IEOR151 Homework 8
Fall 2013
Due: Friday, December 6, 2013

Problem 1:

One of the important issues in facility location modeling is the following. If you are given a problem on a network composed of nodes and links, when do you get the same solution (in terms of the objective function value) if you restrict the facility location to be on the nodes as opposed to the case in which you allow facilities to be on the nodes and the links. Clearly life is much easier if you know that restricting the candidate sites to be the set of nodes does not hurt you as you have a finite set of candidate locations as opposed to the infinite set of candidate locations you would have if you could locate on the nodes and links. (If you think they are different, give an example; If not, please explain thoroughly.)

a) For the set covering problem, do you get the same results if (i) you can locate only on the nodes and (ii) you can locate on the nodes and links? Prove that you either do get the same results or show by example that the results will be different depending on where you are allowed to locate.
b) Repeat question (a) for the maximal covering problem.
c) Repeat question (a) for the P-center problem.
d) Repeat question (a) for the P-median problem.

Problem 2:

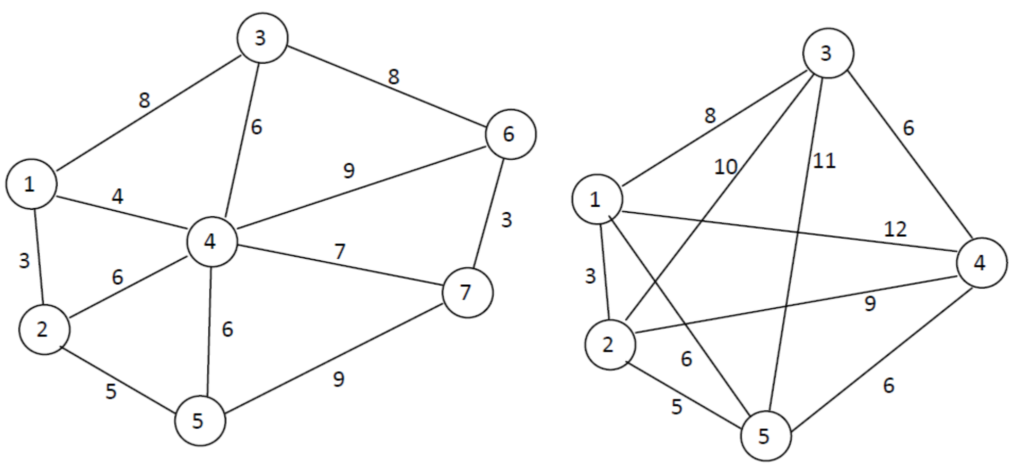
For every finite undirected graph G(N,E), please prove the following equation:

$$\sum_{i \in N} \deg(i) = 2|E|$$

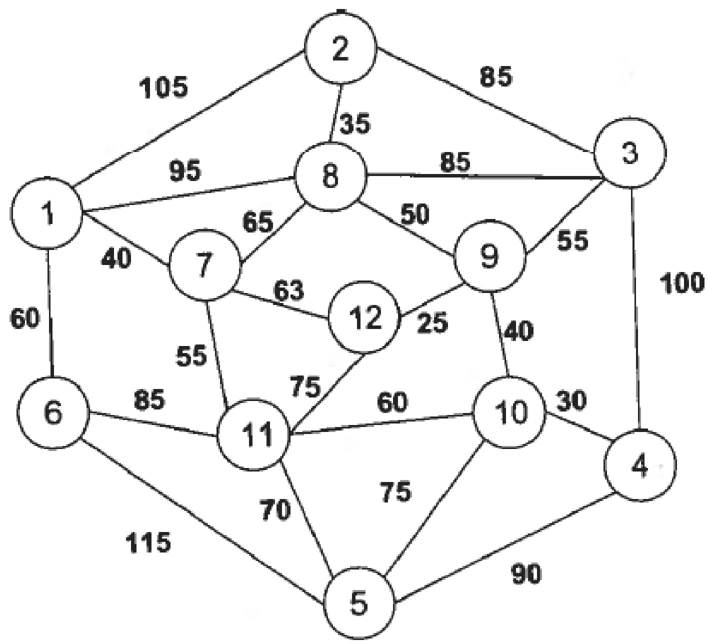
where $\deg(i)$ is the degree of node $i \in N$ and $|E|$ is the number of edges in the graph.

Problem 3:

Find the traveling salesman tours in the left graph using the minimal spanning tree based heuristic and the right graph using the nearest insertion heuristic, respectively. Report the total distances and sequences of nodes.



Problem 4:



Solve the Chinese Postman Problem.

a) What are the odd-degree nodes?
b) What is the optimal pairing of the odd-degree nodes?
c) How much additional distance is added due to the pairing of the odd degree nodes?
d) What is the total length of the original network (without the total distance of the optimal pairing of the odd-degree nodes)?
e) What percentage of the total length of the original network is the total distance of the optimal pairing of the odd-degree nodes?
f) Find an Euler tour on the original network plus the links that are added as a result of the optimal pairing of the odd-degree nodes. List the nodes to be visited in order beginning with node 1.

Problem 5

Consider the data shown below for a vehicle routing problem. The depot is at node 0. Each vehicle has a capacity of 350 units. The maximum distance that a vehicle can travel is 50 units. Compute the distances using the Euclidean distance formula. That is, the distance, d_{jk} between points j and k, with coordinates (x_j, y_j) and (x_k, y_k), respectively, is $d_{jk} = \sqrt{(x_j - x_k)^2 + (y_j - y_k)^2}$.

Node	X-coordinate	Y-coordinate	Demand	Angle	Radius
0	0	0	0		
1	5	7	65	54.46	8.60
2	3	5	95	59.04	5.83
3	6	–6	100	315.00	8.49
4	–5	–1	85	191.31	5.10
5	–3	–9	60	251.57	9.49
6	–7	–6	110	220.60	9.22
7	3	–8	100	290.56	8.54
8	7	2	85	15.95	7.28
9	–3	4	60	126.87	5.00
10	–4	8	75	116.57	8.94

Use the savings algorithm to solve the problem.

a) How many routes do you use?
b) What is the total route length?
c) List the nodes visited on each route, the demand associated with that route, and the route length.

Problem 6

Exercise 1 on page 504 in textbook chapter 9

Hint: Service Science, by Mark Daskin http://onlinelibrary.wiley.com/book/10.1002/9780470877876

Problem 7

Exercise 11 on page 455 in textbook chapter 8