EECS170A Fall2006 Final Exam Solution

12/5/2006 4:00 to 6:00pm

Professor Peter Burke

PROBLEM ONE: (32 points)

A) D — V has the same shape as the bands except it's upside-down.

B) E — Electric field = dE/dx, i.e. proportional to the slope of the bands.

C) A — E_F is constant.

D) C — $E_F - E_V < 3KT$ near x = L.

E) B or D — $E_i - E_F = E_i / 2 - E_i / 3 = E_i / 6$

$p = n_i \exp[(E_i - E_F)/ KT]$

$= 10^{10}$ e [1.12/(6x0.0259)]

$= 1.35 \times 10^{13}/cm^3$

Since no calculators allowed, hence we accept answer D as correct answer, although B is the correct answer.

F) A — Under equilibrium, $J_N = 0$

G) B — $J_{Pldrift} = q\mu_p p\varepsilon = q\mu_p p \times (1/q.dE/dx) = E_G / qL$

H) C — K.E. = E_V (L) – $E_{Hole} = E_G / 3$

Grading criteria: 4 points for each correct answer.

PROBLEM TWO: (36 points)

Question	True	False
A		x
B	x	
C		x
D	x	
E	x	
F		x
G	x	
H	x	
I		x

Grading criteria: 4 points for each correct answer.

PROBLEM THREE: (8 points)

The diode is forward biased.

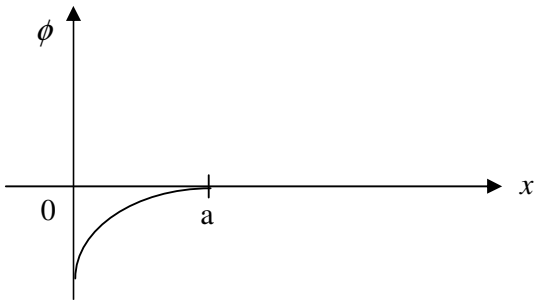
It's because $p_n(x = x_n) > p_{n0} = n_i^2/N_D$ and $n_p(x = -x_p) > n_{p0} = n_i^2/N_A$. That is, there are accumulations of minority carriers at the edges of the depletion region.

Grading criteria: - 4pts for stating "forward biased".

- No credits for answers just mentioning the energy band diagram.
- No credits for just mentioning current flow but not the carriers.
- No credits for just mentioning p_p and n_n only.
- 3 pts for mentioning increases in p_n and n_p, but did not mention at the edges of the depletion region.
- 4 pts for mentioning increases in p_n and n_p at the edges of the depletion region.
- 2 pts for only mentioning diffusions of electrons and holes across the depletion region to the other side of the junction.
- 2 pts for stating p_n increases, but n_p decreases.

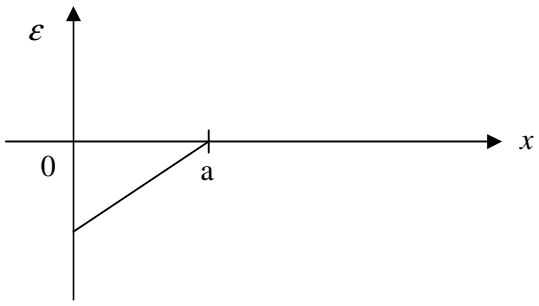
PROBLEM FOUR: (24 points)

A)



2 pts for correct shape
1 pt for correct polarity
1 pt for $\phi = 0$ *for* $x > a$

B)



2 pts for correct shape
1 pt for correct polarity
1 pt for $\varepsilon = 0$ *for* $x > a$

C) A EF is constant

D) B or C or A

Since no calculators allowed, hence we accept answer A and C as correct answers, although B is the correct answer.

E) C
F) B

Grading criteria: 4 points for each correct answer.