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Normal Forms :-

(1) First Normal form (1NF) -

1> Table should not contain any multivalued attribute.

Rollno	Name	Course
1	Omkar	C/C++
2	Ram	Java
3	Jai	C/DBMS

← Table contains multivalued attribute hence not in 1NF.

Now convert table/relation in 1NF.

Method1

Primary key

Rollno	Name	course
1	Omkar	C
1	Omkar	C++
2	Ram	Java
3	Jai	C
3	Jai	DBMS

Only Rollno cannot be a primary key
Only Name cannot be a primary key

if we combine Rollno, Name ; then it uniquely identify each record. Hence it is called as composite primary key.

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Method 2.

Rollno	Name	course1	course2
1	Omkar	C	C++
2	Ram	Java	Null
3	Jai	C	DBMS

PK = Rollno

Here Rollno is a primary key, which uniquely identifies each record.

In this method there is a problem exist if more than 2 courses given, we have to create more columns for it, and if any of the student only enrolled for one course only then there can be possibility for Null values in more columns.

Method 3.

Divide the table in 2 subtables.

1) Base table.
2) Referencing table.

Base table

Rollno	Name
1	Omkar
2	Ram
3	Jai

PK = Rollno

Reference table

Rollno	course
1	C
1	C++
2	Java
3	C
3	DBMS

PK = Rollno, course
FK = Rollno

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(2) Second Normal Form - 2NF

Table is in 2NF if

i) table or relation must be in 1NF.

ii) All the non-prime attributes should be fully functionally dependant on candidate key. (There should be no partial dependency in the table)

Custid	Store id	Location
1	1	Banglore
1	3	Mumbai
2	1	Banglore
3	2	Delhi
4	3	Mumbai

Candidate key = Custid, Storeid

Prime attributes = custid, storeid

Non prime attributes = Location

Here, Location is a non prime attribute, it should be fully functionally dependant on candidate key or primary key.

But, Location is dependent on storeid only.

Hence table is not in 2NF.

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So divide the table in two tables.

Custid	storeid
1	1
1	3
2	1
3	2
4	3

storeid	Location
1	Banglore
2	Delhi
3	Mumbai

candidate key = storeid

Candidate key = Custid storeid

Now both the tables are in 2NF.
as Location is determined by its candidate key only. i.e. Storeid.

ex. (2)

R(ABCDEF)
FD: { C → F, E → A, EC → D, A → B }
Find whether relation is in 2NF.

⇒ Find candidate key.
CK : ECA = FABD.
check for closure of attributes.
i) $E^+ = EABD$
$C^+ = CFD$

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$A^+ = AB$
$EC^+ = ECFADB$
$EA^+ = EABD$
$CA^+ = CAFBD$

Here, EC^+ ~~finds~~ determines all the attributes.

Hence candidate key = EC
prime attributes = E, C
non prime attributes = A, B, D, F.

There should not be partial dependency present in a relation.
~~Non prime attributes~~

check for all functional dependencies.

LHS = RHS.
part of candidate key = non prime attributes } partial dependency.

FD: { C → F , E → A , EC → D , A → B }
Not valid FD | invalid FD | valid FD | invalid FD.

Hence relation is not in 2NF.

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Note :- LHS should be a proper subset of candidate key and RHS should be a non-prime attribute, is called partial dependency.

(3) Third Normal Form 3NF -

A relation is said to be in 3NF
i) A relation is in 2NF
ii) There should be no transitive dependency in the relation or table.

Rollno	state	city
1	MH	Thane
2	GJ	Surat
3	MH	Thane
4	GJ	Surat
5	MP	Indore

CK = Rollno
FD: { Rollno → state
state → city }
Prime attribute = Rollno
Non prime attr = state, city

- Transitive dependency exists
- state determines city
  [non-prime attribute determines non-prime attribute]

Hence Rollno → state and state → city
Rollno → city through state
Relation is not in 3NF.

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∴ Normalize the relation.

Rollno	state
1	MH
2	GJ
3	MH
4	GJ
5	MP

state	city
MH	Thane
GJ	Surat
MP	Indore

CK = Rollno

CK = state.

ex. 2 R(ABCD)

FD : {AB → C, C → D}

CK = ABC = CD

closure of attributes.

$A^+ = AC$

$B^+ = BC$

$C^+ = CD$

$AB^+ = ABCD$ AB determines all attributes

$BC^+ = BCD$

$AC^+ = ACD$

∴ candidate key = CK = AB

Prime attri = A, B

Non prime attri. = C, D

check all FD's

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FD = { AB → C , C → D }
valid FD invalid FD

AB determines C
C determines D.

- Here transitive dependency exist hence it is not in 3NF.
C is non prime attribute, determines D i.e. non prime attribute.

Note :- for each FD, LHS must be a candidate key or super key **OR** RHS is a prime attribute.

ex: 3 R(ABCD)
FD : { AB → CD , D → A }
CK = ABD = ACD
A^+ = ACD
B^+ = BCD
D^+ = DA
AB^+ = ABCD ← CK.
CK = AB

if D → A
then
AB is replaced by D
DB^+ = DBAC
↑ CK.
DB can be a CK.

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Prime attribute = A, B, D
Non prime attribute = C

check for FD's.

FD = { AB → CD, D → A }
by the rule,
LHS must be a candidate key
OR RHS is a prime attr.

AB → CD
↑
CK
valid FD

D → A RHS is a prime attr.
valid FD.

Hence relation is in 3NF as
FD: { AB → CD, D → A }
both are valid.