satisfied by the instance = 1

$yz \to x$

Q.3

Given the following relation instance. [GATE 2 Marks]

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

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

Ans [B]

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

(A) $XY \to Z$ and $Z \to Y$

(B) $YZ \to X$ and $Y \to Z$

(C) $YZ \to X$ and $X \to Z$

(D) $XZ \to Y$ and $Y \to X$

FD

Instance

Rule out the FD Based on the Relation

Trivial FD

Q.4 From the following instance of a relation scheme R (A, B, C), we can conclude that:

[GATE 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

Attribute closure $[X]^+$: 'R' be the Relational Schema

X be the attribute set of R

(The set of all possible Attributes determined from Attribute X is called Attribute closure of X $[X]^+$.)

Attribute closure $[x]^+$

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

$[A]^+ = [A\ B\ C\ D\ E]$

$[B]^+ = [B\ C\ D\ E]$

$[C]^+ = [C\ D\ E]$

$[D]^+ = [D\ E]$

$[E]^+ = [E]$

$[BE]^+ = [B\ E\ C\ D]$

$[CD]^+ = [C\ D\ E]$

Q.5

R (ABCDEFG)

F : (AB → C, BC → AD, D → E, E → G, CE → B)

Find closure of ...

$(AB)^+ = (ABCDEG)$

$(BC)^+ = (BCADEG)$

$(CE)^+ = (CEBADG)$

$(E)^+ = (EG)$

$(F)^+ = (F)$

$(D)^+ = (DEG)$

Q.6

The following functional dependencies are given

$\{PQ \rightarrow RS, PU \rightarrow S, ST \rightarrow U, R \rightarrow V, U \rightarrow T, V \rightarrow P\}$

Which of the following option (s) is/are true ?

[MSQ]

A. $\{RU\}^+ = \{PRSTUV\}$ $[RU]^+ = [RUVTPS] \Rightarrow [PRSTUV]$

B. $\{PU\}^+ = \{PRSTUV\}$ $[PU]^+ = [PUTS]$

C. $\{QV\}^+ = \{PQRSV\}$ $[QV]^+ = [QVPRS] \Rightarrow [PQRSV]$

D. $(PQ)^+ = \{PQRSUV\}$ $[PQ]^+ = [PQRSV]$

Ans (A & C)

Q.7

The following functional dependencies are given:

$AB \rightarrow CD$, $AF \rightarrow D$, $DE \rightarrow F$, $C \rightarrow G$, $F \rightarrow E$, $G \rightarrow A$.

Which one of the following options is false?

GATE : 2M.

(MSQ)

A. $\{CF\}^+ = \{ACDEFG\}$ — True

$[CF]^+ = [CFGEAD] \Rightarrow [ACDEFG]$

B. $\{BG\}^+ = \{ABCDG\}$ — True

$[BG]^+ = [BGACD]$

C. $\{AF\}^+ = \{ACDEFG\}$

$[AF]^+ = [AFDE]$

D. $(AB)^+ = \{ABCDFG\}$

$[AB]^+ = [ABCDG$

Ans [C] & [D]

Keys Concept

$R(ABCDE)$ $[A \to B,\ B \to C,\ C \to D,\ D \to E]$

Sol:

$[A]^+ = [ABCDE]$ — A is Super key

$[B]^+ = [BCDE]$

$[C]^+ = [CDE]$

$[D]^+ = [DE]$

$[E]^+ = [G]$

Note Every key is a Super key.

Note Any Super Set of Super key is also Super key.

A is Super key then Any Super Set of A is also Super key.

AB
AC
AE
ABC

ABCDE

$[A]^+ = [ABCDE]$

$(AB)^+ = [ABCDE]$

$(AE)^+ = [ABCDE]$

$(AC)^+ = [ABCDE]$

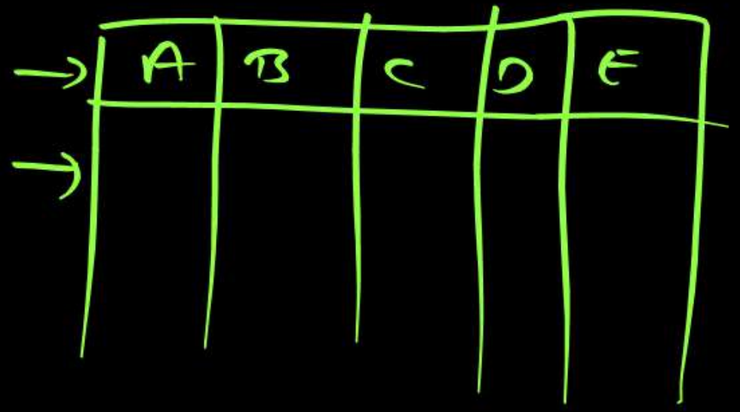
Note

Any Super set of Super key is Super key.

X be the attribute set of 'R'

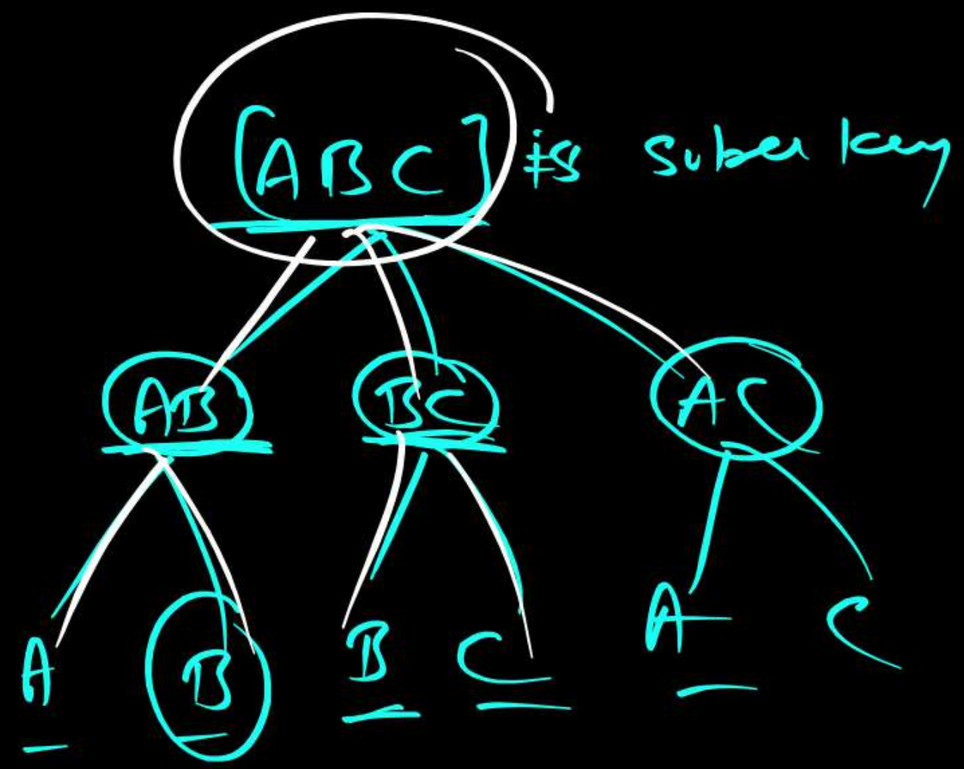
Super key: If Set of All Attribute determined by the Attribute closure of X $[X]^+$ then X is a Super key.

Key Set of Attribute which Uniquely Determine each tuple in the Relation



Candidate key : 'Minimal of Super key'

If Any Proper Subset of Super key is also Super key then that proper Subset is Called Candidate key & so on



R(A B C D)

C.K : A

Subset key = 2^3 = 8 Subset key

A

AB

AC

AD

ABC

ACD

ABD

ABCD

Candidate key: Minimal of Super key

R(ABCDE) {AB→C, C→D, B→EA}

Sol:

$(AB)^+ = (ABCDE)$

AB is Super key

$(A)^+ = (A)$

$(B)^+ = (BEACD)$

B is Candidate key Ans

Prime key Attribute : [B]

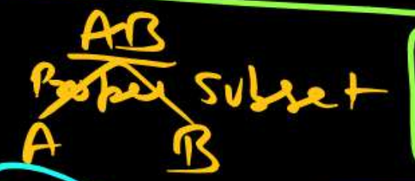
Non Prime / Non key Attribute : [A, C, D, E]

R(ABCDE) {AB→C, C→D, B→E}

Sol:

$(AB)^+ = (ABCDE)$

AB is Super key



Prime key Attribute : [A, B]

$(A)^+ = (A)$

$(B)^+ = (BE)$

Non Prime / Non key Attribute : [C, D, E]

AB is Candidate key Ans

Prime Attribute / Key Attribute : Attribute that belongs (Present) in any Candidate key

Non Prime / Non key Attribute : Attribute that Not belongs (Not Present) in any Candidate key

R(A B C D E)

B is C.K

Super key

Any super set of B is super key

B A

B C

B D

2^4 = 16 super key

R(A B C D E)

[AB is Candidate key]

Super key : AB

Any super set of AB is super key

AB

ABC

2^3 = 8 super key

Key Concept

Super Key

minimal → Candidate Key

Lets Assume 4 C.K

1 Select as → Primary Key (1)

Remaining Candidate Key except Primary Key → Secondary / Alternative Key (3)

Note

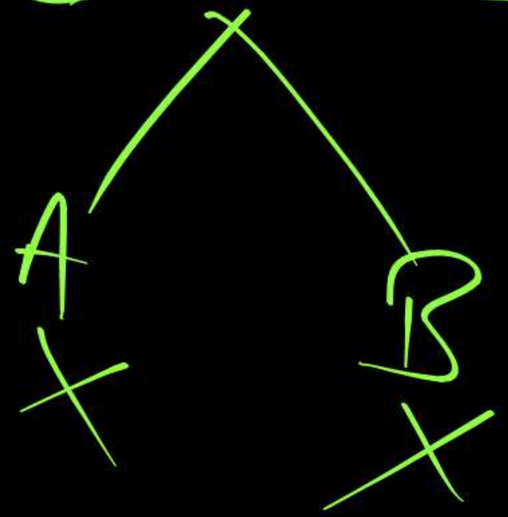
Every key is a Super key.

Minimal of Super key

Candidate key

eg

AB is Candidate key



Finding Multiple Candidate key

first find any One Candidate key

then that Attribute (Present in c.k) is Prime key Attribute.

If $X_{Attribute} \longrightarrow$ [Prime key Attribute]

then Multiple Candidate keys are there.

D $(D)^+ = [- - - - - -]$

Let Assume 'D' is Candidate key

$X_{Attribute} \longrightarrow [Prime\ Attribute]$ Prime/key Attribute $= [D$

C is C.K

$C \longrightarrow D$

$C \longrightarrow DE$

B, C $\rightarrow BC$

$BC \longrightarrow D$

$BC \longrightarrow DE$

Q.8

R(ABCDE) {AB → C, C → D, D → E, B → A, C → B}

Find candidate keys for the relation R ?

Soln

$(AB)^+ = [ABCDE]$

AB is Super key

$(A)^+ = [A]$

$(B)^+ = [BACDE]$

B is Candidate key — (1)

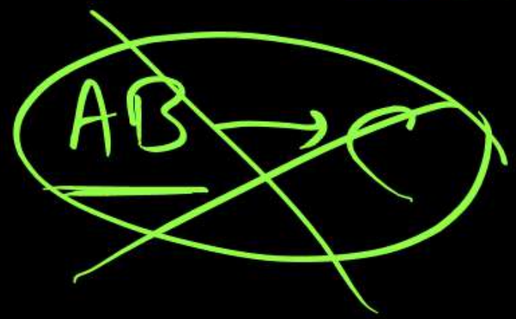
Prime key Attribute = [B, C,

If $X_{Attribute} \rightarrow$ [Prime Attribute]

C → B

$(C)^+ = [CBADE]$

C is Candidate key — (2)



2 CK [B, C] Ans

Q.9

R(ABCDEF) {A → BCDE, BC → AD, D → EF}

Find candidate keys for the relation R ?

Sol^{n}

$[A]^{+} = [ABCDEF]$

A is Candidate key — (1)

If $X_{Attribute} \rightarrow$ [Prime Attribute]

$BC \rightarrow AD$

$[BC]^{+} = [BCADEF]$

$[B]^{+} = [B]$

$[C]^{+} = [C]$

BC is Candidate key — (2)

Prime Attribute = [A, B, C]

2 Candidate key

A, BC

Q.10

Consider the following relational schema R(ABCDEF) with functional dependency {AB → C, C → D, D → E, E → F, F → B}
The number of candidate keys for relation R ?

Q.11

R(ABCDE) {A → BC, CD → E, B → D, E → A}

Find candidate keys for the relation R ?

Q.12

R(ABCDEFGH)

{AB → CD, D → EG, F → H, C → EF, H → A, G → B, A → B}

Find candidate keys for the relation R ?

Q.13

Consider a relation scheme R = (A, B, C, D, E, H) on which of the following functional dependencies hold:

[GATE 2M]

$\{A \rightarrow B,\ BC \rightarrow D,\ E \rightarrow C,\ D \rightarrow A\}$

What are the candidate keys of R?

(A) AE, BE

(B) AE, BE, DE

(C) AEH, BEH, BCH

(D) AEH, BEH, DEH

Q.14

Consider a relation R with five attributes V, W, X, Y, and Z. The following functional dependencies hold : $VY \rightarrow W$, $WX \rightarrow Z$, an $ZY \rightarrow V$. Which of the following is a candidate key for R?

[GATE 2M]

A. VXZ

B. VXY

C. VWXY

D. VWXYZ

Q.15

Relation R has eight attributes ABCDEFGH. Fields of R contain only atomic values.

$F = \{CH \rightarrow G, A \rightarrow BC, B \rightarrow CFH, E \rightarrow A, F \rightarrow EG\}$ is a set of functional dependencies (FDs) so that F is exactly the set of FDs that hold for R.

How many candidate keys does the relation R have? [GATE 2013 : 2 Marks]

A. 3

B. 4

C. 5

D. 6

Q.16

Which of the following is NOT a superkey in a relational schema with attributes V, W, X, Y, Z and primary key VY?

[GATE]

A. V X Y Z

B. V W X Z

C. V W X Y

D. V W X Y Z

Q.17

A prime attribute of a relation scheme R is an attribute that appears

[GATE]

A. In all candidate keys of R.

B. In some candidate key of R.

C. In a foreign key of R.

D. Only in the primary key of R.

RDBMS Concept

FD & its type

Keys Concept (Super key, Candidate key, P.K, A.K/S.K)

Finding Multiple Candidate key

THANK YOU!