Doping

The Primary techniques for doping in semiconductor manufacturing are ion implantation, thermal diffusion and other various forms of deposition.
These methods intentionally introduce impurities (dopants) in to semiconductor material like silicon, to alter its electrical properties and create components like transistor and diodes.

Important doping Techniques:- Ion implatation is important technique in which a high-precision method used to create shallow, highly controlled doping profiles, which is essential for modern integrated circuits

Process:- Dopant atoms are ionised (i.e given a charge), accelerated by an electric field and physically bombarded in to the semiconductor substrate at room temperature.

In process of doping a small of suitable impurity to a crystal in order to improve its properties, is called Doping.

For example, when NaCl is mixed with small amount of $SrCl_2$ and the mixture is fused with subsequent recrystallisation of the melt, some of Na^+ ions in the crystal are replaced by Sr^{++} ions.

In order to maintain the electrical neutrality of the crystal, an equal number of Na^+ ions are lost from their lattice sites creating vacancies there. The crystal of NaCl, dopped with Sr^{++} ions, becomes p-type semiconductor.

Facts regarding n-type & p type semi-conductors

n-type and p-type semiconductor

n-type Semiconductor	p-type semiconductor
1. It is a donor type.	1. It is an acceptor type
2. Impurity atom is Pentavalent.	2. Impurity atom is trivalent.
3. Donor level lies close to the bottom of the Conduction band.	3. Acceptor level lies close to the top of the Valence band.
N-type is designed	P-type is designed

n-type Semi-conductor from Silicon(Si) and Germanium

We know Pure Si and Ge (Germanium) are semiconductors. It can be made more conducting in a controlled manner by doping them with impurities which act as charge carriers.

Silicon (Si) and Germanium (Ge) is first made extremely pure by Zone refining Method.

Then some Arsenic (As) atoms with five Valence electrons are dopped to the Silicon or Germanium Crystal with the result that some of Si or Ge atoms are randomly replaced by As atom.

In this process only four of the five Valence electrons of each As atom are required to form bonds with surrounding Si or Ge atom; the fifth Valence electron remains non-bonded and at low temperature, the fifth non-bonded electron, remains localised on As atom.

However at normal temperature, some of these non bonded electrons are excited in to Conduction band, where they act as Carriers of Charge.

Since the Current, here is Carried by negatively charged electrons, the extrinsic Semi conductor, so obtained is known as n-type semi conductor.

Here the filled dopant band lies just below the empty Conduction band and promotion of electron from filled dopant band to empty-Conduction band becomes so easier.

Now the energy bands in n-type Semiconductor is as follows:-