Introduction to Computer Engineering (E85)
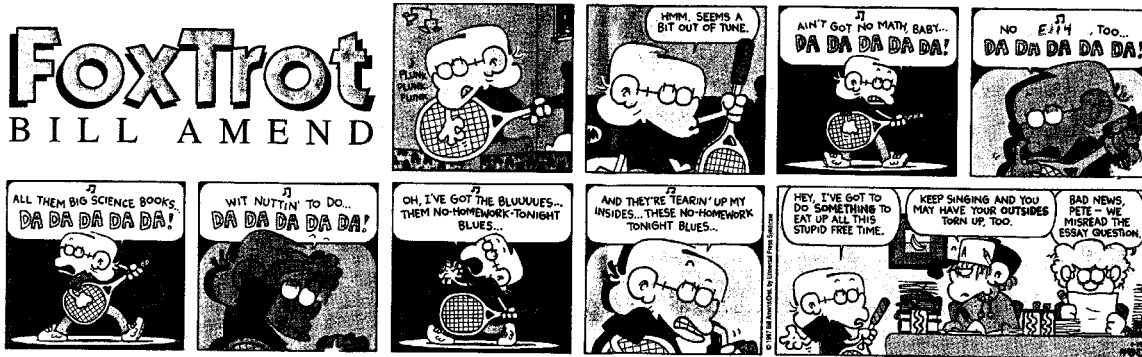
Harris   Spring 2001


Problem Set 4   **Due: Friday, February 16**

1) Timing Analysis

You are designing an adder for the blindingly fast 2-bit RePentium Processor. The adder is built from two full adders such that the carry out of the top adder is the carry in to the bottom adder. You plan to start an addition by loading data into input registers on the rising edge of the clock and must capture the result into the output registers on the next rising edge.

Suppose your full adder has a propagation delay of 40 ps from Cin to Cout or to Sum, 50 ps from A or B to Cout, and 60 ps from A or B to Sum. The adder has a contamination delay of 30 ps from Cin to either output and 45 ps from A or B to either output. Each flip-flop has a setup time of 60 ps, a hold time of 20 ps, a clock-to-Q maximum delay of 70 ps, and a clock-to-Q minimum (contamination) delay of 42 ps.
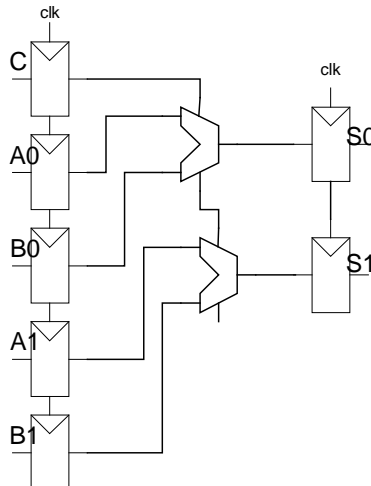
a) If there is no clock skew, what is the maximum operating frequency of the circuit (in MHz)?

b) How much clock skew can the circuit tolerate if it must operate at 4 GHz?

c) How much clock skew can the circuit tolerate before it might experience a hold time violation?

2) Flash Memory

Flash EEPROM is a fairly recent invention that has revolutionized consumer electronics. In this question, we will delve into the physics, economics, and social implications of Flash. Answer at least 3 of the 4 subparts of this question. You should expect to do research outside of what was provided in lecture and the text. Cite your sources to each answer.

a) Explain how Flash memory works. Use a diagram illustrating the floating gate. Describe how a bit in the memory is programmed.

b) Name three major manufactures of Flash chips (not companies that manufacture systems using Flash as a component). How many Flash chips were sold in 2000? What was the gross profit?

c) Suppose the market is expanding at a constant compound growth rate r such that the number of chips sold in a year = (#chips in 2000) * $r^{(Year-2000)}$. Estimate r using data for recent years or forecasts into the near future.

d) Describe a device that somebody you knows owns that includes Flash memory chips. Write a paragraph about the social implications of the invention of Flash.

3) Time

Please indicate how many hours you spent on this problem set. This will not affect your grade, but will be helpful for calibrating the workload for next semester's class.