HW 11.

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The integral term $\int_0^\infty dE_{xy} f_{FD}(E_{xy}+E_{z,n})$ is indeed $\int_0^\infty dE_{xy} f_{FD}(E_{xy}+E_{z,n}-E_F)$.

$$\therefore \int_0^\infty dE_{xy}\frac{1}{1+\exp\left(\frac{1}{k_BT}(E_{xy}+E_{z,n}-E_F)\right)} = k_BT\int_0^\infty de_{xy}\frac{1}{1+\exp\left(e_{xy}-\frac{1}{k_BT}(E_F-E_{z,n})\right)}$$

$$= k_BT\ln\left[1+\exp\left(\frac{1}{k_BT}(E_F-E_{z,n})\right)\right]$$

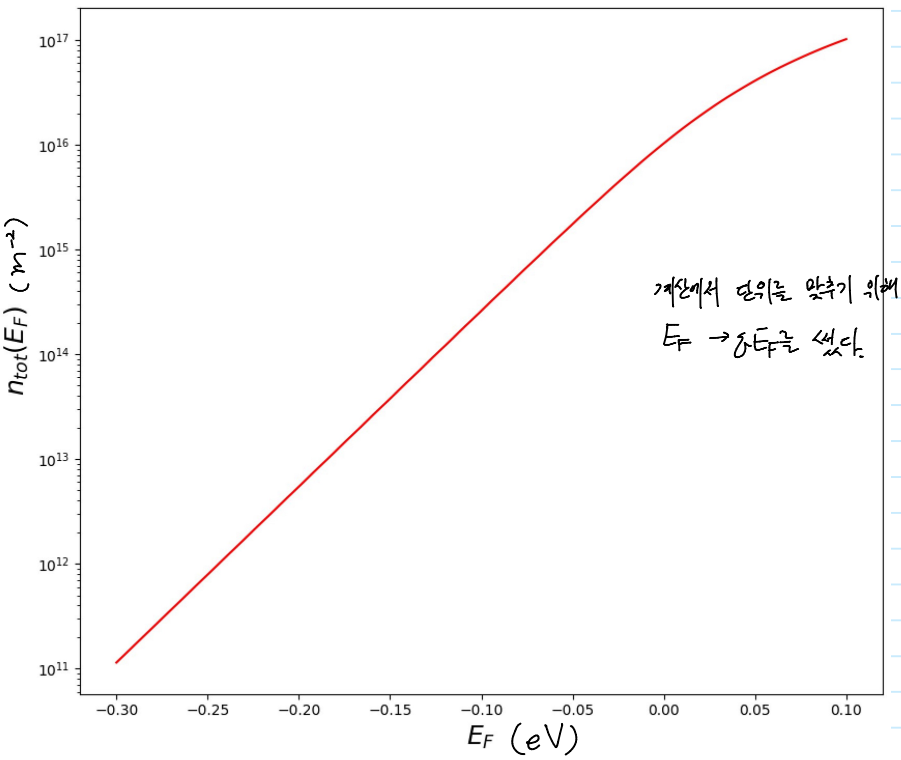
\# of electrons for a subband (per spin) N_n is,

$$N_n = \frac{L_xL_y}{2\pi}\cdot\frac{m_d}{\hbar^2}k_BT\ln\left(1+e^{\frac{1}{k_BT}(E_F-E_{z,n})}\right) \quad \text{where } E_{z,n}=\frac{\hbar^2\pi^2n^2}{2m_{zz}L_z^2},\ m_d=\sqrt{m_{xx}m_{yy}}$$

Total electron density $n_{tot}(E_F) = 2\sum_{n=1}^{\infty}\frac{1}{2\pi}\cdot\frac{m_d}{\hbar^2}k_BT\ln\left(1+e^{\frac{1}{k_BT}(E_F-E_{z,n})}\right)$

Results

$m_{xx}=m_{yy}=0.19\,m_e$, $m_{zz}=0.91\,m_e$, $L_z = 5$ nm, $T=300$K



계산에서 단위를 맞추기 위해 $E_F \to qE_F$를 썼다.