ASSIGNMENT 9 - SOLUTIONS

Soln. by Debdeep Jena

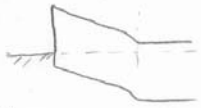
EE 566 - SOLID STATE DEVICES

(Note: I did not include soln. for problem 3 - it was more open-ended)

PROBLEM I - Solution in textbook, PG 194 - 203, SHUR.

a) Use Maxwell-Boltzmann-distribution of electron velocities

Schottky



Mott

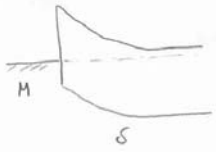
$$J_{S\to M} - J_{M\to S} = J = J_0\left(e^{\frac{qV_a}{kT}} - 1\right)$$

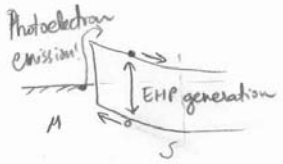
$$J_0 = A^* T^2 e^{-q\phi_B/kT}$$

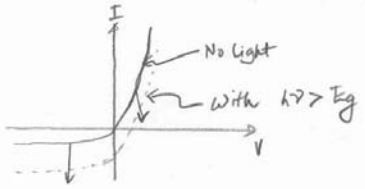
$$\frac{4\pi q m^* k_B^2}{h^3} \approx 120\left(\frac{m^*}{m_0}\right) \frac{A}{cm^2 K}$$

b) Because thermionic emission current depends only on the barrier-height, which is the same in corresponding Schottky & Mott barriers.

c)



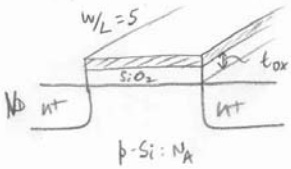




⇒ Acts like a photodetector.

PROBLEM II

a)



b) $R = \rho\frac{L}{A} = \rho\frac{L}{W \cdot t_{inv}}$

$\rho = \frac{1}{q\mu_n n}$ ∴

$R = \frac{1}{\mu_n Q_n}\cdot\frac{W}{L}$

$$\Rightarrow \boxed{\frac{Q_n}{q} = \frac{1}{q}\cdot\frac{1}{R\cdot\mu_n\left(\frac{W}{L}\right)} \approx 4.2\times10^{12}/cm^2}$$

In strong inversion,

c) $Q_n \approx C_{ox}(V_G - V_T)$

$\Uparrow$ $\Uparrow$

$q\cdot 4.2\times10^{12}/cm^2$ $\frac{\epsilon_{ox}}{t_{ox}}$

$$\Rightarrow \boxed{V_G - V_T \approx 3.9\ Volts}$$