Problem 1 [11 points]
The equilibrium energy band diagram for a rectifying metal-Si contact is shown below. $T = 300K$.

![Energy Band Diagram](image)

a) What is the value of the Schottky barrier height, $\Phi_B$? **Indicate it on the band diagram above.** [3 pts]

b) What is the width of the depleted region, $W$? [4 pts]

\[
\sqrt{\frac{10}{1.6}} = 2.5 \\
\sqrt{\frac{1}{1.6}} = 0.8
\]

d) Carefully sketch $E_v$ **corresponding to a reverse bias of 0.25 V** on the band diagram above. [2 pts]
e) Explain how this contact can be made to be practically ohmic. [2 pts]
Problem 2 [8 points]
Consider the following charge density distribution for a Schottky diode under reverse bias:

\[ \rho \text{(C/cm}^3\text{)} \]

\[ \mathcal{E} \text{(V/cm)} \]

1.6\times10^{-3}

0

1.0

x (\mu m)

a) Sketch the electric field distribution on the axes provided. Indicate the numerical value of \( \mathcal{E} \) at \( x = 0 \).

[5 pts] (Note that Coulomb = Farad \times Volt)

b) If the cross-sectional area of this diode is 1 mm \times 1 mm, what is its small-signal capacitance? [3 pts]

Problem 3 [6 points]
The equilibrium energy band diagram for a uniformly doped Si sample with minority-carrier lifetime \( \tau_n = 10^{-6} \text{s} \) is shown below. Suppose this sample is illuminated uniformly with light beginning at time \( t = 0 \), generating electron-hole pairs at a rate \( G_L = 10^{19}/\text{cm}^3/\text{s} \) throughout the sample, so that the excess carrier concentration increases with time as shown below.

\[ \Delta n(t) = \Delta p(t) \]

\[ 0.36 \text{ eV} \]

\[ kT \ln(10) = 0.06 \text{ eV} \]

a) Indicate the final positions of the electron and hole quasi-Fermi levels \( (F_N \text{ and } F_P, \text{ respectively}) \) in this sample \((i.e. \text{ at } t = \infty)\). [4 pts] \( kT \ln(10) = 0.06 \text{ eV} \)

b) Indicate on the plot above how \( \Delta p_n(t) \) would change if \( G_L \) were to be increased. [2 pts]