

1.8 Problems

1-1. How many CPU chips are sold each year? Given that figure, how much dynamic RAM should be sold each year?

1-2. Plot the transistor count data from Example 1-1 as a function of introduction date.

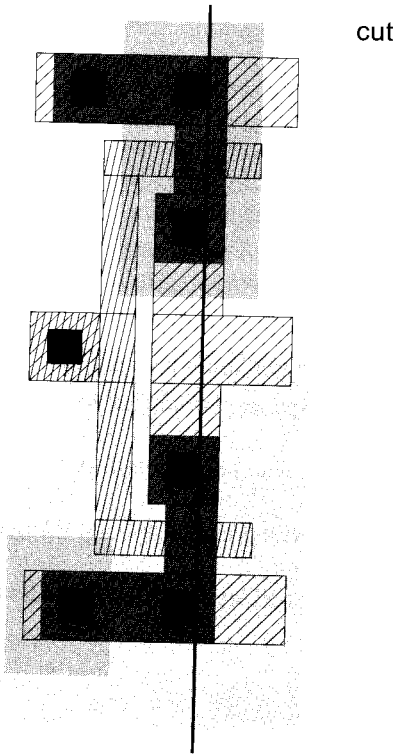
1-3. Hierarchy helps you reuse pieces of a design. The typical large CPU has about one million transistors; assume the layout for one transistor requires drawing five rectangles.

- a) How long would it take you to complete a CPU layout if you drew each rectangle separately?
- b) How long would it take you if half the transistors consisted of cache memory, which was designed from a six-transistor cell which could be replicated to complete the cache?
- c) How long would it take if the non-cache transistors were implemented in 32 identical bit slices, requiring one copy of the bit slice to be drawn, with the rest created by replication?

1-4. Draw a logic diagram for a full-adder (consult Chapter 6 if you don't know how a full adder works). Name each logic gate. Draw a four-bit adder from four full adders. Name each component in the four-bit adder and define the four-bit adder as a type. Draw the component hierarchy, showing the four-bit adder, the full adder, and the logic gates; when a component is repeated, you can draw its sub-components once and refer to them elsewhere in the diagram.

Problems

2-1. Draw the cross-section of the inverter shown below along a cut through the middle of the p-type and n-type transistors.



2-2. Assuming that $V_{gs} = 3.3V$, compute the drain current through n-type transistors of these sizes at V_{ds} values of 1V, 2V, 3.3V, and 5V:

- a) $W/L = 5/2$.
- b) $W/L = 8/2$.
- c) $W/L = 12/2$.
- d) $W/L = 25/2$.

2-3. Using the parameter values given in Example 2-3:

- a) How much would you have to change the gate oxide thickness to reduce the threshold voltage by 0.1 V?
- b) How much would you have to change the doping N_A to reduce the threshold voltage by 0.1 V?