# CS & IT ENGINEERING


## Database Management System

DBMS

Lecture No. 1

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# Topics to be Covered

- **Topic** Integrity Constraints & ER Model (2 Marks)
- **Topic** Normalization (2-4 Marks)
- **Topic** Queries (Relational Algebra, SQL, Tuple Relational Calculus) (4 Marks)
- **Topic** File Organization & Indexing(2-4 Marks)
- **Topic** Transactions & Concurrency Control (2- 4 Marks)

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III Btech – 86 AIR

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'S' grades

17 + years

# Topic : Introduction to DBMS

**Database:**

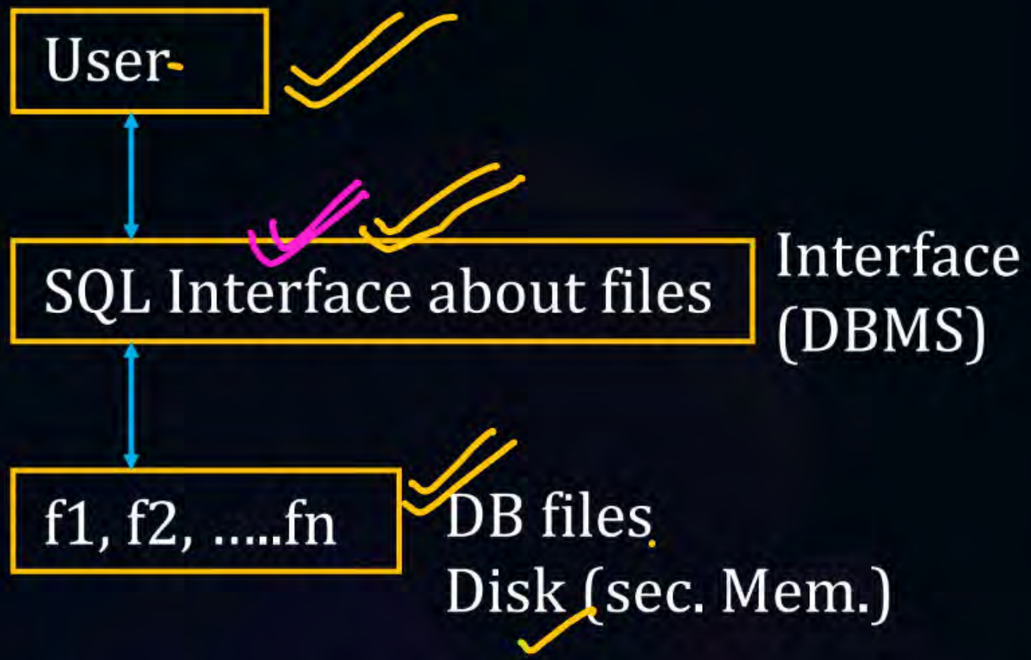
- Collection of related data
- Ex: Student information

**DBMS:**

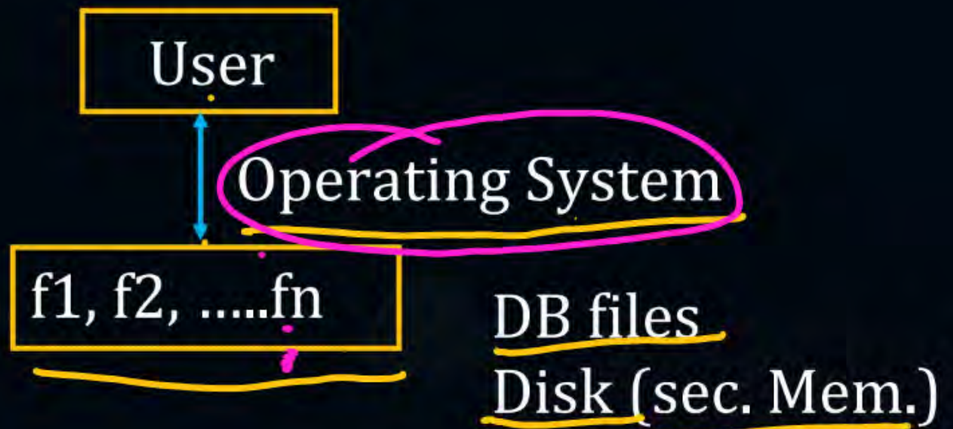
- Software used to manage and access data in more efficient way.

# Topic : Introduction to DBMS

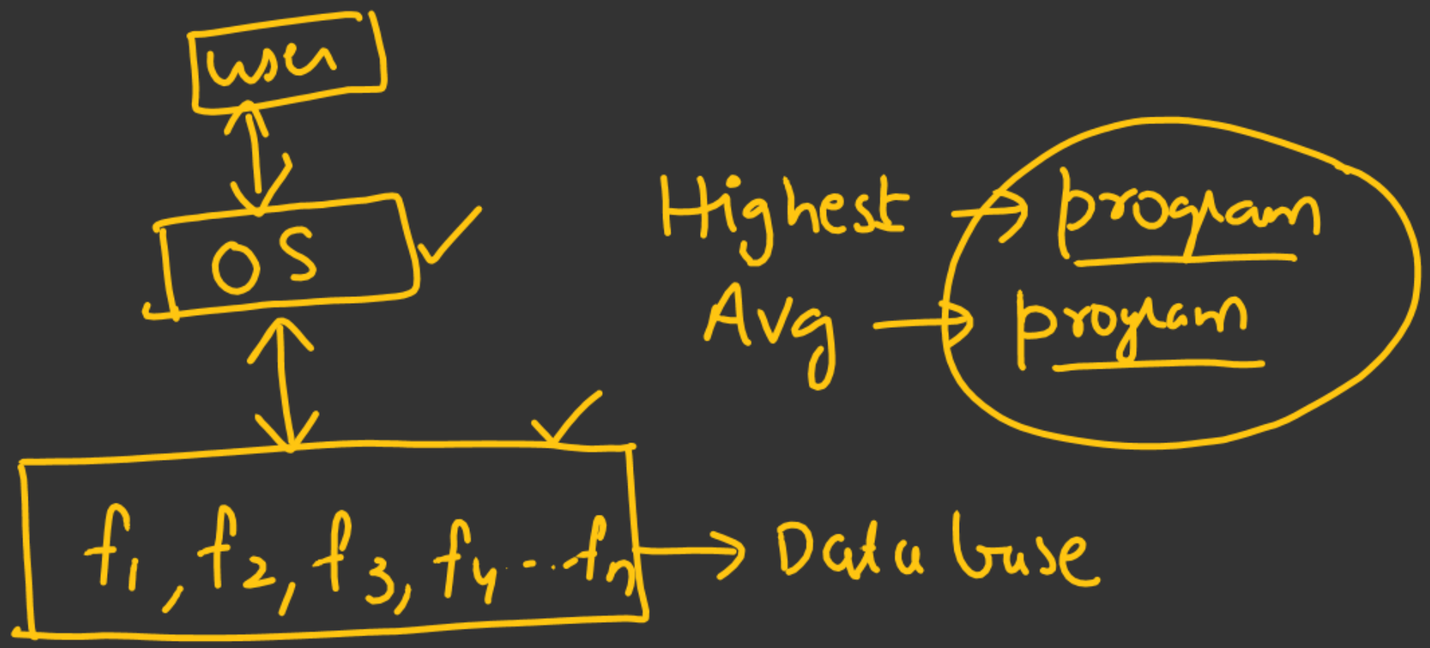
## File System with DBMS:




## Flat file system




- For small DB, flat file system can be used
- For huge DB, flat file system fails


user
OS
$f_1, f_2, f_3, f_4 \cdots f_n$
Database
Highest
program
Avg
program

# Topic : Introduction to DBMS

| Limitation of Flat File System | Advantages of DBMS File System |
|---|---|
| 1. Too Complex to Manage application programs to access data<br>• User directly should manage DB files using programs | 1. DBMS supports data independency<br>• User can access data independently using SQL Interface without knowing storage info of DB files<br>• Easy to develop application |
| 2. More Input Output Cost to access data from DB files | 2. Because of indexing to DB files, it is less costlier than to access data |
| 3. Degree of Concurrency is very less **Ex:** No. of users that can access a file parallelly | 3. More Degree of Concurrency **Ex:** Many users can access the file concurrently because of data control over each row |
| 4. Too Complex to maintain different levels of access controls | 4. Because of VIEWS (Virtual Table), easy to manage access control |
| 5. Too Complex to maintain Non-redundant data | 5. Because of Normalization of data |

# Topic : Integrity Constraints

## Introduction:

- The idea of following certain rules to maintain a correct database are called Constraints.
- There are different Data Models like Object Oriented Model, Network Data Model, etc. to store data.
- The widely used data model is RDBMS i.e. Relational DBMS.

# Topic : Integrity Constraints

## Relational DBMS: (Also known as Codd's Data Model)

- Widely used Data Model proposed by Codd
- Codd proposed 12 rules for design of DBMS software
- Software which follows all these guidelines is called as Complete relational database management system.

# Inspiring Stories : Laxman Nayak

***Background:*** Born 1899 in southern Odisha. Bhumia tribal community.

***Struggles:*** Officials tortured tribals and took their land.

***Achievements:*** Organized people to stand up to oppressors and fought for tribal rights.

***Impact:*** Became a folk hero for courage and fairness.

# Topic : Integrity Constraints

## CODD Rule (RDBMS Guideline):

- Data in Database file must be in tabular format i.e. it is a collection of Rows & Columns
- No two rows of Datafile must be same

Example: Data of students

STUDENTS Table

| Sid | Sname | DOB |
|---|---|---|
| S1 | A | 1990 |
| S2 | A | 1992 |
| S3 | B | 1989 |
| S4 | C | 1990 |

DOB → Attribute / field

S2 A 1992 → Record

In flat file the table is saved as S1, A,1990#S2,A1 1992 # S1

# Topic : Integrity Constraints

- Name of the Column is called "Attribute"
- Each Row of the file is called "Record" or "Tuple"
- Collection of all rows of the table is called "Relational Instance" or "Snapshot" or "record set"

STUDENTS

| Sid | Sname | DOB |
|---|---|---|
| S1 | A | 1990 |
| S2 | A | 1992 |
| S3 | B | 1989 |
| S4 | C | 1990 |

Attribute

Record

Record set

In flat file the table is saved as S1, A,1990#S2,A1 1992 # S1

# Topic : Integrity Constraints

- Relational schema: Definition/structure of the DB Table

**Eg:** STUDENT (Sid, Sname, DOB) → heading

- Arity: Number of fields of the Database Table or Attributes = 3
- Cardinality: Number of records of the table

STUDENTS

| 1 | 2 | 3 |
|---|---|---|
| **Sid** | **Sname** | **DOB** |
| S1 | A | 1990 |
| S2 | A | 1992 |
| S3 | B | 1989 |
| S4 | C | 1990 |

DOB → Attribute

Record

Cardinality = 4

In flat file the table is saved as S1, A,1990#S2,A1 1992 # S1

# Topic : Integrity Constraints

## CANDIDATE KEY:

- "Minimal set of Attribute" that can differentiate the records uniquely

Example-1: STUDENT (SID, Sname, DOB)

# Topic : Integrity Constraints

## CANDIDATE KEY:

- "Minimal set of Attribute" that can differentiate the records uniquely

Example-1: STUDENT (SID, Sname, DOB)

- Candidate Key: SID  Minimal
- SID, Sname → Not Minimal, so not a Candidate Key

# Topic : Integrity Constraints

Example-2 : ENROLL (SID, CID, Fee)

- Same Student can enroll many courses
- Same Course can be enrolled by many students

**Table** ENROLL

| SID | CID | Fee |
|---|---|---|
| S1 | C1 | 9000 |
| S1 | C2 | 8500 |
| S2 | C2 | 8500 |

SID → CK ?

CID → CK ?

# Topic : Integrity Constraints

Example-2 : ENROLL (SID, CID, Fee)

- Same Student can enroll many courses
- Same Course can be enrolled by many students

**Table**

| SID | CID | Fee |
|---|---|---|
| S1 | C1 | 9000 |
| S1 | C2 | 8500 |
| S2 | C2 | 8500 |

- SID or CID solely cannot identify a row uniquely. In that case, combination of SID & CID becomes the Candidate Key
- SID, CID → Candidate Key (Minimal (✓))

# Inspiring Stories : Birsa Munda

***Background:*** **Born 1875 in Jharkhand.**

***Struggles:*** **Tribal forest rights were being wiped out.**

***Achievements:*** **Led a tribal rebellion and announced "Munda Raj"— tribal rule instead of foreign rule**

***Impact:*** **His fight inspired future generations and tribal identity.**

# Topic : Integrity Constraints

**Example:** for the following Relation R. What are Candidate Keys?

| A | B | C |
|---|---|---|
| 5 | 4 | 8 |
| 5 | 4 | 9 |
| 5 | 6 | 8 |
| 5 | 6 | 9 |
| 8 | 4 | 8 |

# Topic : Integrity Constraints

**Example:** for the following Relation R. What are Candidate Keys?

| A | B | C |
|---|---|---|
| 5 | 4 | 8 |
| 5 | 4 | 9 |
| 5 | 6 | 8 |
| 5 | 6 | 9 |
| 8 | 4 | 8 |

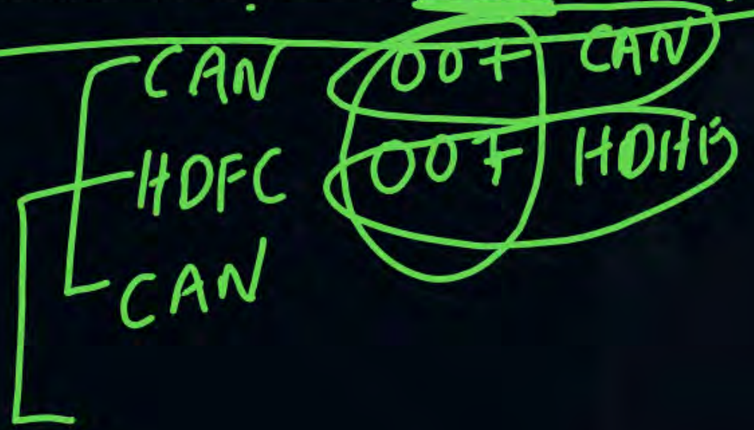
- A, B, AB, BC, AC are not unable to differentiate the records uniquely.
- In that case, combination of all attributes forms the Candidate Key

ABC → Candidate Key

# Topic : Integrity Constraints

**Example-4:**

EMPLOYEE (eid, ename, DOB, passportno, bankname, accNo, IFSC Code, pan)



# Topic : Integrity Constraints

**Example-4:**

EMPLOYEE (eid, ename, DOB, passportno, bankname, accNo, IFSC Code, pan)

- eid, passportno, PAN no. can differentiate the records uniquely
- Also (accNo, IFSC Code) can also be CK, and this is also minimal.

# Topic : Integrity Constraints

## PRIMARY KEY (Integrity Constraints)

- Any one Candidate key whose field values cannot be NULL
- Atmost one Primary key allowed

**E.g.** If eid is Primary key then it shouldn't have NULL

## ALTERNATIVE KEYS:

- All Candidate keys of Relational Schema except Primary key
- NULL values allowed

E.g. Except eid all other keys may have NULL values

# Topic : Integrity Constraints

## Defining schema of a Table:

```
CREATE TABLE EMPLOYEE
(
    eid varchar(10) PRIMARY KEY,
    ename varchar(30),
    DOB date,
    PassportNo varchar(15) UNIQUE,
    AccountNo integer(10),
    IFSC varchar(6),
    PAN varchar(8) UNIQUE NOT NULL,
    UNIQUE (AccNo, Ifsc)
);
```

# Topic : Integrity Constraints

## SIMPLE CANDIDATE KEY:

- Candidate key with only single attribute is called Simple Candidate Key.
- Example 1: STUDENTS (Sid, Sname, DOB)

  Sid – Simple Key
- Example 2: EMP (eid, passportNo., AccNo, IFSC, PAN)

  eid – Simple Key

# Topic : Integrity Constraints

## COMPOUND CANDIDATE KEY:

- Keys with more than 1 attributes
- Example : SID, CID in ENROLL (SID, CID, fee)

## PRIME ATTRIBUTE:

- Attribute that belongs to a Candidate Key.
- Example : For Relation EMP (eid, passportNo, AccNo, IFSC, PAN)

  eid, passportNo, PAN are Candidate Keys

  So, {eid, passportNo, PAN} are Prime Attributes, (AccNo, IFSC)

# Topic : Integrity Constraints

## SUPER KEY : (Used for RDBMS design)

- Set of attributes which can differentiate records uniquely.
- Example : STUDENT (Sid, Sname, DOB)

  Candidate key: SID

  Superkeys : SID → minimal superkey

  {SID, SNAME}

  {SID, DOB}

  {SID, Sname, DOB}

# Topic : Integrity Constraints

# Inspiring Stories : Komaram Bheem

***Background:*** **Born 1900 in Gond tribe, Telangana.**

***Struggles:*** **Nizam's rule over Gond lands hurt tribal lives.**

***Achievements:*** **Gave the slogan "Jal Jangal Zameen" ("Water, Forest, Land")—a rallying cry for tribal rights.**

***Impact:*** **Still chanted today and a symbol of tribal pride and rights.**

# Topic : Integrity Constraints

IMP. How many Super keys are possible with a Relation R(A, B, C, D) and a Candidate key {A}?

# Topic : Integrity Constraints

IMP. How many Super keys are possible with a Relation R(A, B, C, D) and a Candidate key {A}?

Sol. Super key: Candidate key along with any subset of other keys.

| | |
|---|---|
| A | ABC |
| AB | ABD |
| AC | ACD |
| AD | ABCD |

8 Superkeys are Possible

# Topic : Integrity Constraints

Q. How many Super keys are possible if Relation $R(A_1, A_2, ..., A_n)$ with Candidate key $\{A_1\}$?

# Topic : Integrity Constraints

Q. How many Super keys are possible if Relation $R(A_1, A_2, ..., A_n)$ with Candidate key $\{A_1\}$?

Sol. Number of Super keys = $2^{n-1}$

$2^{n-1}$

$A_1$ $2^{n-1}$

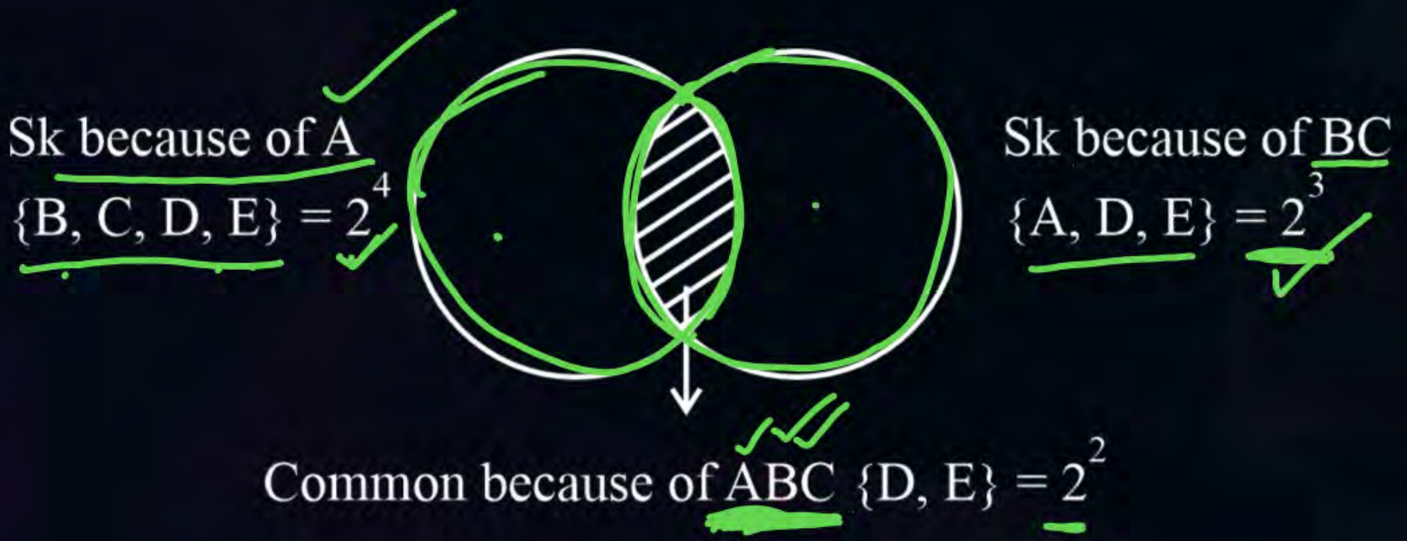
# Topic : Integrity Constraints

#Q. How many Super keys are possible if R(A, B, C, D, E) is given and the candidate keys are A & BC?

# Topic : Integrity Constraints

#Q. How many Super keys are possible if R(A, B, C, D, E) is given and the candidate keys are A & BC?

Sol. We will use set theory to calculate the number.



# Topic : Integrity Constraints

$$n(X \cup Y) = n(X) + n(Y) - n(X \cap Y)$$

$$= 2^4 + 2^3 - 2^2$$

$$= 16 + 8 - 4 = 20 \text{ Superkeys}$$

# Topic : Integrity Constraints

#Q. How many Super keys are possible for the Relation $R(A_1, A_2, \ldots, A_n)$ with $\{A_0, A_1\}, \{A_2, A_3\}$ Candidate keys?

$\{A_1, A_2\}$ $\{A_2, A_3\}$

# Topic : Integrity Constraints

#Q. How many Super keys are possible for the Relation $R(A_1, A_2, \ldots, A_n)$ with $\{A_0, A_1\}, \{A_2, A_3\}$ Candidate keys?

Sol.

$$n(A_1 A_2 \cup A_2 A_3) = n(A_1 A_2) + n(A_2 A_3) - n(A_1 A_2 \cap A_2 A_3)$$

$A_1 A_2 A_3$

$$= 2^{n-2} + 2^{n-2} - 2^{n-3}$$

$$= 2^{n-3}(2 + 2 - 1)$$

$$= 3 \times 2^{n-3}$$

# Inspiring Stories : Thalakkal Chanthu

***Background:*** **From the Kurichiyar tribe in Kerala.**

***Struggles:*** **British tried to control local tribal land.**

***Achievements:*** **Fought with Pazhassi Raja ( a ruler from the Kottayam royal family in northern Kerala) against British.**

***Impact:*** **A tribal warrior remembered as part of larger resistance..**

# Topic : Integrity Constraints

#Q. How many possible SK's in R(ABCDEF) with Candidate keys {A, BC, CD}?

# Topic : Integrity Constraints

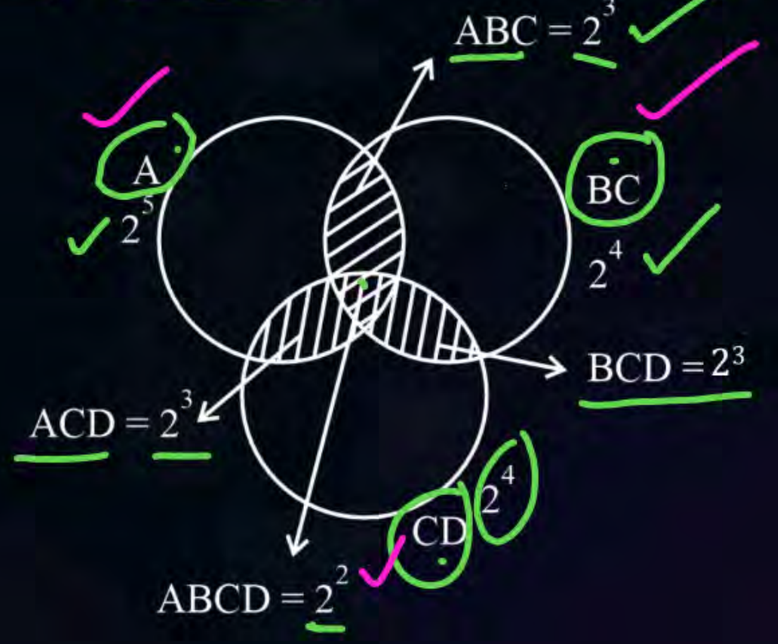
#Q. How many possible SK's in R(ABCDEF) with Candidate keys {A, BC, CD}?

Sol. $n(X \cup Y \cup Z) = n(X) + n(Y) + n(Z) - n(X \cap Y) - n(Y \cap Z) - n(Z \cap X) + n(X \cap Y \cap Z)$

$= 2^5 + 2^4 + 2^4 - 2^3 - 2^3 - 2^3 + 2^2$

$= 32 + 16 + 16 - 8 - 8 - 8 + 4$

$= 44$ Super keys



# Topic : Integrity Constraints

#Q. How many Super Keys are possible for a Relation $R(A_1, A_2, \ldots, A_n)$?

# Topic : Integrity Constraints

#Q. How many Super Keys are possible for a Relation $R(A_1, A_2, ..., A_n)$?

Sol. Except a superkey with zero attributes, all possible combinations form Superkeys.

Therefore possible no. of SK's = powerset – 1

$= 2^n - 1$

assume, every attribute is a CK.

$2^n - 1$ $2^n$ $\phi$

# THANK - YOU