**Network Design [Network Optimization Module]**
Exam 4/07/2017

Surname      _____
Name          _____

## Exercise #1

The graph **net04072017.gml** contains a set of potential cabinets that a telecom company can connect with an optical fibre network. Each cabinet (node) *u* has associated a revenue and each edge *uv* has associated a connection cost. The company can implement two kinds of networks, **Net1** and **Net2**.

> **Net1** uses a technology requiring that each node of the network can have degree at most equal to 3.
> **Net2** uses a technology requiring that maximum number of hops from the root node (node 1 in the graph) is equal to 4.

1. Find the most profitable network to implement.
2. Each node *u* of *G* has an attribute 'population' that contains the number of inhabitants that can be connected from node *i*. With the network type chosen in point 1, is it profitable to receive an incentive of 4,000 Euro to connect at least 85% of the population?
3. The company can locate in any node of *G* (exactly) one hub that connects up to 4 nodes at zero cost. With the network type chosen in point 1, find the network that maximizes company profit.

## Exercise #2

The graph **atsp04072017.gml** represents a logistic distribution network.

**Questions:**
1. Find the shortest Hamiltonian cycle starting from (ending to) node 1 with the lifted MTZ formulation plus the size 2 subtour inequalities. Report the value of the linear relaxation and the number of enumerated nodes. Evaluate the linear relaxation and strengthen the formulation by violated DFJ subtour elimination constraints.
2. Considering that each node in the graph requires one unit of the goods to be delivered, compare the following delivering plans:
   2.1   Plan 1: two vehicles with capacity C = 25
   2.2   Plan 2: one vehicle with capacity C = 20 and a depot located in node 20 in which the vehicle can pick-up goods to deliver.