ANALOG ELECTRONICS

LECTURE NO. 1

ANALOG ELECTRONICS

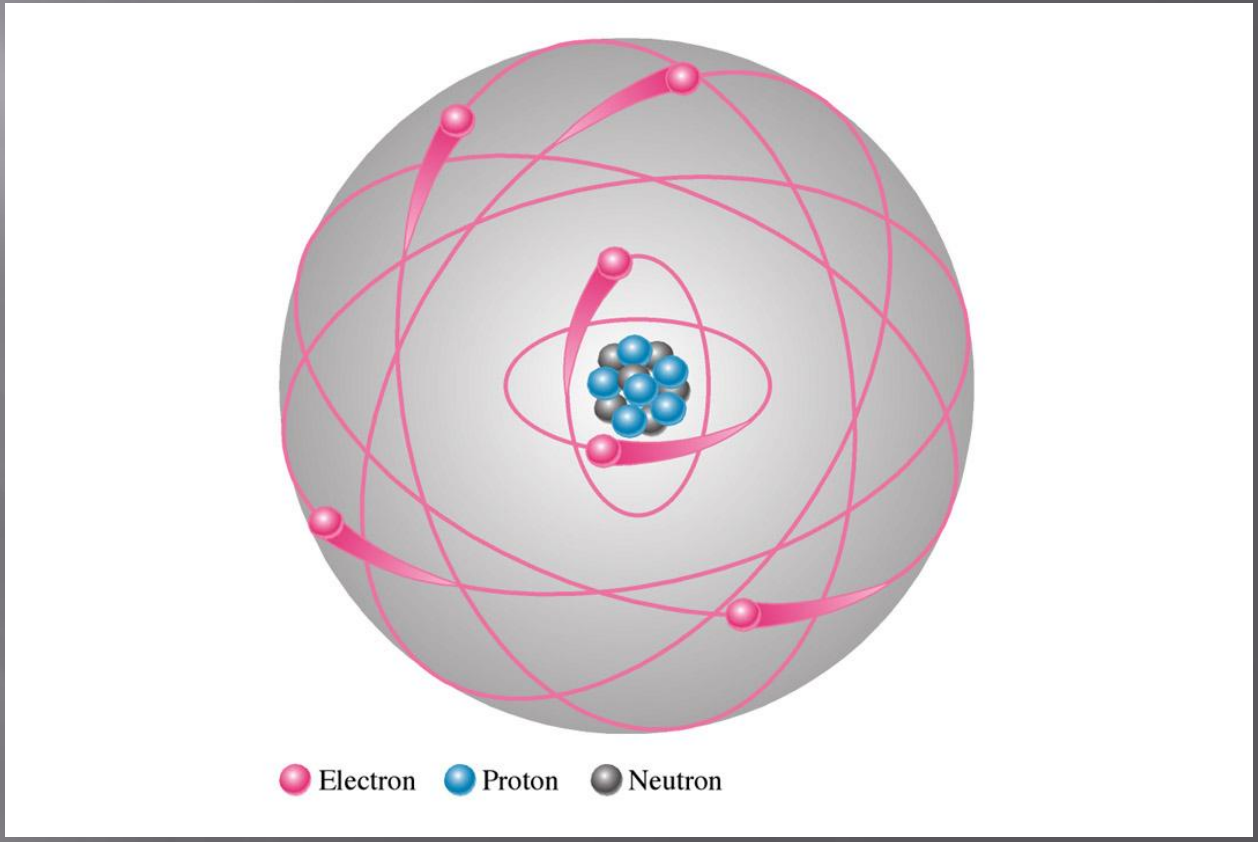
- **Analogue electronics** (or **analog** in American English) are electronic systems with a continuously variable signal, in contrast to digital electronics where signals usually take only two different levels. The term "analogue" describes the proportional relationship between a signal and a voltage or current that represents the signal. The word analogue is derived from the Greek word (analogos) meaning "proportional"

UNIT 1

DIODES

BOHR MODEL OF AN ATOM

As seen in this model, electrons circle the nucleus. Atomic structure of a material determines it's ability to conduct or insulate.



CONDUCTORS, INSULATORS, AND SEMICONDUCTORS

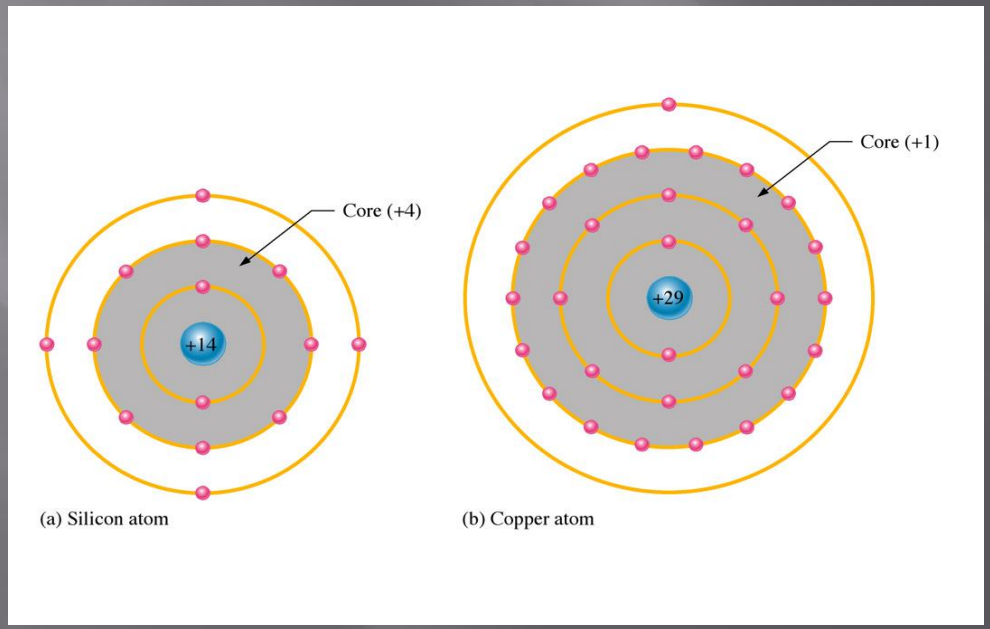
- The ability of a material to conduct current is based on its atomic structure.
- The orbit paths of the electrons surrounding the nucleus are called shells.
- Each shell has a defined number of electrons it will hold. This is a fact of nature and can be determined by the formula, $2n^2$.
- The outer shell is called the valence shell.
- The less complete a shell is filled to capacity the more conductive the material is.

CONDUCTORS, INSULATORS, AND SEMICONDUCTORS

The valence shell determines the ability of material to conduct current.

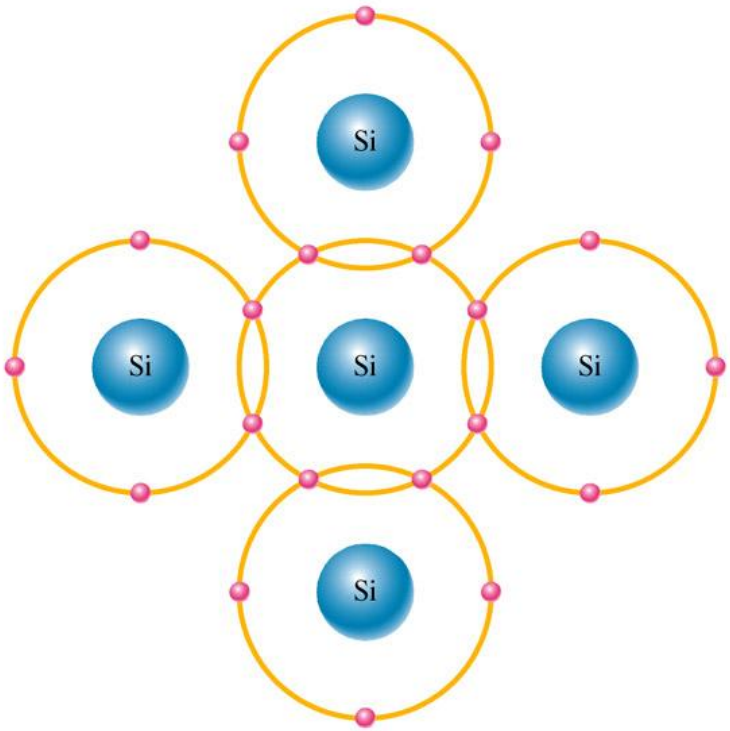
A Copper atom has only 1 electron in it's valence ring. This makes it a good conductor. It takes $2n^2$ electrons or in this case 32 electrons to fill the valence shell.

A Silicon atom has 4 electrons in it's valence ring. This makes it a semiconductor. It takes $2n^2$ electrons or in this case or 18 electrons to fill the valence shell.

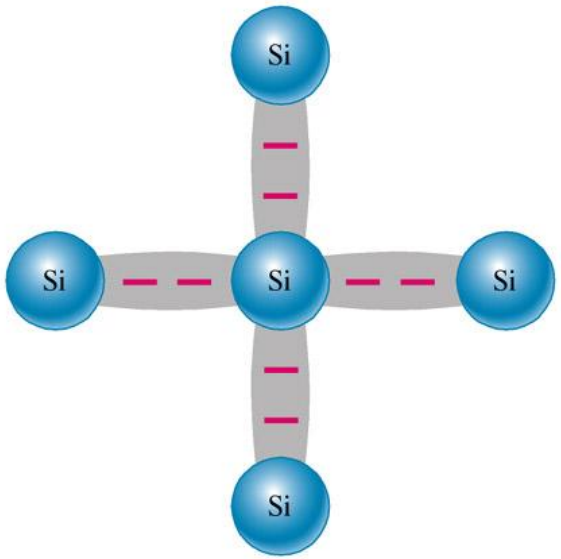


COVALENT BONDING

Covalent bonding is a bonding of two or more atoms by the interaction of their valence electrons.



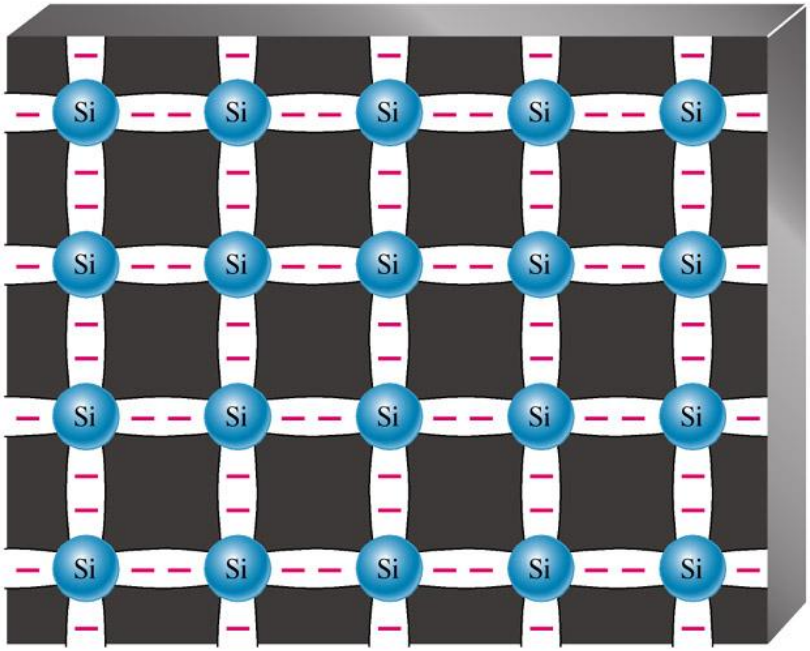
(a) The center atom shares an electron with each of the four surrounding atoms, creating a covalent bond with each. The surrounding atoms are in turn bonded to other atoms, and so on.



(b) Bonding diagram. The red negative signs represent the shared valence electrons.

COVALENT BONDING

Certain atoms will combine in this way to form a crystal structure. Silicon and Germanium atoms combine in this way in their intrinsic or pure state.



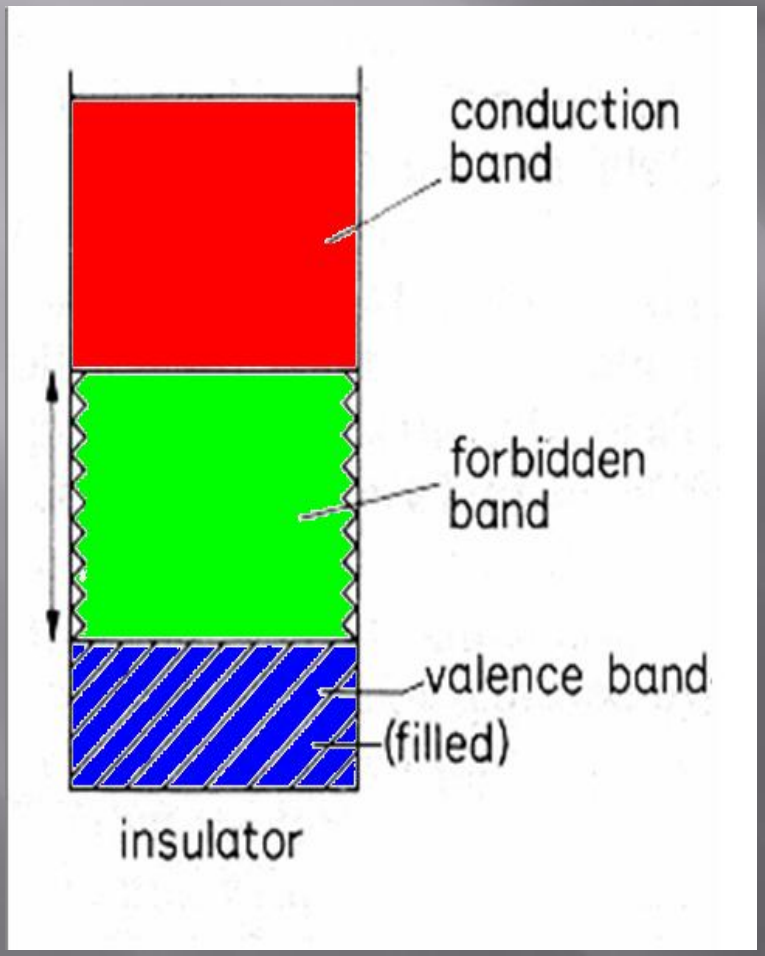
SEMICONDUCTORS AND ELECTRONICS

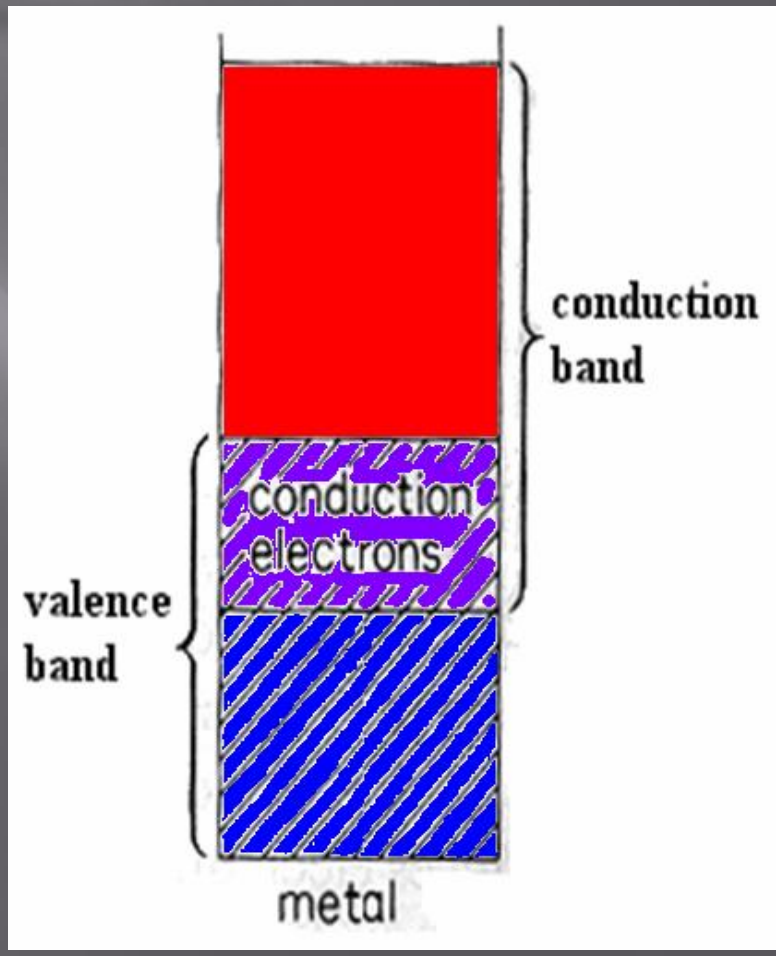
Semiconductors are materials whose electrical conductivities are higher than those of insulators but lower that those of conductors.

Silicon, Germanium, Gallium, Arsenide, Indium, Antimony and cadmium sulphide are some commonly used semiconductors.

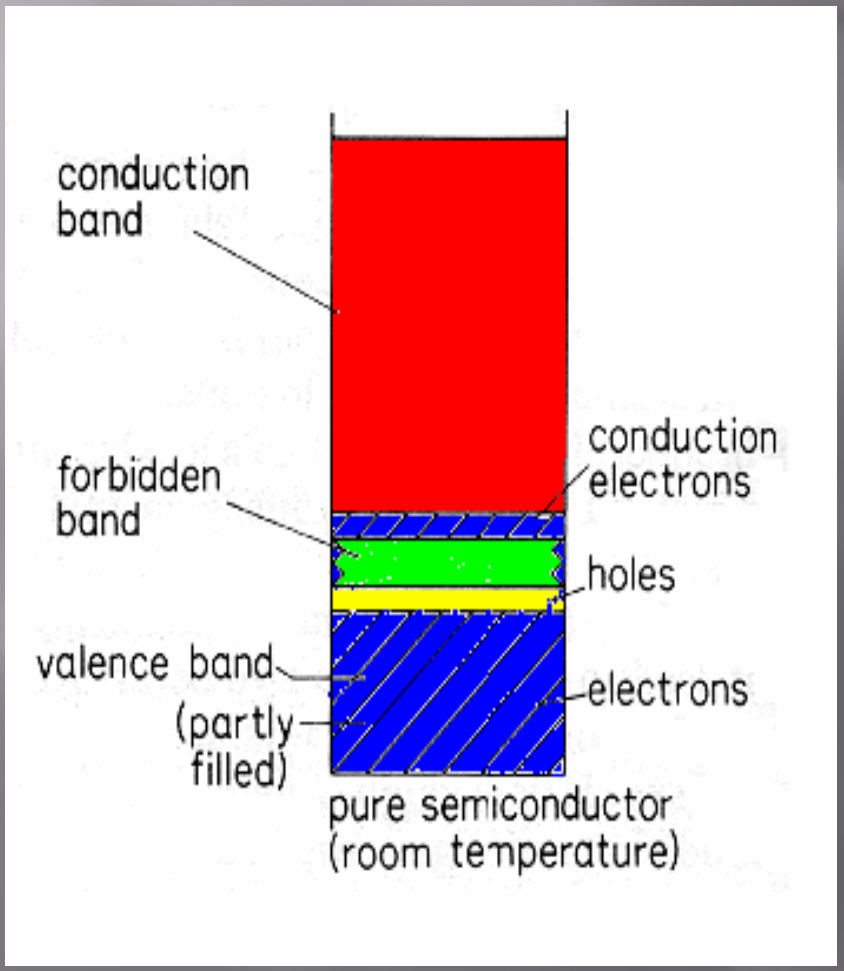
Semiconductors have negative temperature coefficients of resistance, i.e. as temperature increases resistivity deceases.

ENERGY BANDS IN INSULATORS & CONDUCTORS





ENERGY BANDS IN SEMICONDUCTORS



Forbidden band small for semiconductors.

Less energy required for electron to move from valence to conduction band.

A vacancy (hole) remains when an electron leaves the valence band.

Hole acts as a positive charge carrier.

DOPING

The electrical characteristics of Silicon and Germanium are improved by adding materials in a process called doping.

The additional materials are in two types:

- n-type
- p-type

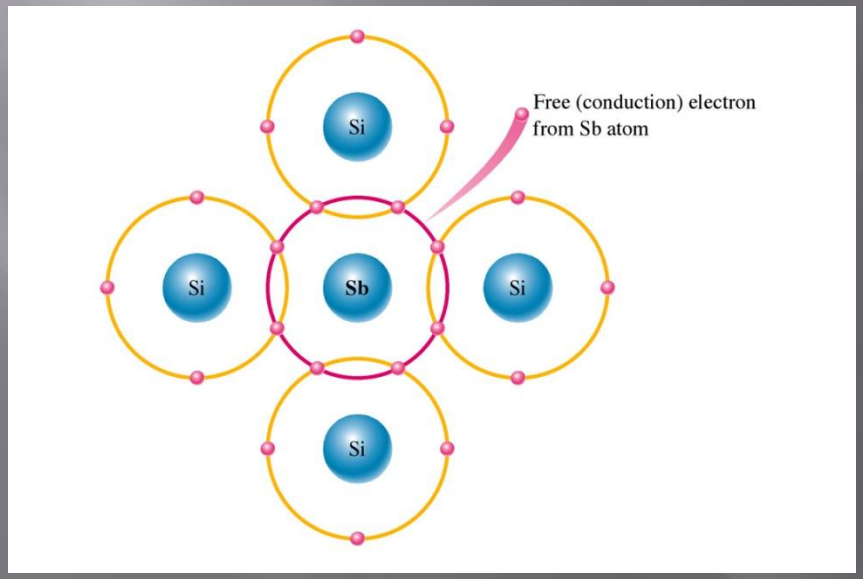
N-TYPE AND P-TYPE SEMICONDUCTORS

The process of creating N and P type materials is called doping.

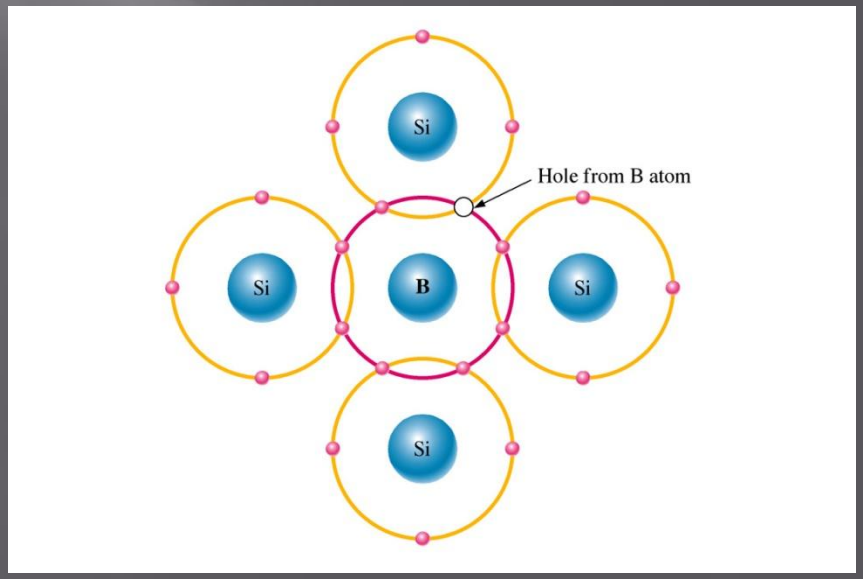
Other atoms with 5 electrons such as Antimony are added to Silicon to increase the free electrons.

Other atoms with 3 electrons such as Boron are added to Silicon to create a deficiency of electrons or hole charges.

N-type



P-type



Research Areas of Analog Electronics

- Chip designinig
- Amplifier design
- Almost each and every electronics
- VLSI
- Microelectronics