

Fifth Normal Form (5NF) in DBMS

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5NF is one of the highest levels of normalization, also known as Project-Join Normal Form (PJNF).

A table is said to be in 5NF if:

- It is already in 4NF
- It cannot be broken down into smaller tables without losing data

In other words, there should be no join dependency left that can cause redundancy.

The main goal of 5NF is to break down a table into the smallest possible pieces while making sure that:

- You can still reconstruct the original data without loss, and
- No unnecessary repetition of data occurs.

Let's have a look at the 2 conditions for 5NF.

Relation Should be Already in 4NF

It should satisfy all the conditions of 4NF i.e

- It should be in BCNF.
- No multi-valued dependency should exist.

Non-Loss Decomposition

- When the table does not contain any join dependency then it is called a lossless /non-loss decomposition.
- In other words, we can say that
 - *A database is in 5NF when there is **no join dependency** present in the table / database.*

- When we decompose the given table to remove redundancy in the data and then compose it again to create the original table, we should not lose any data, and the original table should be obtained as a loss should happen after the decomposition of the table.
- Join dependency for relation R can be stated as
 - $R = (R1 \bowtie R2 \bowtie R3 \bowtie \dots \bowtie Rn)$ where $R1, R2, R3, \dots, Rn$ are sub-relation of R and \bowtie is Natural Join Operator.
- Here R1, R2, R3, ..., Rn are the sub-relation of relation R.

Example

- let's, take **of** Table R which has 3 columns i.e. subject, class, and teacher where each subject can be taught by many teachers in many classes, and a teacher can teach more than 1 subject.

Subject	Class	Teacher
math	class 10	kartik
math	class 9	yash
math	class 10	yash
science	class 10	yash

- Here the subject of math is taught by both teachers kartik and yash. Also yash can teach math and science. Yash teaches math to both class 9 and class 10.
- As there is redundancy in data we will decompose it into two tables R1 and R2 such that R1 will have attribute Subject and Class and R2 will have attribute class and teacher.

Table R1

Subject	Class
math	class 9
math	class 10
science	class 10

- Here we removed the redundancy in the table by removing the extra tuple with the same values i.e. subject math taught in class 10. This tuple is repeated 2 times in the main table but in table R1 this redundancy is removed.

Table R2

Class	Teacher
class 10	kartik
class 9	yash
class 10	yash

- Here we removed the redundancy in the table by removing the extra tuple with the same values i.e. yash is teaching for class 10. This tuple is repeated 2 times in the main table but in table R2 this redundancy is removed.
- After combining both tables R1 and R2 we will get as mentioned below:

Table (R1 ⋈ R2)

Subject	Class	Teacher
math	class 9	yash

Subject	Class	Teacher
math	class 10	kartik
math	class 10	yash
science	class 10	kartik
science	class 10	yash

- Here if we notice the newly composed table from R1 and R2 and the original table, an extra tuple is added that did not exist in the original data, This breaks the second rule of 5NF i.e. **non-loss decomposition**.
- This type of unwanted tuple is known as Spurious tuple.
- Here we will decompose the given table in another relation R3 where it will have 2 columns i.e. subject and teacher.

Table R3

Subject	Teacher
math	yash
math	kartik
science	yash

- Here the newly decomposed table R3 will have 3 tuples only as the repeated tuple (redundancy) is not added to the table. yash teaching the subject math is repeated 2 times in main table R but here it will be added only one time resulting in removing the redundancy in the table.
- Now if we compose or rejoin the tables R1, R2, and R3 we will get

Table (R1 ⋈ R2 ⋈ R3)

Subject	Class	Teacher
math	class 9	yash
math	class 10	yash
math	class 10	kartik
science	class 10	yash

- Now if we see the re-composed table and the original table, there is no loss of data.
- Here all the tables, R1, R2 and R3 had a natural join which resulted in the table R. After the natural join, the original table is retained as it is. There is no loss of the data.
- So it is a **tables**
- Given Table R1, R2 and R3 are in the **Fifth Normal Form(5NF)**.

Uses of Fifth Normal Form(5NF)

- 5NF ensures that there will be no redundancy present in the database. Removing the redundancy in the database helps the data to remain more optimized and easy to perform database actions.
- It also ensures that there will be non-lossy decomposition only which will result in data consistency and data integrity.
- As data redundancy and anomalies are removed, the database performance gets enhanced.

Limitation of Fifth Normal Form(5NF)

- One of the biggest limitations **is** of 5Nf is the complexity of the database. Due to 5Nf large number of tables and relation gets created which eventually increases the complexity of the database.
- Slow exhibition due to large number of tables.

- The cost of implementation of 5NF is also high as it increases the complexity of the database.