Example 2.10

The hole density in an n-type silicon wafer ($N_d = 10^{17}$ cm^{-3}) decreases linearly from 10^{14} cm^{-3} to 10^{13} cm^{-3} between $x = 0$ and $x = 1$ μm. Calculate the hole diffusion current density.

Solution

The hole diffusion current density equals:

$$J_p = qD_p \frac{dp}{dx} = 1.6\times10^{-19} \times 8.2 \times \frac{9\times10^{13}}{10^{-4}} = 1.18 \text{ A/cm}^2$$

where the diffusion constant was calculated using the Einstein relation:

$$D_p = V_t m_p = 0.0259 \times 317 = 8.2 \text{ cm}^2/\text{s}$$

and the hole mobility in the n-type wafer was obtained from Table 2.7.3 as the hole mobility in a p-type material with the same doping density.