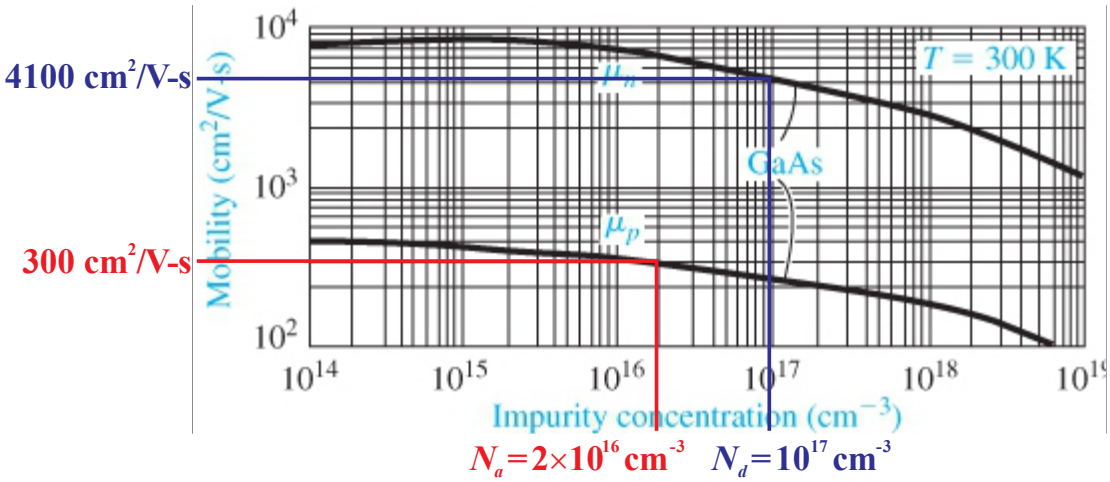
A GaAs pn junction diode at 300 K has a cross-sectional area of 5×10^{-7} m^2. The length of the p-region is 0.8 mm while the length of the n-region is 0.6 mm. The doping concentrations are $N_a = 2 \times 10^{16}$ cm^{-3} and $N_d = 10^{17}$ cm^{-3}. a) Use Figure 5.3 to get mobilities μ_n and μ_p for each region. b) Use Einstein relation to get the diffusion coefficients D_n and D_p for each region. c) Calculate conductivities σ_n and σ_p for each region. d) Neglecting the depletion layer width, find the series resistance $r_{s,n}$ and $r_{s,p}$ for each region as well as overall r_s.

a)



From Fig. 5.3, read the mobilities to be **μ_n = 4100 cm^2/V·s** and **μ_p = 300 cm^2/V·s.**

b) Using (5.47), $\dfrac{D_n}{\mu_n} = \dfrac{D_p}{\mu_p} = \dfrac{k_B T}{e} = \dfrac{8.617333\times10^{-5}(300)}{e} = 0.025852$ V.

Now, we can calculate the diffusion coefficients to be-

$D_n = 0.025852(4100) \Rightarrow$ **D_n = 106 cm^2/s** and $D_p = 0.025852(300) \Rightarrow$ **D_p = 7.76 cm^2/s.**

c) Using (5.23) $\sigma = e(\mu_n n + \mu_p p)$, calculate the conductivities for the two regions-

p-region $\sigma_p \approx e\,\mu_p p \approx e\,\mu_p N_a = 1.602176634\times10^{-19}(300\times10^{-4})2\times10^{22} \Rightarrow$ **σ_p = 96.13 S/m.**

n-region $\sigma_n \approx e\,\mu_n n \approx e\,\mu_n N_d = 1.602176634\times10^{-19}(4100\times10^{-4})10^{23} \Rightarrow$ **σ_n = 6568.92 S/m.**

d) Per (5.22b), $R = L/\sigma A$ for a conductive material. Working in MKS units-

$r_{s,\text{p-reg}} \cong L_{\text{p-region}}/(\sigma_p A) = 0.8\times10^{-3}/[96.13(5\times10^{-7})] \Rightarrow$ **$r_{s,\text{p-reg}}$ = 16.644 Ω.**

$r_{s,\text{n-reg}} \cong L_{\text{n-region}}/(\sigma_n A) = 0.6\times10^{-3}/[6568.92(5\times10^{-7})] \Rightarrow$ **$r_{s,\text{n-reg}}$ = 0.183 Ω.**

$r_s = r_{s,\text{p-reg}} + r_{s,\text{n-reg}} = 16.644 + 0.183 \Rightarrow$ **r_s = 16.827 Ω.**