1. When attribute B depends on attribute A, for every instance of A, there is only a single corresponding instance of B, which is constant and is purely determined by the A. If for every instance of A, there is more than one corresponding instance of B, the functional dependency does not hold.

2. Candidate key: while there are usually exists multiple keys in a table, the set which contains the minimal number of attributes but could uniquely define a row is called candidate key.

3. Primary key: primary key could a single attribute or composite key which is consisted of more than one attribute. Primary key could also uniquely define a row, but unlike candidate key, there is one and only one primary key in a table.

4.

    1. First normal form: in every slot of the table, there should exist only one single entity, which is an indivisible unit and could not be further subdivided.

    2. Second normal form: the table should meet all the properties of first normal form. Furthermore, all non-prime attributes should have functional dependency to the whole set of candidate keys. If there exists a non-prime attribute that depends on the subset of any candidate keys(i.e, not depends on the whole set of candidate keys), the table is not in second normal form.

    3. Third normal form: the table should meet all the properties of first normal form and second normal form, so all non-prime attribute depends on the set of candidate keys. However, if the functional dependency is not direct(for example, one non-prime attribute A depends on another non-prime attribute B, and B is determined by the set of candidate keys, so consequently A is also determined by the set of candidate keys), the table is not in third normal form.

5.

    1. Table description: a piece which is selected from a collection of information of students. The attribute **student_id** is the primary key. Also, attributes in this table include **surname**, **first_name** and **nationalities**.

    2. Not in 1NF: while most students only has one nationality, student 0001 has duel citizenship, so in his nationality slot there are two entities. Therefore, this table is not first normal norm.

    3. Modification: to enforce 1NF to this table, we need to break the nationality slot of client 1 and create additional column and row to store the second nationality, so only one entity is stored in each slot, as table 5.2 is.

Table 5.1: Information of Students

student_id	surname	first_name	nationality

Table 5.1: Information of Students			
0001	Mason	Syd	United Kingdom United States
0002	Waters	Nick	France
0003	Barrett	Roger	Germany

Table 5.2: Information of Students			
student_id	surname	first_name	nationality
0001	Mason	Syd	United Kingdom
0002	Mason	Syd	United States
0003	Waters	Nick	France
0004	Barrett	Roger	Germany

6.

1. Table description: this is a piece of table selected from the database of a mail-service company, whose service is to deliver newspaper to its customer every morning. Customers subscribe and pre-pay for the newspaper they want to read. The attribute **customer_id** is the primary key. Also, attributes in this table include the **subscribed_newspaper** and the corresponding **publishers**. Because we need both **customer_id** and **subscribed_newspaper** to define a row, the candidate keys are {**customer_id** and **subscribed_newspaper**}. In this table, there is only one single entity in each slot, so this table is in 1NL.

2. Not in 2NF: The candidate keys are the **customer_id** and **subscripted_newspaper**, and the publishers depends on the **subscribed_newspaper**, which is a proper subset of the candidate keys. Therefore, this table contains partial dependency and is not in 2NF.

3. Modification: to enforce 2NF to this table, we need to make new tables, which contains the information of customers and the information of newspaper separately, as Table 6.2.1 and 6.2.2 are.

Table 6.1: Information of Customers		
customer_id	subscribed_newspaper	publishers
0001	The Daily Telegraph	Telegraph Media Group
0001	Financial Times	Pearson plc
0002	The Guardian	Guardian Media Group

Table 6.1: Information of Customers		
0003	The Sun	News Group Newspapers
0004	The Guardian	Guardian Media Group

Table 6.2.1: Information of Customers	
customer_id	subscribed_newspaper
0001	The Daily Telegraph
0001	Financial Times
0002	The Guardian
0003	The Sun

Table 6.2.2: Information of Newspaper	
subscribed_newspaper	publishers
The Daily Telegraph	Telegraph Media Group
Financial Times	Pearson plc
The Guardian	Guardian Media Group
The Sun	News Group Newspapers

7. Describe a table which is in second normal form, but not in third normal form, and explain why. Then state what modifications you would have to make to put this table in third normal form.

    1. Table description: this is a piece of table selected from the database of a university, which contains the new applicants, their intended majors and their recommender. One student is allowed to apply two majors at maximum, the student needs to provide different **recommender_surname** and **recommender_contact_numbers** for each major. Therefore, the candidate keys of this table is {**student_id**, **major_id**}. There is only one entity in each slot, so this table is in 1NL. Also, the two non-prime keys, **recommender_surname**, **recommender_contact_number**, depend on the whole set of candidate keys instead of any proper subset, so this table is in 2NL.

    2. Not in 3NF: the non-prime attribute **recommender_contact_number** depends on recommender_surname, which is depends on the candidate keys. Therefore **recommender_contact_number** transitively depends on the candidate keys. Therefore, this table is not in 3NF.

    3. Modification: to enforce 2NF to this table, we need to make new tables, which contains the information of applicants and the information of recommender separately, as Table 7.2.1 and 7.2.2 are.

Table 7.1: Information of applicants			
student_id	major	recommender_surname	recommender_contact_number
0001	Computer Engineering	White	2033228352
0001	Math	Roger	3317568387
0002	History	Morgan	1588673337
0002	Music	Johnson	9233745421
0003	Geology	May	7904834897
0003	History	Taylor	7926541680