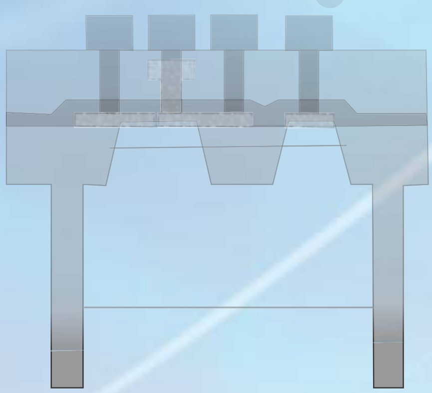
Pro-One

GATE

Graduate Aptitude Test in Engineering

Electronics and Communication Engineering

Electronic Devices and Circuits



btechguru.com

ELECTRONIC DEVICE AND CIRCUITS-THEORY

Introduction:

*Semiconductor → It's a material whose conductivity is in between metal and insulator. Germanium (Ge) and silicon (Si) are most commonly used semiconductor in VLSI technology

Orbital structure of Si → 2, 8, 4 so there are 4 electrons in outermost band and ready to form bonding.

For Ge orbital structure will be 2, 8,18,4 and thus electrons are there to form bonding.

As we increase temperature more and more electrons get free. So in other word material

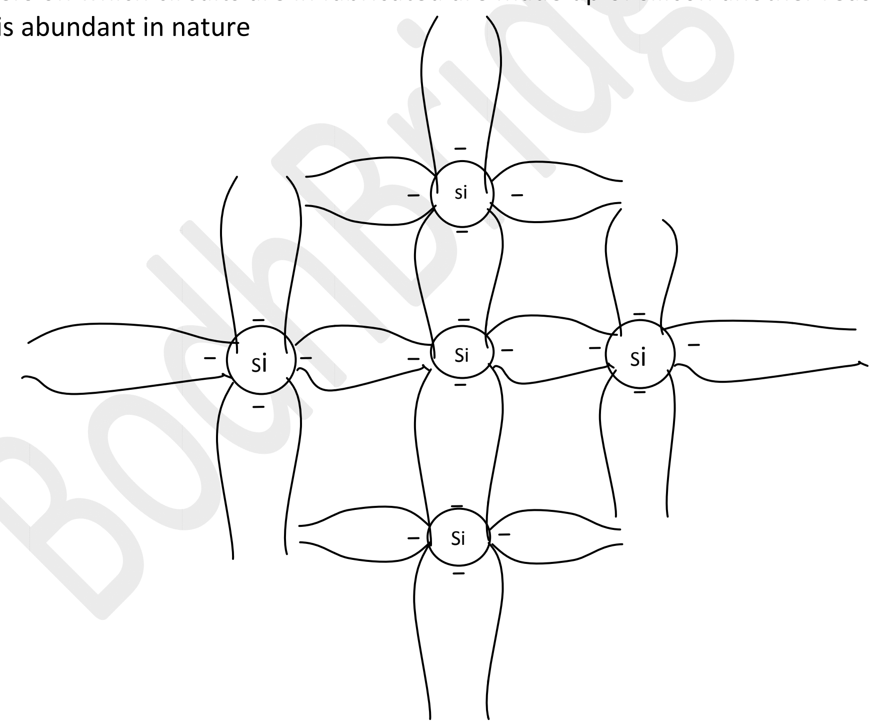
Become more and more conductive; but $R \propto \frac{1}{conductivity}$

Hence as temperature increases { T,↑ },

Resistance decreases (R,↓}

Application →

All wafers on which circuits are in fabricated are made up of silicon another reason of using silicon is that it is abundant in nature



Bond formation of silicon

DEVICE MODELLING - QUESTIONS

1) A Si-bar 0.1cm long 100 μ m^2 area (cross-sectional) doped with 10^{17}/cm^3 phosphorous find current?(neglect temperature effect) $\mu_n = 700cm^2/vs$,q=1.6x$10^{-19}C$; applied voltage is 10V

Resistivity

(a)1.5mA (b)1.3mA (c)1.12mA (d)1 μ A

---

2) If mobility due to impurity scattering is $1cm^2/v-s$ and due to lattice $2cm^2/v-s$ .what is resultant scattering in material.

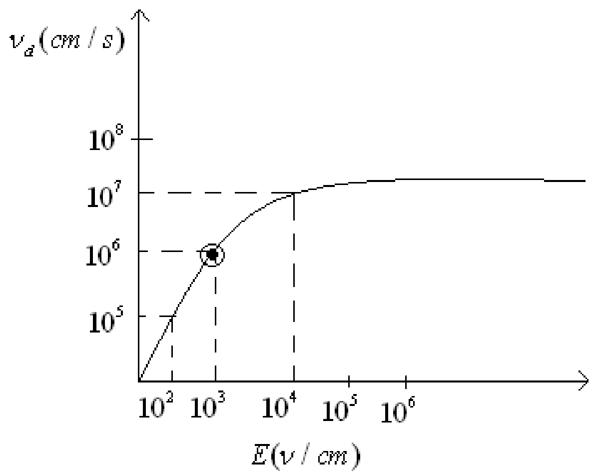
Mobility

(a) $2cm^2/v-s$ (b) $1cm^2/v-s$ (c) $0.5cm^2/v-s$ (d) $0.67cm^2/v-s$

---

3) What is mobility at point x in figure below.

Mobility



(a) $10\,cm^2/v-s$ (b)$100\,cm^2/v-s$ (c)$1000\,cm^2/v-s$ (d)$10000\,cm^2/v-s$

---

4) A hypothetical semiconductor having donor concentration(N_d) equal to $10^{16}/cm^3$ and acceptor concentration (N_a) $2\times10^{16}/cm^3$ .what is new electron and hole concentration.

Intrinsic and Extrinsic Silicon

(a) $n_0 = 10^4/cm^3$ $p_0 = 10^{16}/cm^3$ (b) $p_0 = 10^{16}/cm^3$ $n_0 = 10^4/cm^3$

(c) $p_0 = 10^{16}/cm^3$ $n_0 = 10^{16}/cm^3$ (d) $p_0 = 10^4/cm^3$ $n_0 = 10^4/cm^3$

DEVICE MODELLING – SOLUTIONS

1) SOLUTION: (c)

$\sigma = nq\mu_n$ (conductivity)

$= 10^{17} \times 1.6 \times 10^{-19} \times 700 = 11.2$

$\rho = \frac{1}{\sigma} = 0.08928 = resistivity$

$R = \frac{\sigma L}{A} = 8928.57$

$I = \frac{V}{R} = 1.12mA$

2) SOLUTION: (d)

$$\frac{1}{\mu} = \frac{1}{\mu_1} + \frac{1}{\mu_2} + \ldots\ldots + \frac{1}{\mu_n}$$

Here n=2 $\frac{1}{\mu} = \frac{1}{\mu_1} + \frac{1}{\mu_2}$

$\frac{1}{\mu} = \frac{1}{1} + \frac{1}{2} = 1.5$ $\mu = 0.67cm^2 / v - s$

3) SOLUTION: (c) $v_d = \mu E$

$$\frac{10^6}{10^3} = \mu = 1000cm^2 / v - s$$

4) SOLUTION: (b)

$N_a > N_d$

$n_0 = N_a - N_d = 10^{16} / cm^3$

$n_0 p_0 = n_i^{\,2}$

$n_0 = 10^4 / cm^3$