DEPARTMENT OF PHYSICS AND NANOTECHNOLOGY
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

18PY103J – Physics: Semiconductor Physics
Module-I, Lecture-16

Numericals Based on Fermi Level and Fermi Distribution Fuction

1. **The Fermi level** for **potassium is 2.1eV**. **Calculate the velocity** of the **electron** at **the Fermi level**.

Solution:-

We have the formula, $E_F = 1/2\, mv_F^2$

Therefore, $v_F = (2E_F/m)^{1/2}$

$= (2 \times \mathbf{2.1} \times 1.602 \times 10{-}19 / 9.11 \times 10{-}31)^{1/2}$

$v_F = 8.6 \times 10\ 5\ m/s.$

2 . Evaluate the Fermi function for energy K_BT above the Fermi energy.

Solution:

We know Fermi Function $F(E) = \frac{1}{1+e^{(E-E_F)K_BT}}$

For an energy K_BT aboveFermi energy

$$E - E_F = K_BT$$

$$F(E) = \frac{1}{1+e^1} = \frac{1}{1+2.7183}$$

Fermi distribution function $F(E) = 0.2689$

3. The Fermi temperature of a metal is 24600 K. Calculate the Fermi velocity.

Solution:

Given data:

Temperature = 24600 K

The relation between Fermi energy, Fermi velocity and Fermi temperature is given by

$$E_F = \frac{3}{2}K_B T_F = \frac{1}{2}mV^2{}_F$$

$$V_F = \sqrt{\frac{3K_B T_F}{m}} = \sqrt{\frac{31.38\text{x}10^{-23}\text{x}24600}{9.11\text{x}10^{-31}}}$$

Fermi velocity $V_F = 863.30 \times 10^3 ms^{-1}$

4. **Use the Fermi distribution function to obtain the value of F(E) for $E - E_F$ = 0.01 eV at 200K.**

Given data:

Fermi Function $F(E) = \dfrac{1}{1+e^{(E-E_F)/K_BT}}$

Boltzman constant $K_B = 1.38 \times 10^{-23}\ JK^{-1}$

$E - E_F = 0.01\ eV = 0.01 \times 1.6 \times 10^{-19} = 1.6 \times 10^{-21} J$

$T = 200\ K$

$$F(E) = \frac{1}{1+e^{1.6 \times 10^{-21}/\left(1.38 \times 10^{-23} \times 200\right)}}$$

$$= \frac{1}{1+e^{0.5797}}$$

$$= \frac{1}{1+1.7855} = \frac{1}{2.7855}$$

Fermi function $F(E) = 0.3589$