Problem 1: Electrons at the Fermi edge  

Determine for the metal copper the fraction of electrons whose energy at room temperature \( T \ll T_F \) is larger than \( E_F - 2k_B T \). Here, \( T_F(Cu) = 8.1 \cdot 10^4 \text{K} \).

Problem 2: Cyclotron mass  

An electron follows the semi-classical equation of motion

\[
M \ddot{\mathbf{v}} = -e(\mathbf{v} \times \mathbf{B}),
\]

where \( M \) is the effective mass tensor, and \( \mathbf{B} \) a homogeneous magnetic field along the \( z \) axis. Show that the equation of motion has the periodic form

\[
\mathbf{v} = \mathbf{v}_0 \exp(-i\omega t),
\]

with

\[
\omega = \omega_c = eB/m_c
\]

and

\[
m_c = \left[ \frac{\text{Det}M}{M_{zz}} \right]^{1/2}
\]

as effective cyclotron mass tensor.

Problem 3: Heavy and light holes

A non-degenerate semiconductor is described by a parabolic conduction band (effective electron mass: \( m_n \); minimum energy at \( k = 0 \): \( E_C \)) and two parabolic valence bands (effective hole masses: \( m_+ \) and \( m_- \); maximum energy of both bands at \( k = 0 \): \( E_V \)). Calculate the concentration of heavy and light holes \( (p_+ \) and \( p_- \)) from the neutrality condition \( n = p_+ + p_- \).