1. A planar p-n junction has 7E15/cm³ phosphorous doping on one side and 3E18/cm³ boron on the other side. The p-side is 0.5E-4 cm thick and the n-side is 5E-4 cm thick. a. First, solve for the zero-voltage depletion thickness.

\[ W = \frac{\sqrt{4V + \sqrt{16V^2 + 4d_n^2}}}{2d_n} \]

b. Next, find the dimension of the charge-neutral region on the n-side for zero-voltage.

\[ x_{n,CNR} = \frac{d_n}{2} \]

c. Next, find the dimension of the charge-neutral region on the p-side for zero-voltage.

\[ x_{p,CNR} = \frac{d_p}{2} \]

d. Next, find the minority carrier diffusion length on the n-side.

\[ L_n = \sqrt{\frac{\tau_{min}}{q_i N_i^2}} \]

e. Next, find the minority carrier diffusion length on the p-side.

\[ L_p = \sqrt{\frac{\tau_{min}}{q_i N_p^2}} \]
e. [5] L
= ____________________.
f. Next, find the saturation current density for hole diffusion.

s,p = ____________________.
g. Next, find the saturation current density for electron diffusion.

g. [5] J
s,n = ____________________.
h. Next, find the minority carrier concentration at the n-edge of the depletion region when V_a = 750 mV.

h. [5] p_n(0) = ____________________.
i. Next, find the minority carrier concentration at the p-edge of the depletion region when V_a = 750 mV.

i. [5] n_p(0) = ____________________.
j. Next, find the diode current density when V_a = 600 mV.
2. An ideal n-Si ($N_d = 3E16$) to gold Schottky-barrier diode is to be analyzed.  

a. First, calculate the barrier for flow of electrons from the metal into the silicon.

$$ \phi_{bn} = \text{______________} $$

b. Next, calculate the barrier for flow of electrons from the silicon into the metal.

$$ V_{bi} = \text{______________} $$

c. Next, calculate the electron concentration at the metal-silicon interface.

$$ n_s = \text{______________} $$

d. Next, calculate the zero-volt depletion width.
d.[5] W = ________________.

3. A planar npn bipolar junction transistor is to be fabricated with the following parameters:
   - emitter charge neutral width = 0.5E-4 cm, \( N = N_d - N_a = 1E18 \text{ cm}^3 \),
   - base charge neutral width = 0.5E-4 cm, \( N = -1E16 \text{ cm}^3 \), and
   - collector charge neutral width = 2E-4 cm, \( N = 1E15 \text{ cm}^3 \).

(Unless otherwise directed, assume the same width values for all biases.)

f. First, calculate the emitter efficiency.

a.[5] \( \gamma = \______________ \).  
b. Next, calculate the base transport factor.

b.[5] \( \alpha_T = \______________ \).  
c. Next, calculate the base transit time.

c.[5] \( \tau_T = \______________ \).  
d. Next, calculate the base-emitter voltage for the onset of high level injection of minority carriers into the base.

d.[5] VKF = ________________.