3.13

(a) ∵ E_F 处于禁带中央

∴ $E_{Si} - E_F = 0.56eV$

$E_{Ge} - E_F = 0.33eV$

$E_{GaAs} - E_F = 0.71eV$

∴ $f(E_{Si}) = \frac{1}{1+\exp(\frac{E_{Si}-E_F}{K_B T})} = 3.91 \times 10^{-10}$

$f(E_{Ge}) = \frac{1}{1+\exp(\frac{E_{Ge}-E_F}{K_B T})} = 2.86 \times 10^{-6}$

$f(E_{GaAs}) = \frac{1}{1+\exp(\frac{E_{GaAs}-E_F}{K_B T})} = 1.18 \times 10^{-12}$

(b)

$1 - f(E_{Si}) = 1 - \frac{1}{1+\exp(\frac{-1.12}{2 K_B T})} = 4.42 \times 10^{-10}$

$1 - f(E_{Ge}) = 1 - \frac{1}{1+\exp(\frac{-0.66}{2 K_B T})} = 2.86 \times 10^{-6}$

$1 - f(E_{GaAs}) = 1 - \frac{1}{1+\exp(\frac{-1.42}{2 K_B T})} = 1.18 \times 10^{-12}$

3.22

∵ $N_A > N_D$ ∴ 均为P型.

对于Si: $n_0 = \frac{N_D - N_A}{2} + \sqrt{\left(\frac{N_D+N_A}{2}\right)^2 + n_i^2} \approx 1.5\times10^7\ cm^{-3}$.

$p_0 = \frac{n_i^2}{n_0} = 1.5\times10^3\ cm^{-3}$.

对于Ge, $n_0 = \frac{N_D - N_A}{2} + \sqrt{\left(\frac{N_D+N_A}{2}\right)^2 + n_i^2} = 1.7\times10^{13}\ cm^{-3}$

$p_0 = \frac{n_i^2}{n_0} = 3.3\times10^{13}\ cm^{-3}$.

对于GaAs: $n_0 = 1.5\times10^{13}\ cm^{-3}$.

$p_0 = 0.216\ cm^{-3}$.

3.24

$N_C = 2.8\times10^{19}\ cm^{-3}$ $N_V = 1.04\times10^{19}\ cm^{-3}$

$p_0 = N_V \exp\left[\frac{-(E_F - E_V)}{k_B T}\right] = 2.13\times10^{15}\ cm^{-3}$

$n_0 = N_C \exp\left[\frac{-(E_C - E_F)}{k_B T}\right] = 2.33\times10^4\ cm^{-3}$.