1) (a)Show that the minimum conductivity of a semiconductor sample occurs when $n_0 = n_i\sqrt{\frac{\mu_p}{\mu_n}}$.
   (b)What is the expression for the minimum conductivity $\sigma_{\min}$.
   (c) Calculate $\sigma_{\min}$ for Si at 300K and compare with the intrinsic conductivity.

2) Prove that the width of the transition region in terms of the contact potential and doping concentration can be expressed by :

$$w = \left[\frac{2\varepsilon V_0}{q}\left(\frac{1}{N_a}+\frac{1}{N_b}\right)\right]^{1/2}$$

3) Aluminum is alloyed into an n-type Si sample ($N_d = 10^{16} cm^{-3}$), forming an abrupt junction of circular crass section, with a diameter of 20 mils. Assume that the acceptor concentration in the alloyed regrown region is $N_a = 4\times10^{18} cm^{-3}$. Calculate V_0, x_{n0}, x_{p0}, Q_+ and E_0 for this junction at equilibrium (300K). Sketch E(x) and charge density to scale. *Hint:* 1mil= 10^{-3} in, 1 in =2.54 cm, $\varepsilon_r = 11.8, \varepsilon_0 = 8.85\times10^{-14}\ F/cm$.

4) Discuss why the reverse current of diode depends on temperature and light density ?