Prelim 4-13-13 Problem 6 Solutions

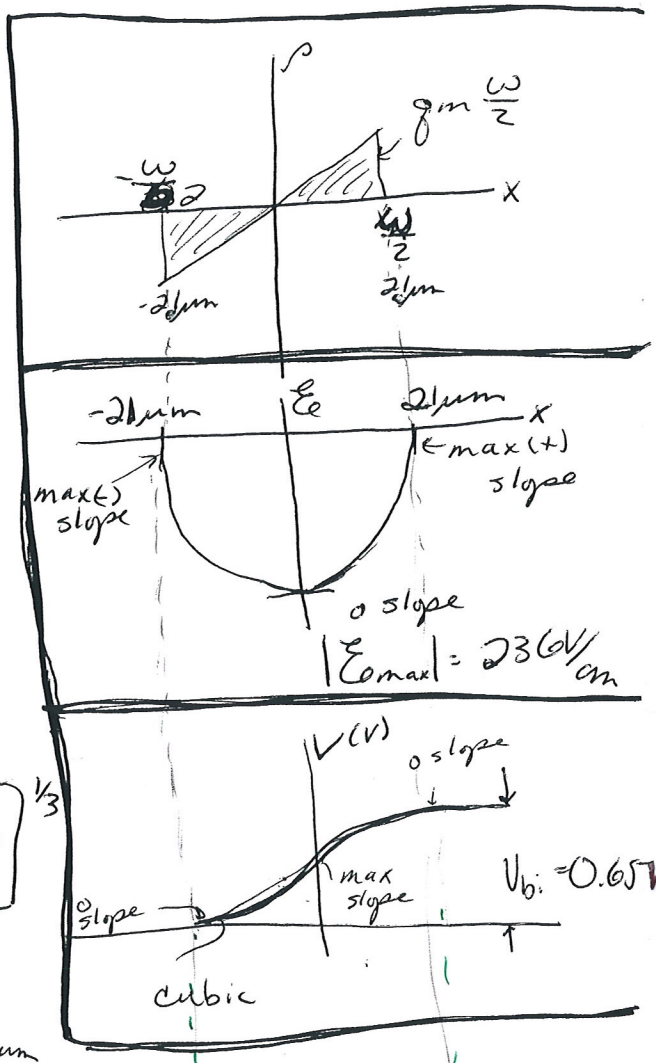
Semiconductor Devices

Linearly graded Si pn junction

$\rho(x) = q_m x$ (in depletion Zone)

$$\frac{\partial \mathcal{E}}{\partial x} = \frac{\rho}{K_s \varepsilon_0}$$

$$\mathcal{E} = \frac{q_m}{2K_s\varepsilon_0}\left(x^2 - \left(\frac{W}{2}\right)^2\right) \quad \text{quadratic}$$



$$\frac{\partial V}{\partial x} = -\mathcal{E} \quad \text{so}$$

$$V = \frac{q_m}{6K_s\varepsilon_0}\left[2\left(\frac{W}{2}\right)^3 + 3\left(\frac{W}{2}\right)^2 x - x^3\right]$$

$$= 0.65V \text{ @ } x = \frac{W}{2}$$

$$W = \left[\frac{12(11.8)(8.85\cdot10^{-14}\,F/m)}{(1.6\cdot10^{-19})(7\cdot10^{14}\,cm^{-4})}(0.65V)\right]^{1/3}$$

$$\boxed{W = 4.2\mu m \quad (4.2\cdot10^{-3}\,cm)}$$

$$|\mathcal{E}_{max}|_{x=0} = \frac{(1.6\cdot10^{-19})(7\cdot10^{14}\,cm^{-4})}{2(11.8)(8.85\cdot10^{-14})}\left(\frac{W}{2}\right)^2 = 236\,V/cm \quad \left(\frac{W}{2} = 4.2\mu m\right)$$