

ECSE-2210 Microelectronics Technology
Homework 7

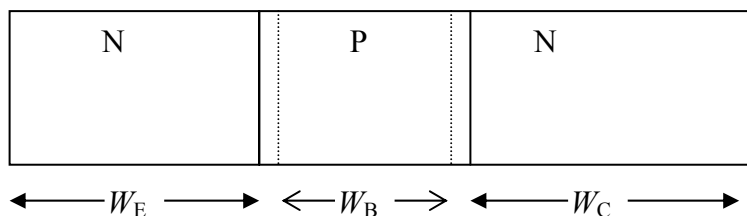
Reading List: Chapter 10, Chapter 11 (pages 389 - 403)

1. Consider an npn transistor with doping concentration and dimensions shown below.

Answer the following questions.

- a. If $V_{BC} = 0$, and $I_C = 1$ mA, what is value of V_{BE} ?
- b. With the transistor biased as in (a), what is the component of the base current due to recombination in the base region?
- c. With the transistor biased as in (a), what is the component of the base current due to injection of holes into the emitter region?
- d. What is the value of the emitter injection efficiency, γ ?
- e. What is the value of the base transport factor, α_T ?
- f. What is the value of the common emitter current gain, β_{dc} ?
- g. If V_{BE} is held constant at the value found in (a), and the collector-to-base voltage is increased so as to reduce the width of the neutral base region, W_B , to 10^{-4} cm, what is the common emitter current gain, β_{dc} now? Note that this is called “base width modulation” (also called “Early effect”) which is common in narrow base-width transistors.

Area $A = 1$ cm²



| | <u>Emitter</u> | <u>Base</u> | <u>Collector</u> |
|----------------------------------------------|--------------------|-------------|--------------------|
| <i>Doping conc.</i> (cm ⁻³) | 5×10^{18} | 10^{16} | 5×10^{18} |
| <i>W</i> (μm) | 10 | 2 | 10 |
| <i>Lifetimes</i> (s) | 10^{-9} | 10^{-7} | 10^{-9} |
| <i>Elect. mobility</i> (cm ² /Vs) | 120 | 1000 | 120 |
| <i>Hole mobility</i> (cm ² /Vs) | 75 | 300 | 75 |