# Introduction to Electronic Design Automation

**Spring 2014**

**National Taiwan University**

## Problem Set 4

Due on 2014/06/16 (Mon)

Please drop your solution in the instructor's mail box at EE2 building by 18:00

## 1 [Partition]

[10%] Given an undirected graph $G = (V, E)$, let $V = \{a, b, c, d, e, f\}$ with weighted connections as shown in the following table. Suppose the vertices are initially partitioned into $\{a, b, c\}$ and $\{d, e, f\}$. Apply the Kernighan-Lin algorithm to find a good partition. Show intermediate steps.

| | $a$ | $b$ | $c$ | $d$ | $e$ | $f$ |
|---|---|---|---|---|---|---|
| $a$ | 0 | 1 | 3 | 1 | 2 | 0 |
| $b$ | 1 | 0 | 1 | 1 | 0 | 4 |
| $c$ | 3 | 1 | 0 | 2 | 2 | 2 |
| $d$ | 1 | 1 | 2 | 0 | 3 | 1 |
| $e$ | 2 | 0 | 2 | 3 | 0 | 1 |
| $f$ | 0 | 4 | 2 | 1 | 1 | 0 |

## 2 [Floorplan]

[20%]

Given the following Polish expression $E = 1234567VHVVHV$.

(a) Rewrite $E$ to a normalized Polish expression.

(b) Give a slicing tree corresponding to the expression $E$.

(c) Assume modules 1, 2, 3, 4, 5, 6, and 7 have the sizes $1 \times 6$, $2 \times 8$, $3 \times 3$, $1 \times 4$, $2 \times 4$, $2 \times 5$, and $2 \times 2$, respectively. Assuming that all the modules are rigid and rotation is allowed, what is the size of the smallest bounding rectangle corresponding to the floorplan of Polish expression $E$? Show all steps leading to your answer.

(d) Give a B*-tree for the floorplan derived in (b).

(e) Show all steps for computing the coordinates of the modules (packing) from the B*-tree of (c).

## 3 [Wirelength Estimation]

[9%] Given a net $N$ with its four pin locations $p1 = (8, 12)$, $p2 = (6, 2)$, $p3 = (1, 7)$, and $p4 = (5, 3)$, estimate its wire length using the following methods:

(a) semi-perimeter approximation,
(b) minimum rectilinear Steiner tree, and
(c) minimum rectilinear spanning tree.

## 4 [Maze routing]

[10%] Find a shortest routing path from $S$ to $T$ in Fig. 1

(a) using Lee's algorithm,
(b) using Hadlock's algorithm.

(Show the corresponding numbers on grids and the final routing solution.)

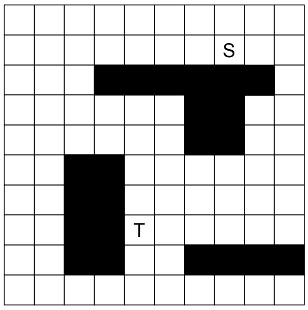


**Fig. 1.** Maze routing from S to T.

## 5 [Channel Routing]

[20%] Consider a channel with pins $(1, 0, 2, 3, 1, 4, 5, 6, 0, 4)$ and $(3, 1, 6, 5, 2, 3, 6, 2, 5, 0)$ in order on the upper and lower boundaries, respectively, where "0" denotes no pin assignment.

(a) Draw the corresponding horizontal constraint graph (HCG) and vertical constraint graph (VCG).
(b) Determine a tight lower bound on the channel height from the HCG and VCG.
(c) Is the basic left-edge algorithm applicable to the routing instance (under two metal layers)? Is the constrained left-edge algorithm applicable to the routing instance (under two metal layers)? If yes, what is the routing result? If not, why is so?
(d) Perform channel routing with two metal layers using the constrained left-edge algorithm with doglegging and show the routing result.

## 6 [Testing]

Exercise 14.2 (5%).
Exercise 14.4 (10%).
Exercise 14.11 (6%).
Exercise 14.13 (10%).