18-360
Intro to Computer-Aided Digital Design
ECE Department

Carnegie Mellon

Out: 4/1/04 | Homework 6 | Due: 4/13/04

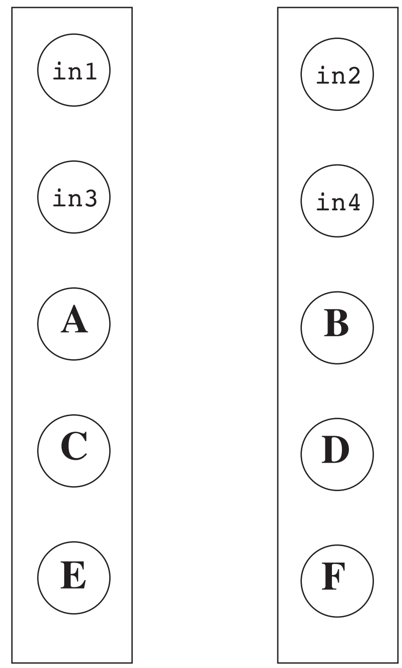
We'll discuss the solutions to these problems at the beginning of class on the due date. Bring your solutions then. Solutions will be handed out, so we can't accept late assignments.

1. Partitioning — 20%

For the following circuit, set up the partitioning problem for the K&L method. *Do not run the algorithm*, just set up the initial partitions with the correct interconnectivity representation. Input ports in1 and in3 are fixed in the left partition, and input ports in2 and in4 are fixed in the right partition.(They don't move.)

a. Draw the diagram, set up the partitioning problem, and calculate the cost of the nets crossing the cut in each case.

b. Does the actual logic matter when it comes to setting up the graph at the right?




```
module ToPartition (names, and, commas);
      input in1, in2, in3, in4;
      output d, f;
      wire a, b, c, e;

      assign a = d | i3;          // GATE A
      assign b = in1 | in4;       // GATE B
      assign c = in3 ^ e;         // GATE C
      assign d = b | a;           // GATE D
      assign e = in1 & in2;       // GATE E
      assign f = c & e;           // GATE F
endmodule
```

2. Calculating D_{new} from D_{old} — 20%

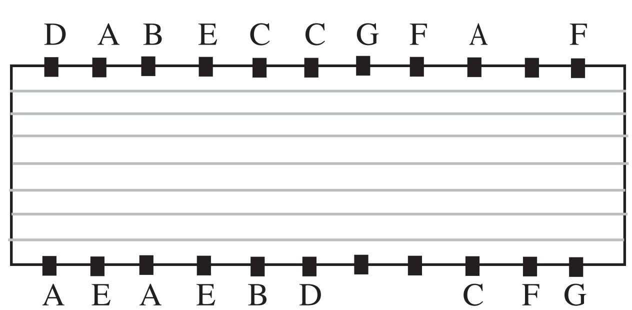
Show that, for partitions A and B, after swapping nodes a in A and b in B the new D value for node x in A is: (hint: see the lecture notes on K&L partitioning costs)

$$D_{x(new)} = D_{x(old)} + 2C_{xa} - 2\,C_{xb}$$

3. Channel Routing — 30%

a. Draw the vertical constraint graph for the channel

b. Choose a net to dogleg based on alphabetical order (i.e., choose to dogleg A before G). Put this dogleg in the 7th column from the left (G on the bottom) and redraw the vertical constraint graph.



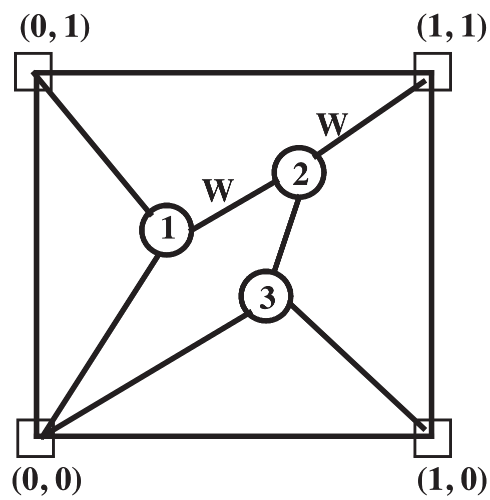
c. Could we have put the dogleg in column EE? Why or why not?

d. Could we have put the dogleg in column BC? Why or why not?

e. Route the channel using the left edge algorithm. Tell us the order in which you routed the nets.

4. Quadratic placement 30%

Consider this quadratic placement that has 4 fixed pads and 3 moveable objects, as shown in the figure below. The placement area is the unit square. All the 2-point wires have C_{ij}=1 except the two wires labeled with "W".



a. Assume W=2, and show how to formulate and solve the quadratic placement problem as in the class notes. Show the [C_{ij}] matrix, the [A] matrix, the two b vectors (one for solving the x problem, one for the y problem), and the matrix forms of quadratic wire length. Solve the two resulting matrix problems, either by hand calculation or using a software program such as MATLAB, to get a placement. Plot the placement solution, just like the figure shown here.

b. Change W to 10, and re-solve the two matrix problems to get a new placement. Show essential details, especially those that are different from part (a). Plot the new solution.

c. Reset W=2, but change the pad at (1, 1) to (1, 0.5). Re-solve the two matrix problems to get a new placement. Show essential details, especially those that are different from part (a). Plot the new solution.

d. Briefly discuss how the changes in W and pad location affected the placement solutions.