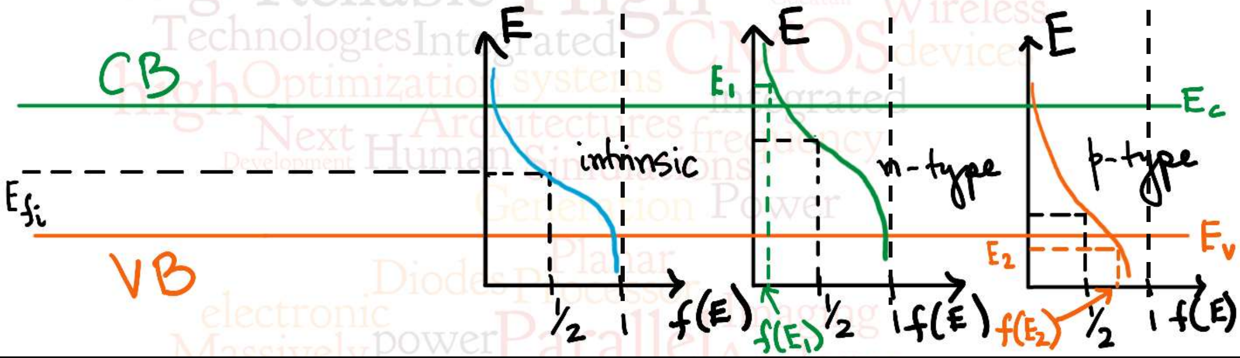
Fermi function/Occupation Probability

$$f(E) = \frac{1}{1 + e^{\frac{E-E_F}{kT}}}$$

$$f(E_F) = \frac{1}{2}$$

- The function $f(E)$, is also known as **OCCUPATION PROBABILITY**

$$\boldsymbol{n = \int \rho(E) f(E)\, \mathrm{d}E} \qquad \boldsymbol{p = \int \rho(E)[1 - f(E)]\, \mathrm{d}E}$$



58

Carrier Concentration

$$f(E) = \frac{1}{1 + e^{\frac{E-E_F}{kT}}}$$

$$\boldsymbol{n = \int_{E_C}^{\infty} \rho(E) f(E)\, \mathrm{d}E}$$

$$g_C(E)_{3D} = \frac{1}{2\pi^2}\left(\frac{2m_e^*}{\hbar^2}\right)^{\frac{3}{2}} (E - E_C)^{\frac{1}{2}}$$

$$n = N_C^{3D} \frac{2}{\sqrt{\pi}} \mathcal{F}_{\frac{1}{2}}(\eta_C)$$

Effective CB Density of States

Effective VB Density of States

$$p = N_V^{3D} \frac{2}{\sqrt{\pi}} \mathcal{F}_{\frac{1}{2}}(\eta_V)$$

Rigorously correct expression for Carrier Concentration

Defining,

$$N_C^{3D} = 2\left(\frac{m_e^* kT}{2\pi\hbar^2}\right)^{3/2}$$

$$N_V^{3D} = 2\left(\frac{m_h^* kT}{2\pi\hbar^2}\right)^{3/2}$$

Effective density of states at 300 K

Semiconductor	N_C (cm^{-3})	N_V (cm^{-3})
Ge	1.03×10^{19}	5.35×10^{18}
Si	3.23×10^{19}	1.83×10^{19}
GaAs	4.21×10^{17}	9.52×10^{18}

59