<u>Closure Method</u>

This method is used to find out all possible candidate keys in a relation or table.

Example 1 – R(ABCD)

FD { A → B , B → C , C → D }

So, with the help of FD we can say

Step 1 - $A^+ = B$ [∵ A is determining B]

Step 2 - $A^+ = BC$ [∵ A is determining B and B is determining C]

Step 3 - $A^+ = BCD$ [∵ A is determining B and B is determining C and C is determining D]

Step 3 - $A^+ = ABCD$ [∵ A is also determining itself]

So, here we can determine all attributes using A. So, we can identify A as candidate key of this relation.

Now, we will try to find out all other candidate keys .

$B^+ = BCD$

We can determine B , C and D using B . But , B can not determine A. So , B is not a Candidate Key .

$C^+ = CD$

We can determine C and D using C . But , C can not determine A and B . So , C is not a Candidate Key .

$D^+ = D$

We can determine only D using D . But , D can not determine A , B and C . So , D is not a Candidate Key .

So , CK = { A }

Now , if we try $(AB)^+ = ABCD$

So, we can determine all attributes with the help of AB . But it is not a candidate key .Because A is already proved as candidate key and if we try to add any attribute with it , it will become a super key .

Example 2 – R(ABCD)

FD { A → B , B → C , C → D ,D → A }

∴ A^+ = ABCD
∴ B^+ = BCDA
∴ C^+ = CDAB
∴ D^+ = DABC

∴ In this above example we can say that all keys are candidate keys.

∴ CK = { A , B , C , D }

Now , What is primary attribute ?
Attributes present in the CK are prime attributes .

<u>In Example 2</u>

Prime attributes = { A , B , C , D }

Non Prime attributes = { Ø }

<u>In Example 1</u>

Prime attributes = { A }

Non Prime attributes = {, B , C , D }

So, we have to find out all CKs then we can find out all prime and non prime attributes.

Example 3 – R(ABCDE)

FD { A → B , BC → D , E → C ,D → A }

Now , if we look at the FD , we can see B , D ,C and A can be determined (∵ at the right side of FD)

So, = BDCA

But , only E is not determined by any other attribute . So, we can assume that E can determine other attributes. So , if we try to place E to the RHS then we have to place it to the LHS too.

So, E = BDCAE

It means all possible candidate keys must have E.

So, E itself is not a Candidate key [∵ E^+ = EC].

So, AE^+ = ABECD

Now, BE^+ = BECDA

Another method to find other CKs is to replace the right side attribute with left side attribute.(D → A)

AE^+ = ABECD
↓
DE^+ = DEACB

So , CK= { AE , BE , DE }

<u>Closure to find out 3NF</u>

If there is no non key attribute is functionally dependent on another non key attribute , only then we can say that, the relation is in 3NF.

We can use closure method to check whether a relation is in 3NF or not.

Example 1 – R(ABC)

FD { AB →C , C → D }

AB^+ = ABCD

∴ CK = { AB }

∴ Primary Attributes = A , B

∴ Non Primary Attributes = C , D

Here , C and D both are non key attributes and C is determining D . So, we can say that the table is not in 3NF.

Example 2 – R(ABCD)

FD { AB →CD , D → A }

AB^+ = ABCD [∴ AB is Candidate Key]

DB^+ = DBAC [∴ DB is another Candidate Key]

∴ CK ={AB, DB }

∴ Primary Attributes = A , B , D

∴ Non Primary Attributes = C

Now , we have to check the following condition in each and every FD –

LHS must be CK or SK OR RHS must be a Prime Attribute

In this example in every FD this condition is satisfying . So , it is proved that this table is in 3NF.