MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Department of Electrical Engineering and Computer Science

6.301 Solid State Circuits

Fall 2013 — Issued : Dec 10, 2013

Problem Set 9 — Due : Not due

Problem 1: In this problem, a transistor is controlled by supplying a base current drive as seen in Figure 1. Analyze the dynamics of the transistor and sketch q_F, q_S, i_C, and i_B versus time. Each sketch should clearly indicate important slopes, final values, time constants, etc. Read this whole problem before starting to solve the first part.

1. Assume that the transistor remains in the forward active region. Determine the time constants and final values etc, and sketch the curves.

2. Since $\beta_F i_B > i_{C_{SAT}}$, the device will not remain in the forward active region for all time. Indicate on your graphs the point at which saturation occurs. Find q_{BO}, the final values (in saturation) for i_C and q_S and evaluate the time constant τ_S. Continue the sketches. How long does it take to traverse the active region?

3. Now consider turning off the device, $i_B = 0$. Assume that athe transistor remains saturated, that is $i_C = i_{C_{SAT}}$ for all time. Determine the final values for q_S and sketch the curves.

4. Obviously, the transistor does not remain saturated but enters the forward active region when q_S equals zero. Determine the storage delay time, that is, the time during which the device remains saturated even though $i_B = 0$. Determine the time spent crossing the active region. Sketch the curves.

5. Compare turn-on times and turn-off times: explain the difference.

6. It is observed that the storage delay time decreases if the input pulse duration is reduced. Explain.

Problem 2: Charge Control

1. Sketch q_F, q_S, i_C, and i_B versus time for the circuit shown in Figure 2.

2. Now assume that you are free to choose the capacitor value. what value should be chosen so that final conditions for both the turn on and the turn off transient are established as quickly as possible?