MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.012
Microelectronic Devices and Circuits

Fall 1999
November 5, 1999 - Homework 7
Due November 12, 1999

Reading: Chapter 7 Section 7.1 - 7.5
Chapter 8 all except 8.7

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1. An npn transistor with emitter area A_E = 5 µm X 5 µm is biased in the forward active region, with the collector current I_C = 25 µA. The emitter and base dimensions and doping are: $N_{dE} = 10^{19}$ cm–3,
W_E = 0.3 µm, $N_{aB} = 10^{17}$ cm–3, and W_B = 0.25 µm.

(a) Sketch the minority carrier concentrations in the emitter and base.

(b) Find the base-emitter bias V_{BE}.
(c) Find the base current I_B.

2. Given the npn transistor with the parameters and operating point above, with the additional information that V_{An} = 25 V.
(a) Find the transconductance g_m.
(b) Find the input resistance r_π.
(c) Find the output resistance r_o.

3. Given the npn transistor with the parameters and operating point above, with the additional information that the emitter-base depletion width is x_{BE} = 0.05 µm.

(a) What is the minority electron charge storage $Q_{NB}(V_{BE})$ at this operating point?
(b) What is C_π at this operating point?
(c) At what frequency does $|1/j\omega C_\pi| = r_\pi$?

4. H & S P7.6

5. H & S E8.8

6. H & S E8.12