(a) CUSTOMERS table is as follows:

```
(b)+----+----------+-----+-----------+----------+
(c)| ID | NAME     | AGE | ADDRESS   | SALARY   |
(d)+----+----------+-----+-----------+----------+
(e)|  1 | Ramesh   |  32 | Ahmedabad |  2000.00 |
(f)|  2 | Khilan   |  25 | Delhi     |  1500.00 |
(g)|  3 | kaushik  |  23 | Kota      |  2000.00 |
(h)|  4 | Chaitali |  25 | Mumbai    |  6500.00 |
(i)|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
(j)|  6 | Komal    |  22 | MP        |  4500.00 |
(k)|  7 | Muffy    |  24 | Indore    | 10000.00 |
(l)+----+----------+-----+-----------+----------+
```

(b) Another table is ORDERS as follows:

```
+-----+---------------------+-------------+--------+

|OID  | DATE                | CUSTOMER_ID | AMOUNT |

+-----+---------------------+-------------+--------+

| 102 | 2009-10-08 00:00:00 |           3 |   3000 |

| 100 | 2009-10-08 00:00:00 |           3 |   1500 |

| 101 | 2009-11-20 00:00:00 |           2 |   1560 |

| 103 | 2008-05-20 00:00:00 |           4 |   2060 |

+-----+---------------------+-------------+--------+
```

Now, let us join these two tables in our SELECT statement as follows:

```
SQL> SELECT ID, NAME, AGE, AMOUNT

        FROM CUSTOMERS, ORDERS

        WHERE CUSTOMERS.ID = ORDERS.CUSTOMER_ID;
```

this would produce the following result:

```
+----+----------+-----+--------+

| ID | NAME     | AGE | AMOUNT |

+----+----------+-----+--------+

|  3 | kaushik  |  23 |   3000 |

|  3 | kaushik  |  23 |   1500 |
```

```
|  2 | Khilan   |  25 |   1560 |
|  4 | Chaitali |  25 |   2060 |
+----+----------+-----+--------+
```

SQL Join Types:

There are different types of joins available in SQL:

- **INNER JOIN:** returns rows when there is a match in both tables.
- **LEFT JOIN:** returns all rows from the left table, even if there are no matches in the right table.
- **RIGHT JOIN**: returns all rows from the right table, even if there are no matches in the left table.
- **FULL JOIN:** returns rows when there is a match in one of the tables.
- **SELF JOIN:** is used to join a table to itself as if the table were two tables, temporarily renaming at least one table in the SQL statement.
- **CARTESIAN JOIN**: returns the Cartesian product of the sets of records from the two or more joined tables.

INNER JOIN

Syntax:

The basic syntax of **INNER JOIN** is as follows:

```
SELECT table1.column1, table2.column2...
FROM table1
INNER JOIN table2
ON table1.common_field = table2.common_field;
```

```
QL> SELECT  ID, NAME, AMOUNT, DATE
     FROM CUSTOMERS
     INNER JOIN ORDERS
     ON CUSTOMERS.ID = ORDERS.CUSTOMER_ID;
```

This would produce the following result:

```
+----+----------+--------+---------------------+
| ID | NAME     | AMOUNT | DATE                |
+----+----------+--------+---------------------+
|  3 | kaushik  |   3000 | 2009-10-08 00:00:00 |
|  3 | kaushik  |   1500 | 2009-10-08 00:00:00 |
|  2 | Khilan   |   1560 | 2009-11-20 00:00:00 |
|  4 | Chaitali |   2060 | 2008-05-20 00:00:00 |
+----+----------+--------+---------------------+
```

LEFT JOIN

Syntax:

The basic syntax of **LEFT JOIN** is as follows:

```
SELECT table1.column1, table2.column2...
FROM table1
LEFT JOIN table2
ON table1.common_field = table2.common_field;
```

Now, let us join these two tables using LEFT JOIN as follows:

```
SQL> SELECT ID, NAME, AMOUNT, DATE
     FROM CUSTOMERS
     LEFT JOIN ORDERS
     ON CUSTOMERS.ID = ORDERS.CUSTOMER_ID;
```

This would produce the following result:

```
+----+----------+--------+---------------------+
| ID | NAME     | AMOUNT | DATE                |
+----+----------+--------+---------------------+
|  1 | Ramesh   |   NULL | NULL                |
|  2 | Khilan   |   1560 | 2009-11-20 00:00:00 |
|  3 | kaushik  |   3000 | 2009-10-08 00:00:00 |
|  3 | kaushik  |   1500 | 2009-10-08 00:00:00 |
|  4 | Chaitali |   2060 | 2008-05-20 00:00:00 |
|  5 | Hardik   |   NULL | NULL                |
|  6 | Komal    |   NULL | NULL                |
|  7 | Muffy    |   NULL | NULL                |
+----+----------+--------+---------------------+
```

RIGHT JOIN

Syntax:

The basic syntax of **RIGHT JOIN** is as follows:

```
SELECT table1.column1, table2.column2...
FROM table1
RIGHT JOIN table2
ON table1.common_field = table2.common_field;
```

Now, let us join these two tables using RIGHT JOIN as follows:

```
SQL> SELECT  ID, NAME, AMOUNT, DATE
     FROM CUSTOMERS
     RIGHT JOIN ORDERS
     ON CUSTOMERS.ID = ORDERS.CUSTOMER_ID;
```

This would produce the following result:

```
+------+----------+--------+---------------------+
| ID   | NAME     | AMOUNT | DATE                |
+------+----------+--------+---------------------+
|    3 | kaushik  |   3000 | 2009-10-08 00:00:00 |
|    3 | kaushik  |   1500 | 2009-10-08 00:00:00 |
|    2 | Khilan   |   1560 | 2009-11-20 00:00:00 |
|    4 | Chaitali |   2060 | 2008-05-20 00:00:00 |
+------+----------+--------+---------------------+
```

FULL JOIN

Syntax:

The basic syntax of **FULL JOIN** is as follows:

```
SELECT table1.column1, table2.column2...
FROM table1
FULL JOIN table2
ON table1.common_field = table2.common_field;
```

Now, let us join these two tables using FULL JOIN as follows:

```
SQL> SELECT  ID, NAME, AMOUNT, DATE
     FROM CUSTOMERS
     FULL JOIN ORDERS
     ON CUSTOMERS.ID = ORDERS.CUSTOMER_ID;
```

This would produce the following result:

```
+------+---------+--------+---------------------+
| ID   | NAME    | AMOUNT | DATE                |
+------+---------+--------+---------------------+
|    1 | Ramesh  |   NULL | NULL                |
|    2 | Khilan  |   1560 | 2009-11-20 00:00:00 |
|    3 | kaushik |   3000 | 2009-10-08 00:00:00 |
|    3 | kaushik |   1500 | 2009-10-08 00:00:00 |
|    4 | Chaitali|   2060 | 2008-05-20 00:00:00 |
|    5 | Hardik  |   NULL | NULL                |
|    6 | Komal   |   NULL | NULL                |
|    7 | Muffy   |   NULL | NULL                |
|    3 | kaushik |   3000 | 2009-10-08 00:00:00 |
|    3 | kaushik |   1500 | 2009-10-08 00:00:00 |
|    2 | Khilan  |   1560 | 2009-11-20 00:00:00 |
|    4 | Chaitali|   2060 | 2008-05-20 00:00:00 |
+------+---------+--------+---------------------+
```

SELF JOIN

Syntax:

The basic syntax of **SELF JOIN** is as follows:

```
SELECT a.column_name, b.column_name...
FROM table1 a, table1 b
WHERE a.common_field = b.common_field;
```

Here, WHERE clause could be any given expression based on your requirement.

Example:

Consider the following two tables, (a) CUSTOMERS table is as follows:

```
+----+----------+-----+-----------+----------+
| ID | NAME     | AGE | ADDRESS   | SALARY   |
+----+----------+-----+-----------+----------+
|  1 | Ramesh   |  32 | Ahmedabad |  2000.00 |
|  2 | Khilan   |  25 | Delhi     |  1500.00 |
|  3 | kaushik  |  23 | Kota      |  2000.00 |
|  4 | Chaitali |  25 | Mumbai    |  6500.00 |
|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
|  6 | Komal    |  22 | MP        |  4500.00 |
|  7 | Muffy    |  24 | Indore    | 10000.00 |
+----+----------+-----+-----------+----------+
```

Now, let us join this table using SELF JOIN as follows:

```
SQL> SELECT  a.ID, b.NAME, a.SALARY
     FROM CUSTOMERS a, CUSTOMERS b
     WHERE a.SALARY < b.SALARY;
```

This would produce the following result:

```
+----+----------+---------+
| ID | NAME     | SALARY  |
+----+----------+---------+
|  2 | Ramesh   | 1500.00 |
|  2 | kaushik  | 1500.00 |
|  1 | Chaitali | 2000.00 |
|  2 | Chaitali | 1500.00 |
|  3 | Chaitali | 2000.00 |
|  6 | Chaitali | 4500.00 |
|  1 | Hardik   | 2000.00 |
|  2 | Hardik   | 1500.00 |
|  3 | Hardik   | 2000.00 |
|  4 | Hardik   | 6500.00 |
```

```
|  6 | Hardik    | 4500.00 |
|  1 | Komal     | 2000.00 |
|  2 | Komal     | 1500.00 |
|  3 | Komal     | 2000.00 |
|  1 | Muffy     | 2000.00 |
|  2 | Muffy     | 1500.00 |
|  3 | Muffy     | 2000.00 |
|  4 | Muffy     | 6500.00 |
|  5 | Muffy     | 8500.00 |
|  6 | Muffy     | 4500.00 |
+----+----------+---------+
```

CARTESIAN JOIN

Syntax:

The basic syntax of **CARTESIAN JOIN** or **CROSS JOIN** is as follows:

```
SELECT table1.column1, table2.column2...
FROM  table1, table2 [, table3 ]
```

Example:

Consider the following two tables,

(a) **CUSTOMERS** table:

(b) Another table is **ORDERS**:

Now, let us join these two tables using INNER JOIN as follows:

```
SQL> SELECT ID, NAME, AMOUNT, DATE
     FROM CUSTOMERS, ORDERS;
```

This would produce the following result:

```
 ID | NAME     | AMOUNT | DATE                |
+----+----------+--------+---------------------+
```

```
|  1 | Ramesh   |   3000 | 2009-10-08 00:00:00 |
|  1 | Ramesh   |   1500 | 2009-10-08 00:00:00 |
|  1 | Ramesh   |   1560 | 2009-11-20 00:00:00 |
|  1 | Ramesh   |   2060 | 2008-05-20 00:00:00 |
|  2 | Khilan   |   3000 | 2009-10-08 00:00:00 |
|  2 | Khilan   |   1500 | 2009-10-08 00:00:00 |
|  2 | Khilan   |   1560 | 2009-11-20 00:00:00 |
|  2 | Khilan   |   2060 | 2008-05-20 00:00:00 |
|  3 | kaushik  |   3000 | 2009-10-08 00:00:00 |
|  3 | kaushik  |   1500 | 2009-10-08 00:00:00 |
|  3 | kaushik  |   1560 | 2009-11-20 00:00:00 |
|  3 | kaushik  |   2060 | 2008-05-20 00:00:00 |
|  4 | Chaitali |   3000 | 2009-10-08 00:00:00 |
|  4 | Chaitali |   1500 | 2009-10-08 00:00:00 |
|  4 | Chaitali |   1560 | 2009-11-20 00:00:00 |
|  4 | Chaitali |   2060 | 2008-05-20 00:00:00 |
|  5 | Hardik   |   3000 | 2009-10-08 00:00:00 |
|  5 | Hardik   |   1500 | 2009-10-08 00:00:00 |
|  5 | Hardik   |   1560 | 2009-11-20 00:00:00 |
|  5 | Hardik   |   2060 | 2008-05-20 00:00:00 |
|  6 | Komal    |   3000 | 2009-10-08 00:00:00 |
|  6 | Komal    |   1500 | 2009-10-08 00:00:00 |
|  6 | Komal    |   1560 | 2009-11-20 00:00:00 |
|  6 | Komal    |   2060 | 2008-05-20 00:00:00 |
|  7 | Muffy    |   3000 | 2009-10-08 00:00:00 |
|  7 | Muffy    |   1500 | 2009-10-08 00:00:00 |
|  7 | Muffy    |   1560 | 2009-11-20 00:00:00 |
|  7 | Muffy    |   2060 | 2008-05-20 00:00:00 |
+----+----------+--------+---------------------+
```

Normalization of Database

Database Normalization is a technique of organizing the data in the database.

- Normalization is a systematic approach of decomposing tables to eliminate data redundancy and undesirable characteristics like Insertion, Update and Deletion Anomalies.
- It is a multi-step process that puts data into tabular form by removing duplicated data from the relation tables.

Normalization is used for mainly two purpose,

- Eliminating reduntant(useless) data.
- Ensuring data dependencies make sense i.e data is logically stored.

Problem Without Normalization

Without Normalization, it becomes difficult to handle and update the database, without facing data loss. Insertion, Updation and Deletion Anamolies are very frequent if Database is not normalized. To understand these anomalies let us take an example of **Student** table.

S_id	**S_Name**	**S_Address**	**Subject_opted**
401	Adam	Noida	Bio
402	Alex	Panipat	Maths
403	Stuart	Jammu	Maths
404	Adam	Noida	Physics

- **Updation anomalies**: To update address of a student who occurs twice or more than twice in a table, we will have to update **S_Address** column in all the rows, else data will become inconsistent.
- **Insertion anomalies**: Suppose for a new admission, we have a Student id(S_id), name and address of a student but if student has not opted for any subjects yet then we have to insert **NULL** there, leading to Insertion Anomaly.
- **Deletion anomalies**: If (S_id) 401 has only one subject and temporarily he drops it, when we delete that row, entire student record will be deleted along with it.

Normalization Rule

Normalization rule are divided into following normal form.

1. First Normal Form
2. Second Normal Form
3. Third Normal Form
4. BCNF

First Normal Form (1NF)

As per First Normal Form**, no two Rows of data must contain repeating group of information** i.e each set of column must have a unique value, such that multiple columns cannot be used to fetch the same row. Each table should be organized into rows, and each row should have a primary key that distinguishes it as unique.

The **Primary key** is usually a single column, but sometimes more than one column can be combined to create a single primary key. For example consider a table which is not in First normal form

Student Table:

Student	Age	Subject
Adam	15	Biology, Maths
Alex	14	Maths
Stuart	17	Maths

In First Normal Form, any row must not have a column in which more than one value is saved, like separated with commas. Rather than that, we must separate such data into multiple rows.

Student Table following 1NF will be:

Student	Age	Subject
Adam	15	Biology
Adam	15	Maths
Alex	14	Maths
Stuart	17	Maths

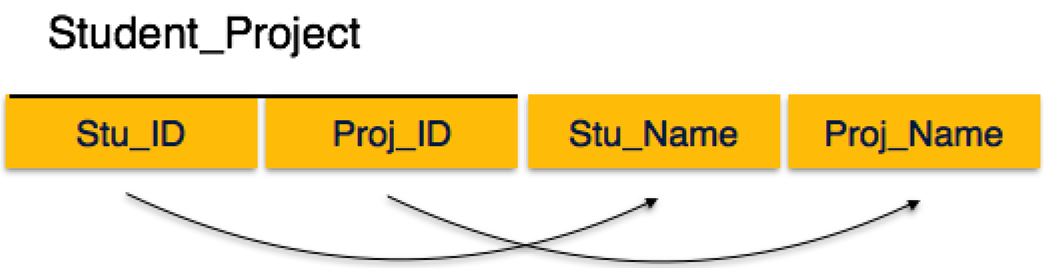
Using the First Normal Form, data redundancy increases, as there will be many columns with same data in multiple rows but each row as a whole will be unique.

Second Normal Form (2NF)

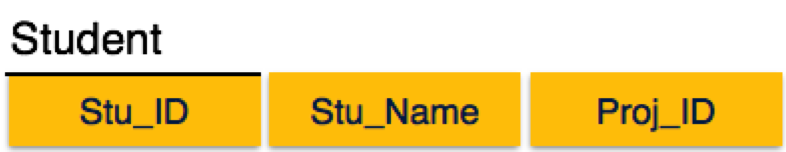
Before we learn about the second normal form, we need to understand the following

- **Prime attribute** − An attribute, which is a part of the prime-key, is known as a prime attribute.
- **Non-prime attribute** − An attribute, which is not a part of the prime-key, is said to be a non-prime attribute.

If we follow second normal form, then **every non-prime attribute should be fully functionally dependent on prime key attribute**. That is, if X → A holds, then there should not be any proper subset Y of X, for which Y → A also holds true.



We see here in Student_Project relation that the prime key attributes are Stu_ID and Proj_ID. According to the rule, non-key attributes, i.e. Stu_Name and Proj_Name must be dependent upon both and not on any of the prime key attribute individually. But we find that Stu_Name can be identified by Stu_ID and Proj_Name can be identified by Proj_ID independently. This is called **partial dependency**, which is not allowed in Second Normal Form.



We broke the relation in two as depicted in the above picture. So there exists no partial dependency.

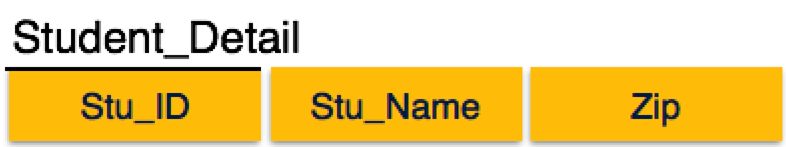
Third Normal Form (3NF)

For a relation to be in Third Normal Form, it must be in Second Normal form and the following must satisfy −

- No non-prime attribute is transitively dependent on prime key attribute.
- For any non-trivial functional dependency, X → A, then either −
    - X is a superkey or,
    - A is prime attribute.

We find that in the above Student_detail relation, Stu_ID is the key and only prime key attribute. We find that City can be identified by Stu_ID as well as Zip itself. Neither Zip is a superkey nor is City a prime attribute. Additionally, Stu_ID → Zip → City, so there exists **transitive dependency**.

To bring this relation into third normal form, we break the relation into two relations as follows −



For example, consider a table with following fields.

Student_Detail Table :

Student_id	Student_name	DOB	Street	city	State	Zip

In this table Student_id is Primary key, but street, city and state depends upon Zip. The dependency between zip and other fields is called **transitive dependency**. Hence to apply **3NF**, we need to move the street, city and state to new table, with **Zip** as primary key.

New Student_Detail Table :

Student_id	Student_name	DOB	Zip

Address Table :

Zip	Street	city	state

The advantage of removing transtive dependency is,

- Amount of data duplication is reduced.
- Data integrity achieved.

Boyce and Codd Normal Form (BCNF)

Boyce-Codd Normal Form (BCNF) is an extension of Third Normal Form on strict terms. BCNF states that −

- For any non-trivial functional dependency, X → A, X must be a super-key.

In the above image, Stu_ID is the super-key in the relation Student_Detail and Zip is the super-key in the relation ZipCodes. So,

Stu_ID → Stu_Name, Zip

and

Zip → City

Which confirms that both the relations are in BCNF.