17-2 $J_{e,diff} = eD_e \frac{dn}{dx} \approx e\bar{D}_e \frac{\Delta n}{\Delta x}$

D_e for GaAs at 300K $= 220\ cm^2 s^{-1}$

$$J_{e,diff} = (1.6 \times 10^{-19})(220)\left(\frac{1\times10^{18} - 7\times10^{17}}{0.1}\right)$$

$$= \underline{106\ A\,cm^{-2}}$$

17.3 Determine the induced electric field in a semiconductor in thermal equilibrium, given a linear variation in doping concentration.

Consider an n-type semiconductor at 300K, and

$$N_d(x) = (10^{15} - 10^{19}x) \ (cm^{-3})$$

$$E_x = -\left(\frac{k_B T}{e}\right)\frac{1}{N_d(x)}\frac{dN_d(x)}{dx}$$

Solution:

$$\frac{dN_d(x)}{dx} = -10^{19} \ (cm^{-4})$$

$$E_x = (-0.0259)\left(\frac{1}{10^{15} - 10^{19}x}\right)(-10^{19})$$

at $x = 0$: $E_x = 259$ V

small E-fields → significant drift current densities

this induced E-field from non-uniform doping → significantly affect device characteristics.

17-4

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$$\frac{D}{\mu} = \frac{k_B T}{e}$$

$$D = 0.0259 \cdot 1000$$
$$= \underline{25.9\,\mathrm{cm}^2\,\mathrm{s}^{-1}}$$