Area: Solid State Devices

Problem 1: A one-dimensional (1D) nanowire has a E-k relation of \( E = \alpha k^2 \).

(a) What is the effective mass? The answer should be expressed in terms of \( \alpha \), and the reduced Planck constant \( \hbar \). (50%)

(b) What is the density-of-states (DOS) as a function of energy \( E \)? The answer should be expressed in terms of \( \alpha \). (50%)

Problem 2: A silicon sample is doped by As atoms to a doping density of \( N_D = 10^{16}/cm^3 \) at room temperature.

(a) What are the electron and hole densities? (50%)

(b) What is the Fermi level position in eV in reference to \( E_i \), where \( E_i \) is the intrinsic energy level. (50%)

(Hint: The intrinsic carrier density of silicon at room temperature is \( n_i = 10^{10}/cm^3 \), and the thermal energy at room temperature is \( k_BT \approx 26\text{meV} \).)