Consider a silicon pnp transistor with the following characteristics:

Acceptor density of emitter: \( N_E = 3.9 \times 10^{17} \text{cm}^{-3} \)
Diffusion coefficient of electrons in the emitter: \( D_E = 5.18 \text{cm}^2\text{sec}^{-1} \)
Diffusion length of electrons in the emitter: \( L_E = 22.8 \times 10^{-4} \text{cm} \)
Width of the base: \( W = 4 \mu\text{m} \)
Diffusion length of holes in the base: \( L_B = 46.9 \times 10^{-4} \text{cm} \)
Diffusion coefficient for holes in the base: \( 22 \text{cm}^2\text{sec}^{-1} \)
Donor density of base: \( N_B = 1.57 \times 10^{16} \text{cm}^{-3} \)
Diffusion length of electrons in the collector: \( L_C = 39.5 \times 10^{-4} \text{cm} \)
Diffusion coefficient for holes in the collector: \( 15.6 \text{cm}^2\text{sec}^{-1} \)
Acceptor density of collector: \( 2 \times 10^{14} \text{cm}^{-3} \)
Area of transistor: \( 1.265 \times 10^{-4} \text{cm}^2 \)

1. Sketch the band diagram in equilibrium.

2. Ignoring recombination-generation in the space-charge region, find the emitter injection efficiency \( \gamma \), the base transport factor \( \alpha_T \), the common-base DC current gain \( \alpha \), and the common-emitter DC current gain \( \beta \).

3. Find the Ebers-Moll coefficients for this device and plot \( I_C \) versus \( V_{EC} \) (the common-emitter I-V characteristic) for \( I_B = 0.5 \mu\text{A}, 1.0 \mu\text{A}, 1.5 \mu\text{A}, 2 \mu\text{A} \).