Concordia University
Department of Building, Civil and Environmental Engineering
Civil Engineering Systems (CIVI-341) Winter – 2012

FINAL **[20 marks in total]**

Instructor: Dr. L. Amador **NAME:_____** **ID#:_____**

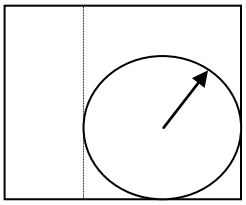
Due: Monday, April 28th, 2012 **Start 2:00 am. - End 5:00 am**

1. For the following function z(x,y) use the gradient search. Your starting point is (2,3) = (x,y), your first step is -5 (minus five) units, your second step is -0.1 (minus zero point one). **[4 marks]**

    a) Are these two steps getting you closer to an optimal point? Why?
    b) What kind of point do you have: maximum, minimum, saddle, discontinuity on space (a hole), inconclusive OR you are still far away from an optimal point after your second step. Provide proof of your conclusion.

$$z = (x-3)^2 + (y+2)^2$$

2. Use Lagrange multipliers to obtain the maximum volume for a cylindrical tank with bottom and top (lit), use a **square sheet of metal of size *S***, you can cut and weld anywhere, however you want to weld as little as possible. What are the optimal dimensions (r = radius, x = elevation of the tank). See figure below**. [2 marks]**

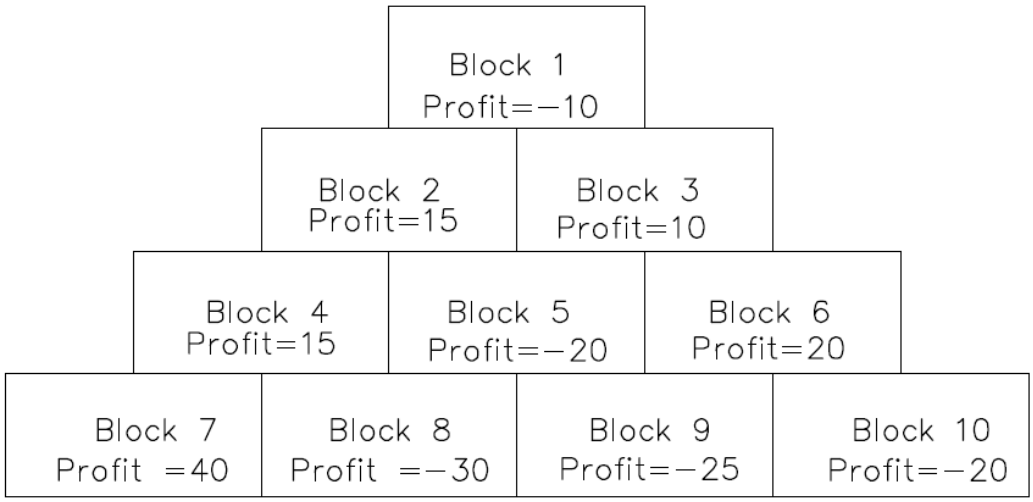


[---x---][-------2r-------]

3. An aluminum company in Northern Quebec is planning the excavation (from top to bottom) of a new open-sky mine located in a hill (see Figure below) and wishes to maximize profit p_i *(negative = cost).* **[6 marks]**

    a. If x_i denotes a binary decision variable for excavating block i, apply the branch and bound method to enumerate courses of action. Show the cumulative value of your objective inside every node.
    b. Environmental regulations will limit the ability to excavate to a maximum number of blocks ***"B".*** If B = 5 find the solution to this problem.

    (HINT: you need to mine -dig- blocks 1 before excavating block 2 or 3, similar relationships hold for the rest).



4. A contractor has to build a new road of 1 km. The cost of construction is $2 million dollars if they chose granular pavement, 2.5 if they go for a full depth or 2.25 if they select a concrete pavement. A ***granular*** pavement placed on poor soil (low bearing capacity) will suffer damage and require two rehabilitations, if the soil is fair (medium bearing capacity) it will require one rehabilitation. A ***concrete*** pavement on poor soil will also suffer damages and require one rehabilitation in its lifespan. A **full depth** pavement will suffer no damage at all in its lifespan (that's why they call it perpetual pavement). The contractor may chose to don't conduct any testing and select a type of pavement based on experience or to do both tests in order to improve the chances of designing a more reliable pavement. Using the information provided in the following tables build a decision tree and chose the preferred solution. **[3 marks]**

Table 1. Construction and Rehabilitation cost (in millions of $)

Type of Pavement	Construction (millions of $)	Rehabilitation if poor soil	Rehabilitation if fair soil	Rehabilitation if good soil
Granular	2	Half million - 2 times	Half million one time	0
Full depth	2.5	0	0	0
Concrete	2.25	0.25 - one time	0	0

Table 2. Likelihood of results depending test (test accuracy)

	Accuracy (%)	Cost (millions of dollars)
Test 1	60	0.05
Test 2	40	0.1

Table 3. Previously observed results from adjacent sites

Soil strength	Historical Likelihood (%)
Low – poor	30
Fair – medium	50
High - Good	20

5. The town where you live -town "b"- and a group of 10 other towns connected by a road network (see Figure below), had agreed to build a maximum of 4 fire stations at certain locations (building on a road link is not allowable, you must build at a Town). They wish to make sure that at least 1 fire truck can reach every town in no more than 15 minutes (travel time in minutes is shown in the arcs –half circles- in the Figure); they also want to maximize coverage, such that in the event of a large fire they can assistance from several fire units, actually as many as possible. Formulate the objective and constraints (all of them, exhaustively, don't use condensed formulation) and solve the problem using any method. **[5 marks]**