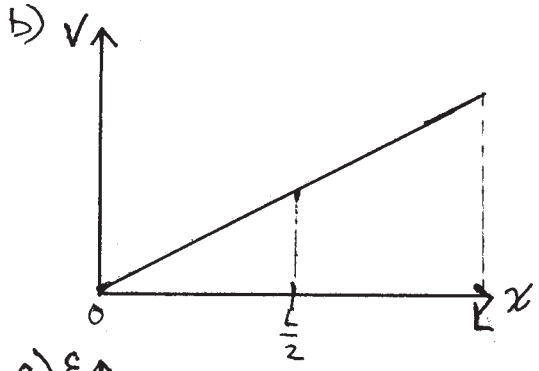
ECE113A: Section A
Homework #3
Solutions & Grading Criteria

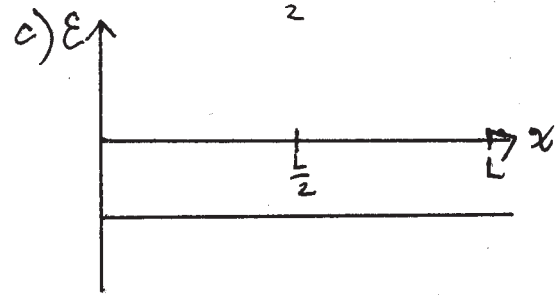
1) a) Yes since E_F remains constant relative to position.
↳ must mention E_F being constant to receive 5 pts

b)



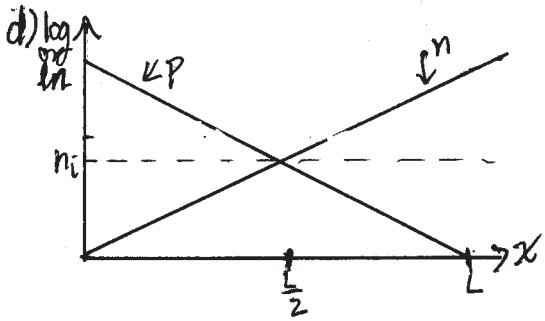
5pts as long as it is linear with a positive slope

c)



5pts if constant and negative

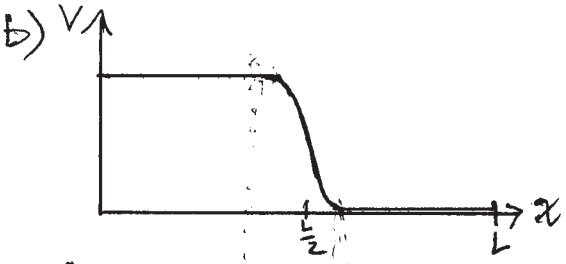
d)



2pts for n: middle of curve should cross p at $\frac{L}{2}$
3pts for n: must have positive slope
2pts for p: middle of curve should cross n at $\frac{L}{2}$
3pts for p: must have negative slope
*no credit if not in log or ln scale

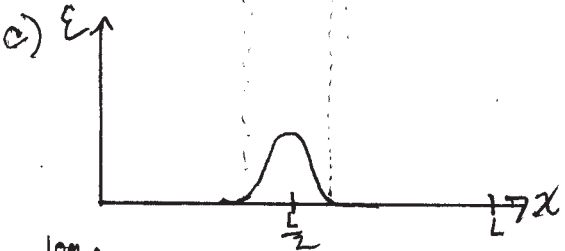
2) a) Yes since E_F remains constant relative to position.
↳ same criteria as 1a)

b)



5pts: must have correct shape

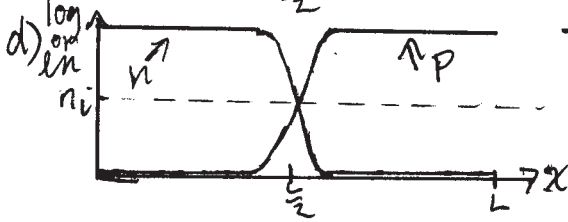
c)



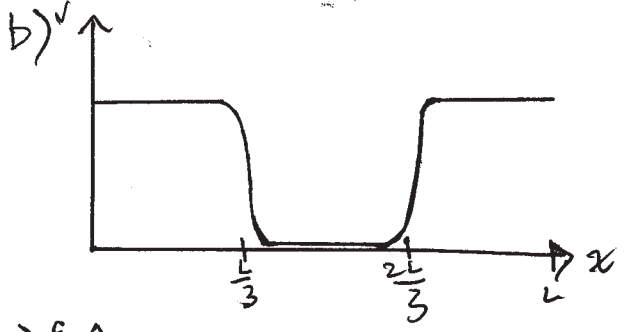
5pts: correct shape and should be approximate width of change seen in V curve

3pts for n: have correct shape
3pts for p: have correct shape
2pts for n: middle of curve should cross p at $\frac{L}{2}$
2 pts for p: middle of curve should cross n at $\frac{L}{2}$
*no credit if not in log or ln scale

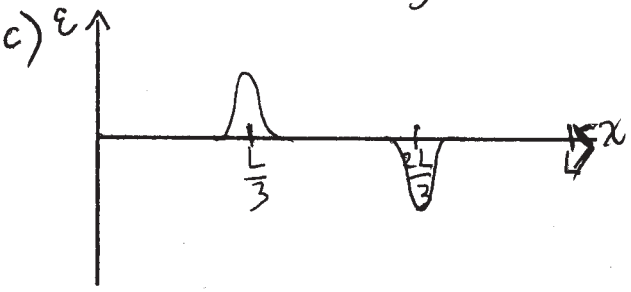
d)



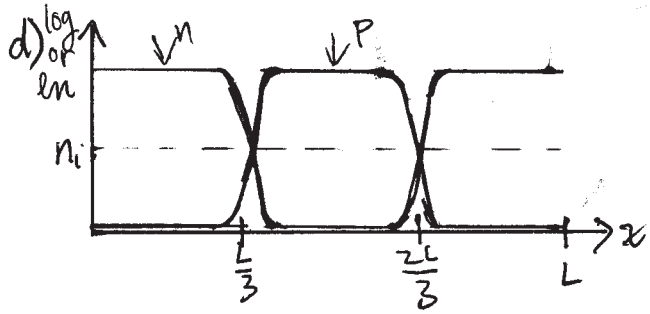
3) a) Yes since E_F remains constant relative to position
↳ same criteria as 1a)

b) 

5pts for shape

c) 

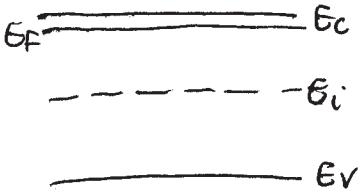
5pts: must have correct positive and negative portions & width of ε curves should be approximately equal to widths of change seen in V curve

d) 

2pts for n: must cross p curve at $\frac{L}{3}$ & $\frac{2L}{3}$
2pts for p: must cross n curve at $\frac{L}{3}$ & $\frac{2L}{3}$
3pts for n: correct shape
3pts for p: correct shape
* no credit if not in log or ln scale

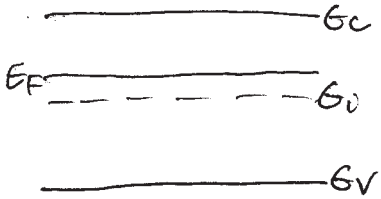
4) $N_C = (2.51\times10^{19}/cm^3)(m_n^*/m_0)^{3/2} = 2.51\times10^{19}/cm^3)(1.18)^{3/2} = 3.217\times10^{19}/cm^3$
$N_V = (2.51\times10^{19}/cm^3)(m_p^*/m_0)^{3/2} = 2.51\times10^{19}/cm^3)(.81)^{3/2} = 1.830\times10^{19}/cm^3$
$E_C - E_F = -kT\ln\frac{n}{N_C}$
$E_V - E_F = kT\ln\frac{p}{N_V} = (E_G - E_F) - E_G$
↳ $E_C - E_F = E_G + kT\ln\frac{p}{N_V}$

a) $E_C - E_F = -(.0259eV)\ln\left(\frac{10^{17}}{3.217\times10^{19}}\right) = \boxed{.14\text{-}.15\ eV}$ 3pts



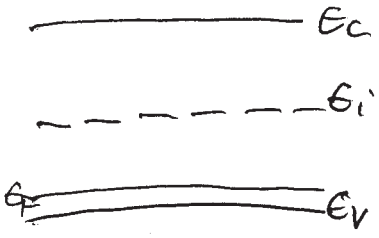
2pts: E_F must be closer to E_C than E_i

b) $E_C - E_F = -(.0259eV)\ln\left(\frac{10^{15}}{3.217\times10^{19}}\right) = \boxed{.26\text{-}.27\ eV}$ 3pts



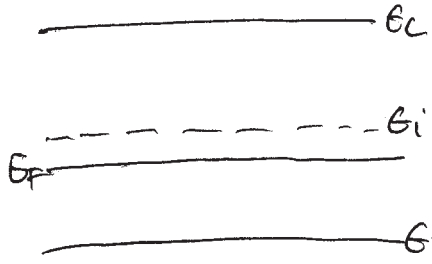
2pts: E_F must be closer to E_i than E_C

c) $E_c - E_F = 1.12eV + (.0259eV)\ln\left(\frac{5\times10^{17}}{1.82974\times10^{19}}\right) = \boxed{1.0-1.1eV}$ 3pts



2pts: E_F must be closer to E_v than E_i

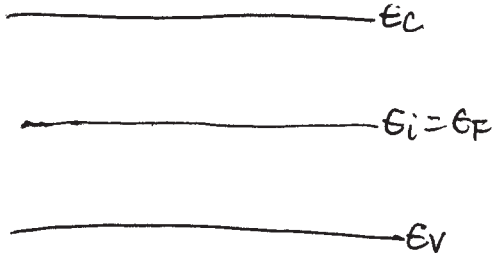
d) $E_c - E_F = 1.12eV + (.0259eV)\ln\left(\frac{10^{14}}{1.82974\times10^{19}}\right) = \boxed{.80-.81eV}$ 3pts



2pts: E_F must be closer to E_i than E_v

e) $E_c - E_F = -kT\ln\frac{n}{N_c} = -kT\ln\frac{n_i}{N_c} = -(.0259eV)\ln\left(\frac{10^{10}}{3.217\times10^{19}}\right)$

$= \boxed{.565-.570eV}$ 3pts



2pts: approximately in the middle, but should be slightly closer to E_v (do not mark off if in center)