5.30 The steady-state electron distribution in silicon can be approximated by a linear function of x. The maximum electron concentration occurs at $x = 0$ and is $n(0) = 2 \times 10^{16}$ cm^{-3}. At $x = 0.012$ cm, the electron concentration is 5×10^{15} cm^{-3}. If the electron diffusion coefficient is $D_n = 27$ cm^2/s, determine the electron diffusion current density.

From (5.33), $J_{nx|dif} = e\, D_n \dfrac{dn}{dx}$.

We can approximate the derivative with the linear slope-

$$\frac{dn}{dx} \simeq \frac{\text{rise}}{\text{run}} = \frac{5\times10^{15} - 2\times10^{16}}{0.012 - 0} = -1.25\times10^{18}\ \text{cm}^{-4}$$

$$J_{nx|dif} \simeq (1.6022\times10^{-19}\ \text{C})(27\,\text{cm}^2/\text{s})(-1.25\times10^{18}\ \text{cm}^{-4}) \quad \Rightarrow \quad \underline{\boldsymbol{J_{nx|dif} = -5.41\ \text{A/cm}^2}}$$