16.2

[redacted] (Drift)

Ge ; 300K ; $N_d = 0$; $N_a = 10^{16} cm^{-3}$ * ($n_i = 2.4 \times 10^{13} cm^{-3}$)

Assume complete ionisation
and electron + hole mobilities $\mu_e = 3900 cm^2 V^{-1} s^{-1}$
$\mu_h = 1900 cm^2 V^{-1} s^{-1}$

Calculate drift current density if $E = 50 V cm^{-1}$.

Solution:

Material is p-type, hence

$$p = \frac{N_a - N_d}{2} + \sqrt{\left(\frac{N_a - N_d}{2}\right)^2 + n_i^2}$$

$$\cong 10^{16} cm^{-3} \ * \qquad \text{(slide 139)}$$

$$n = \frac{n_i^2}{p} = \frac{(2.4 \times 10^{13})^2}{10^{16}} = 5.8 \times 10^{10} cm^{-3}$$

($n \ll p \sim N_a$)

$$\rightarrow \quad J_{drf} = e(\mu_n n + \mu_p p)E \cong e \mu_p N_a E$$

$$(1.6 \times 10^{-19})(1900)(10^{16})(50) = \underline{152 \ A cm^{-2}}$$

Significant drift currents induced by applying relatively small fields.
(Primarily due to majority carrier in extrinsic scs)

16·3

[redacted] For a p-type semiconductor at 300K

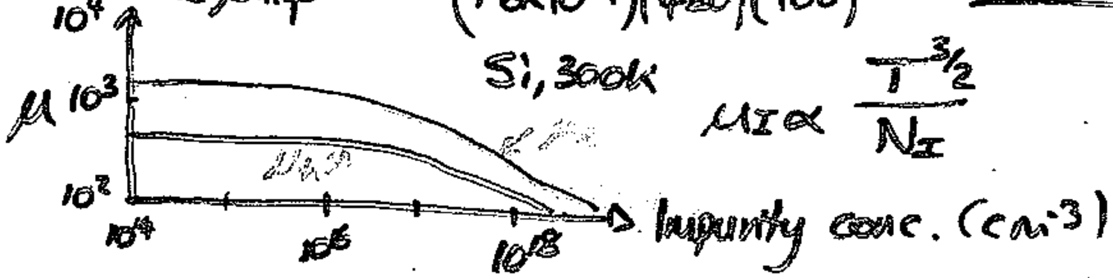
$$\rho \cong \frac{1}{e\mu_h p} = \frac{1}{e\mu_h N_a}$$

[redacted] slide 16.1

Using graph on slide 16.2, a resistivity of 100 Ωcm corresponds to low doping concentration.

∴ assume $\mu_h = 480\ cm^2 V^{-1} s^{-1}$ (slide [redacted] 15.4)

$$N_a = \frac{1}{e\mu_h p} = \frac{1}{(1.6\times10^{-19})(480)(100)} = \underline{1.3\times10^{14}\ cm^{-3}}.$$



The hole mobility for this doping concentration ($10^{14} cm^{-3}$) is essentially equal to our assumed value.

→ for high resistivity semiconductors, the mobility corresponding to a low impurity conc. is a good first approx.