

QE Semiconductor : Electronic devices (40 points)

Physical Constants

Electronic charge, $q=1.6 \times 10^{-19} \text{C}$

$\epsilon_0 = 8.85 \times 10^{-14} \text{F/cm}$

Relative Dielectric constant of Si $\epsilon_{r,\text{Si}} = 11.8$ Relative Dielectric constant of SiO_2 $\epsilon_{r,\text{SiO}_2} = 3.9$

1. (MOSFET) Supposed an ideal nMOSFET is operated at room temperature. Using the square-law results,
 - a) (10 pts) when $V_D > 0$ and $V_G - V_D = V_T/2$: derive the I_D equation and sketch the inversion layer and depletion region inside the MOSFET with labeling all parts of the device.
 - b) (10 pts) when $V_D > 0$ and $V_G - V_D = 2V_T$: repeat (a)
2. (BJT) Consider a pnp BJT where $I_{Ep} = 1 \text{mA}$, $I_{En} = 0.01 \text{mA}$, $I_{Cp} = 0.98 \text{mA}$, and $I_{Cn} = 0.1 \mu\text{A}$. Calculate
 - a) (10 pts) γ and I_B
 - b) (10 pts) β