Name:_________________         ID:______________

There are four questions. Be precise, show every step, and state your assumptions (if any), to get full credit.

1. (30 points) Decide whether the following statements are true or false.
   
   (a) An algorithm will always terminate if it is totally correct.
   (b) Kernighan-Lin algorithm can always find an optimal partitioning since it considers swapping two subsets in each iteration.
   (c) If $g_1, g_2, \ldots, g_n$ are the gains of swapping node pairs in one iteration of Kernighan-Lin algorithm, then $g_1 + g_2 + \cdots + g_n = 0$.
   (d) When a flow in a network is maximal, there must exist a cut where the flows on the backward edges are zero.
   (e) Combining a list of $m$ rectangles and a list of $n$ rectangles in the slicing floorplan area optimization algorithm (a.k.a. Stockmeyer’s algorithm) takes $m + n - 1$ time.
   (f) Both $12V3HV45H$ and $123HV45VH$ are normalized Polish expressions.
   (g) The simulated annealing floorplanning algorithm of Wong-Liu can always find an optimal floorplan since the neighborhood structure is complete.
   (h) In placement, minimizing the total cut sizes is equivalent to minimizing the total wire lengths estimated by the half perimeters.
   (i) For any graph, the minimal spanning trees given by Kruskal’s algorithm and by Prim’s algorithm are the same.
   (j) For any given $n$ points in a plane, the number of edges in a spanning graph constructed by Zhou’s algorithm is $n \log n$. 

Midterm Examination
2. (25 points) Apply Kernighan-Lin algorithm to the following partitioning. Assume each edge has a weight of 1. Show each step of the computation.
3. (a) (10 points) Consider the Polish expression $123V45HHV$, is it normalized? If not, normalize it. Then draw a slicing tree corresponding to it.

(b) (15 Points) Given the floorplan topology in (a), and the module shapes as follows: 1: (4,3), 2: (3,5), 3: (6,4), 4: (5,2), 5: (7,4), find the orientation for each module such that the chip *perimeter* is minimized.
4. (20 points) Find a minimal spanning tree on the given graph, both by Kruskal’s and Prim’s algorithms. Give the edges’ order of being added to the tree.
5. **(bonus: 20 points)** You will get a bonus if you can help to prove a theorem for rectilinear spanning tree construction. Let’s assume that $(x_1, y_1)$ and $(x_2, y_2)$ are two points in the $R1$ region of the origin $(0, 0)$. The theorem stated that the distance between the points is smaller than the longest of their distances from the origin. A point $(x, y)$ is in the $R1$ if and only if $x \geq 0 \land x < y$. With both $(x_1, y_1)$ and $(x_2, y_2)$ satisfying this property, you need to prove that

$$|x_1 - x_2| + |y_1 - y_2| < \max(x_1 + y_1, x_2 + y_2).$$