CS 494/594, Graph Algorithms, Applications and Implementations
Spring 2015, Homework 5

1. (10 points) Have one member of your team email a brief description of your team's project topic to the TA. A few sentences will suffice. Copy Dr. Langston and the other members of your team. As a sample, here are the specifics for Team 3:

> **Team 3.**
> Members: Isaac Sherman, Shawn Cox, Liang Tong
> Topic: Graph Planarity Testing
> Goals: Discuss the topological order, Euler's formula, Kuratowski's Theorem and related topics. Describe the Lempel-Even-Cederbaum algorithm, and applications such as crossing number and circuit layout. Implement and compare classic planarity testing algorithms like Hopcroft-Tarjan and Williamson.

2. (50 points) Implement a program that uses Hierholzer's algorithm to find an Eulerian cycle in a simple, unweighted, undirected graph. If the graph contains no Eulerian cycle, the program should output a message to that effect. Otherwise it should output the Eulerian cycle as shown below.

```
>./hierholzer graph8.txt
0-2-3-7-5-6-4-8-3-6-1-4-0
```

So that everyone's code produces the same output, use the following implementation guidelines.

- Begin at vertex 0.
- When extending a trail, choose the unused edge leading to a vertex with lowest number, even if that vertex has already been visited.
- When selecting a vertex to start a new trail, select the lowest numbered visited vertex with unused edges.

As usual, your program should take a file name as a command-line argument and output to standard output. All graph files will be in the format discussed in class. All stipulations regarding the first two homework assignments remain in effect. Be sure to test that your programs compile and run in Linux on the EECS lab machines.

3. a. (10 points) State the size of the minimum vertex cover and the size of the minimum dominating set for graph1.txt, graph2.txt and graph4.txt from the TA website. You may use your vertex cover code to find the minimum VC size (if you trust it).

b. (10 points) Recall that a vertex cover is also a dominating set. Therefore, the size of a minimum vertex cover is an upper bound on the size of a minimum dominating set. We know from $K_3$ that a minimum vertex cover may be two times the size of a minimum dominating set. What is the largest it can it be for any graph? Three times? More? Explain.

4. (20 points) The firehouse problem is defined as follows: given an edge-weighted graph *G,* with positive real distances on the edges, and a real number *d*, find a minimum

number of vertices (designated as “firehouses”) such that every vertex in *G* is at most distance *d* from a firehouse. Describe the relationship between the firehouse problem and the dominating set problem.

Email your source code from problem 2 and any other files necessary to compile and run your code to cphill25@utk.edu prior to the beginning of class next Wednesday, February 11. Include the answers to problems 3 and 4 as a separate attachment in plain text, Word, or .pdf format. If you have any questions, please do not hesitate to email me or drop by during office hours.