

## Phys 4050 Assignment 5

1. Kronig-Penney model.
  - a) For the delta function potential and with  $P \ll 1$ , find at  $k = 0$  the energy of the lowest energy band.
  - b) For the same problem, find the band gap at  $k = \pi/a$ .
2. Ionization of donors. In a particular semiconductor there are  $10^{13}$  donors/cm<sup>3</sup> with an ionization energy  $E_d$  of 1 meV and an effective mass 0.01  $m$ .
  - a) Estimate the concentration of conduction electrons at 4 K.
  - b) What is the value of the Hall coefficient? Assume no acceptor atoms are present and that  $E_g \gg kT$ .
3. Hall effect with two carrier types. Assuming concentrations  $n, p$ ; relaxation times  $\tau_e, \tau_h$  and masses  $m_e, m_h$  show that the Hall coefficient in the drift velocity approximation is

$$R_H = \frac{1}{ec} \cdot \frac{p - nb^2}{(p + nb)^2}$$

where  $b = \mu_e / \mu_h$  is the mobility ratio. In the derivation neglect terms of order  $B^2$ . Hint: In the presence of a longitudinal electric field, find the transverse electric field such that the transverse current vanishes. You may neglect  $(\omega_c \tau)^2$  in comparison with  $\omega_c \tau$ .