INSTITUTO SUPERIOR DE ECONOMIA E GESTÃO

OPERATONAL REASEARCH – Semester 1

2010/01/12 **EN** Duration: **2h**

(**Note**: Justify all your answers and present the calculations)

1. Consider the following output, from the *Solver*/*Excel* solution of the LP problem formulated, to determine the tons of each of the three products (**P1**, **P2** e **P3**) that maximize the total profit:

$$Max\ Z = 5x_1 + 8x_2 + 10x_3 \qquad \text{total profit } (m.u.)$$

$$\text{s. to: } \begin{cases} x_1 + 2\,x_2 + x_3 \le 2000 & \text{machine (capacity in } m.h.) \\ x_1 + 0{,}5\,x_2 + 2x_3 \le 4000 & \text{warehouse (capacity in } m^3) \\ x_1 + x_2 \ge 300 & \text{selling agreement } (ton.) \\ x_1, x_2, x_3 \ge 0 \end{cases}$$

Microsoft Excel 12.0 Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C7	P1	300	0	5	5	7
D7	P2	0	-7	8	7	1E+30
E7	P3	1700	0	10	1E+30	5

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F3	machine (m.h.)	2000	10	2000	150	1700
F4	warehouse (m^3)	3700	0	4000	1E+30	300
F5	selling agreement (ton.)	300	-5	300	1700	300

a) (3 points) Write and explain the above results, including decision variables, slack variables and shadow prices.

b) (1,5 points) Identify and justify a value for the unitary profit of **P3** that will induce changes on the optimal solution plan.

c) (2 points) The board of directors is considering the replacement of the machine by an identical one with an increased capacity. Justify what the maximum capacity of the new machine should be in order to keep the production of the same products. Compute the change in the optimal total profit if the a machine with that maximum capacity costs *50 m.u.*.

d) (1,5 points) Suppose that a flood reduces the warehouse capacity to half. Explain how should the initial formulation be changed in order to obtain a model that will help you decide to either: i) keep the old warehouse, in the conditions after the flood or, ii) rent another warehouse with a capacity of *3500* m^3 at a cost of *2 000 m.u.*.

(→)

2. David, a student living in Lisboa, usually takes the underground. The relevant underground network follows in figures **A** and **B**.

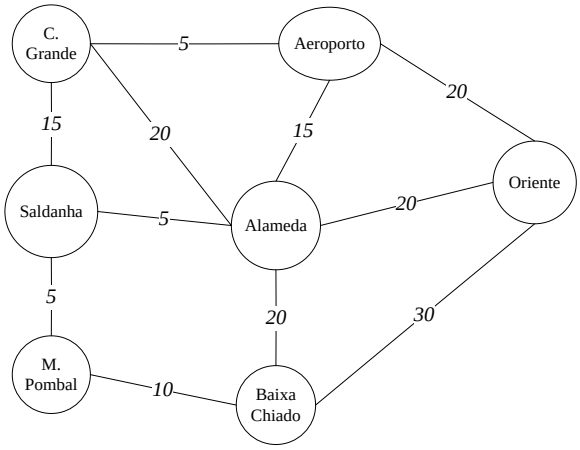


Figure **A**

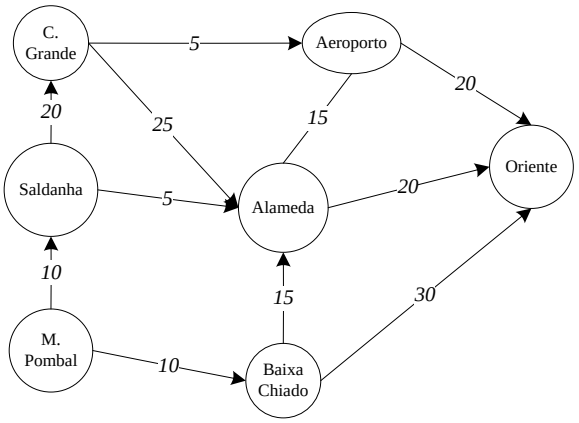


Figure **B**

a) (3 points) Suppose that a computer network is to be set connecting all the different underground stations. With that purpose, a cable network will be installed along the underground tunnels, thus linking the computers together. Every station has one computer and each needs to get connected to the network. Considering figure **A** where numbers on the links represent the cost (in *m.u.*) between the stations, determine the solution that minimizes the total cost of cables to be installed.

b) (3,5 points) Consider that the numbers on arcs in **B** represent the time (in minutes) between stations. With the purpose of moving as fast as possible from **M.Pombal** to **Oriente**, David chose the best direction for every link but for the one between **Aeroporto** and **Alameda**, as depicted in **B**. Complete the *Excel* worksheet and the *Solver* window in the attachment, while writing all parameters and formulas needed by David to solve the problem.

3. Consider the following simplex tableau from an LP maximization problem with two decision variables and three functional $\leq$ constraints:

VB	Z	x_1	x_2	x_3	x_4	x_5	R.H.S.
Z	*1*	*-2*	*0*	*0*	*1*	*0*	*10*
	0	*-1*	*0*	*1*	*1*	*0*	*2*
	0	*0*	*1*	*0*	*3*	*0*	*9*
	0	*-2*	*0*	*0*	*-1*	*1*	*4*

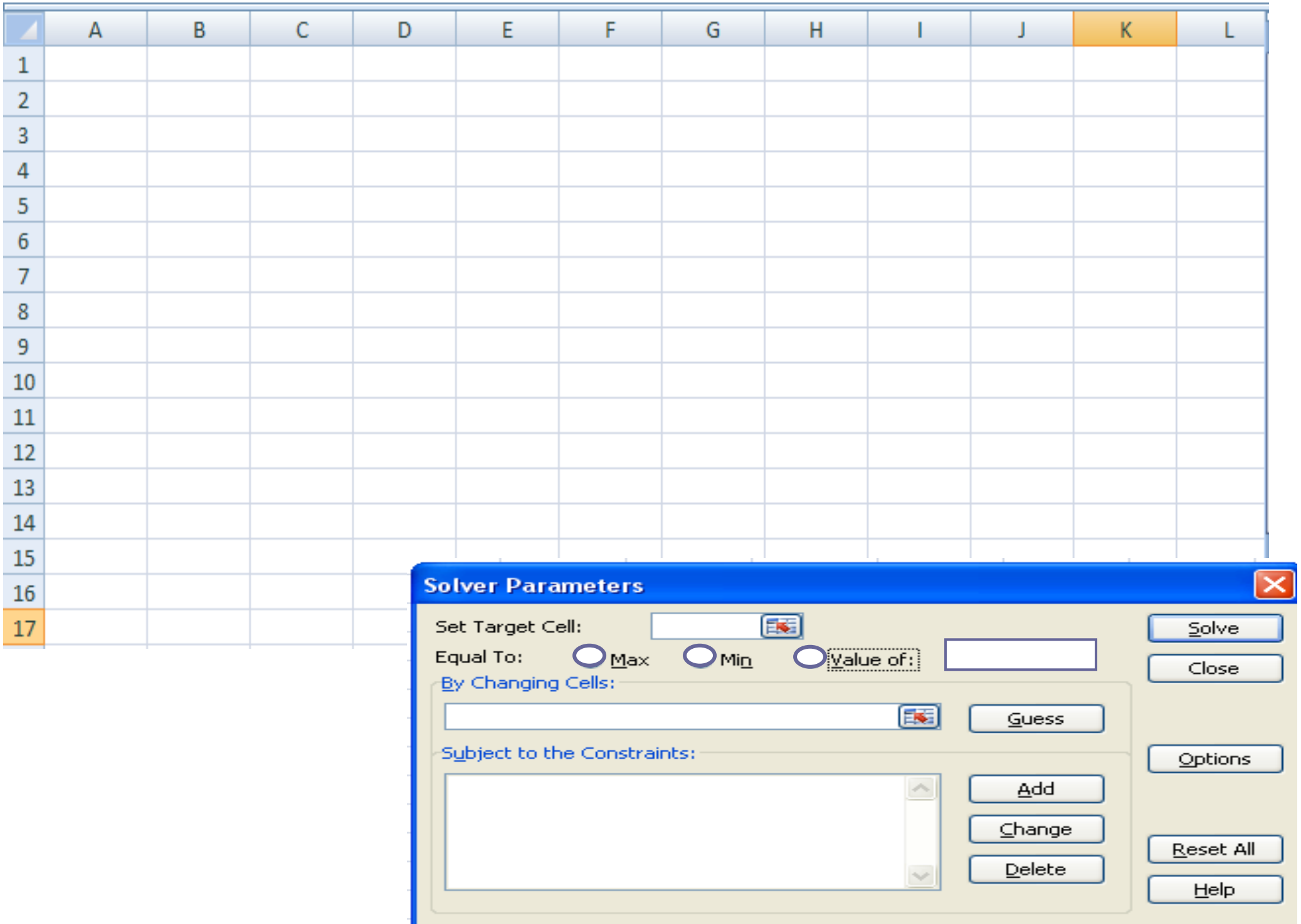
a) (1 points) Write and classify the primal solution shown on the tableau.

b) (1,5 points) Indicate the consequences to the solution shown on the tableau of an increment by one unit in the value of x_4.

c) (1,5 points) Solve the problem.

d) (1,5 points) Classify and explain the sentence: "The feasible region of the above problem is convex and bounded".

Name: _____ **Number:** _____


A B C D E F G H I J K L
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Solver Parameters
Set Target Cell:
Equal To: Max Min Value of:
By Changing Cells:
Subject to the Constraints:
Solve
Close
Guess
Options
Add
Change
Delete
Reset All
Help