ECE 5205 Spring 2014 HW#2 2-11-2014 turn in 2-20-2014 during the lecture

1) Determine the ideal reverse saturation current density in a Si junction at T=300K. Consider following parameters: $N_a=N_d=1x10^{16}$ $cm^{-3}$, $n_i=1.5 \times 10^{10}$ $cm^{-3}$, $D_n=25$ $cm^2/sec$, $D_p=10$ $cm^2/sec$; $t_{p0}=t_{n0}=5x10^{-7}$ sec, and $\varepsilon_r=11.7$; What would be the total current if the pn junction cross sectional area were $A=10^{-4}cm^2$.

2) Potential difference and average electric field in non-uniformly doped semiconductor: Assume that in Si semiconductor the doping is gradually increasing from right to left. At $x_1=1\mu m$ the dopant concentration is $N_1=5x10^{15}$ $cm^{-3}$ and at $x_2=2\mu m$ $N_2=7x10^{16}$ $cm^{-3}$. Find what is the potential difference between $x_1$ and $x_2$? What is the average electric field between $x_1$ and $x_2$?

3) Band-to-band tunneling of 10 mA flows across a silicon pn junction of $10^{-5}$ $cm^2$ cross-section. Assume $N_v=10^{22}$ $cm^{-3}$ and $v_{therm}=10^7 cm/sec$. What is the tunneling probability? What is the electrical field in the junction and what is the width L of the triangular barrier?

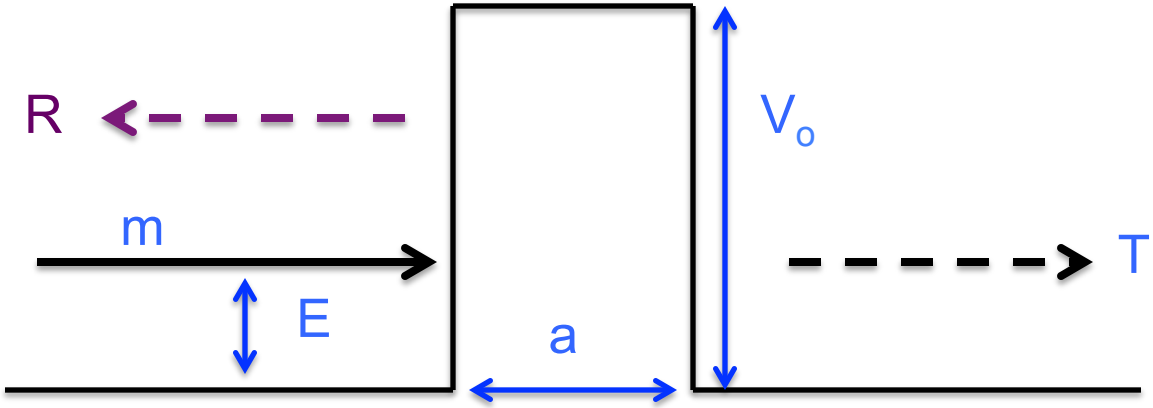
4) The quantum mechanical formula for electron tunneling probability T to tunnel through a rectangular barrier is given by the formula given below. Assume a mass of a free electron. The barrier height of the barrier is $V_o$=10 eV. The thickness of the barrier a is a) 5 nm and b) 1 nm. The kinetic energy of the electron is E=7 eV

(a) Calculate what is the tunneling probability for a=5 nm and 1nm

(b) Calculate what is the reflection coefficient R (R=1-T) for a=1 nm

(c) Calculate the tunneling probability for a=1 nm when the kinetic energy of electron is E=3 eV

(d) Summarize your observations resulting from these calculations




$$T = T_o \exp(-2\alpha a)$$

$$\alpha = \sqrt{\frac{2m(V_o - E)}{(h/2\pi)^2}}$$

$$T_o = \frac{16E(V_o - E)}{V_o^2}$$