

Semiconductor Device Theory: BJT – Theoretical Exercise

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1. Express the h-parameters in a common emitter configuration in terms of the h-parameters in a common-base configuration.
2. (a) Plot the energy-band diagram of an *npn*-transistor in forward-active mode, clearly indicating the major components to the emitter, collector and base currents.
(b) Describe schematically the Early effect and how it modulates the output characteristics of the BJT in a common-emitter configuration.
3. Determine the expression for the excess electron concentration as a function of position x in an *npn* BJT. Assume that $\Delta n_E(0) = n_B \left(e^{V_{BE}/V_T} - 1 \right)$ and $\Delta n_C(W_B) = n_B \left(e^{V_{BC}/V_T} - 1 \right)$. Note that n_B is the equilibrium electron concentration within the base, Δn_E is the excess electron concentration at the edge of the emitter-base depletion region and Δn_C is the excess electron concentration at the edge of the collector-base depletion region. Assume that the collector junction is strongly reverse biased and that the equilibrium electron concentration is negligible with respect to the electron concentration injected for the emitter.