

Homework 11 (optional extra credit)

EE 362 Electronic, Magnetic, & Optical Properties of Materials (Spring 2026)

Friday, May 1, 2026

- 1) 12.3 with $D_n = 22 \text{ cm}^2/\text{s}$ and $x_B = 1 \text{ }\mu\text{m}$.
- 2) 12.5ab with $\alpha = 0.988$. Use modified 12.3 parameters.
- 3) 12.11
- 4) At 300 K, a silicon npn bipolar junction transistor (BJT), with each region uniformly doped, has the following parameters:

$N_E = 10^{18} \text{ cm}^{-3}$	$N_B = 5 \times 10^{16} \text{ cm}^{-3}$	$N_C = 10^{15} \text{ cm}^{-3}$
$D_E = 7.6 \text{ cm}^2/\text{sec}$	$D_B = 13.6 \text{ cm}^2/\text{sec}$	$D_C = 10.4 \text{ cm}^2/\text{sec}$
$\tau_{E0} = 11 \text{ ns}$	$\tau_{B0} = 42 \text{ ns}$	$\tau_{C0} = 94 \text{ ns}$
$x_E = 1.2 \text{ }\mu\text{m}$	$x_B = 0.75 \text{ }\mu\text{m}$	$x_C = 110 \text{ }\mu\text{m}$

Also, $A_{BE} = 5 \times 10^{-3} \text{ cm}^2$, $V_{BE} = 0.68 \text{ V}$ and $V_{CE} = 5 \text{ V}$. Then:

- a) Find the thermal equilibrium minority carrier concentrations p_{E0} , n_{B0} , and p_{C0} .
- b) Calculate the diffusion length and fractional length (e.g., x_C/L_C) of each region.
- c) Find the current densities J_{nE} and J_{pE} as well as the emitter current I_E (mA). What fraction of I_E is due to electrons?
- d) Calculate V_{bi} and x_{BE} .
- e) Find the current density constants J_{s0} and J_{r0} .
- f) Find the approximate base transport factor α_T , emitter injection efficiency γ , and recombination factor δ .
- g) Find the approximate common-base α and common-emitter β current gains.
- h) Find the collector I_C (mA) and base I_B (mA) currents.

Due Wednesday, May 6, 2026 at my office or EECS mail box by 2 pm.

Notes:

- If completed, this extra credit opportunity will replace your *lowest counting* HW or quiz grade (as best advantages your overall grade).
- There will be at least one question dealing with this material on the final exam.
- Read *Note* on page 560.
- Carry *at least* 6 significant figures on constants/parameters in calculations. Give answers with 4-5 significant figures.
- If a solution requires the use of a graph, include the graph with work shown.