INSTITUTO SUPERIOR DE ECONOMIA E GESTÃO

OPERATIONAL RESEARCH – 1ST Semester

Date: 12/01/2016 **Época Normal – Block 2** Duration: **1 hour**

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

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1. A company aims to maximize the weekly profit with the production and sales of products **A**, **B** and **C**.

To produce **A**, **B** and **C**, 240 hours machine (h.m) are available per week. Prior to selling, products need to be in an oven that has 700 m^3 capacity. The company cannot sell more units of **B** and **C** together than **A**. An agreement forces the production of a minimum of 20 units of **C** every week. The corresponding LP formulation follows:

$$\max Z = 10x_A + 20x_B + 40x_C$$

$$\text{s.t.:} \begin{cases} x_A + x_B + 4x_C \leq 240 \\ 4x_A + 2x_B + x_C \leq 700 \\ x_A - x_B - x_C \geq 0 \\ x_C \geq 20 \\ x_A,\ x_B,\ x_C \geq 0 \end{cases}$$

By Solver/Excel the following "Sensitivity Report" was obtained:

Microsoft Excel 15.13 Sensitivity Report

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B7	x_A	90	0	10	10	16,6667
C7	x_B	70	0	20	1E+30	10
D7	x_C	20	0	40	25	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
E2	machine (h.m.)	240	15	240	60	140
E3	oven (m^3)	520	0	700	1E+30	180
E4	sales - A vs B & C	0	-5	0	140	180
E5	sales of C	20	-25	20	28	18

Answer all the following questions based only on the "Sensitivity Report" and consider them independent.

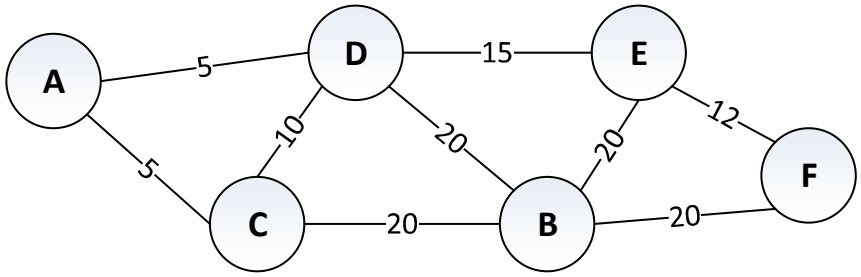
a) (1,5 points) News about harm to health caused by **C** led to a 10% decrease in the profit of that product. Evaluate the consequences of such a change.

b) (2,0 points) An explosion in the factory results on a decrease in 30 hours machine per week in the capacity. Determine the weekly profit of the company after the accident, justify if there is a change considering the initial profit.

c) (1,0 point) Justify if it is possible to make available for other products a part of the capacity of the oven, maintaining the production plan given in the report

(please turn)

2. (1,0 point) Consider the following network, where the values on the edges represent time. Justify <u>without solving</u> what will be the effect in the optimal value of the minimal spanning tree in this network if Prim algorithm starts by vertex **B** instead of vertex **A**.



3. The weekly distribution of waters for three big supermarkets (**S1**, **S2** and **S3**), could be done from two warehouses (**A1** and **A2**). The warehouses have a weekly capacity of 1000 and 800 boxes, respectively. The unit transportation cost in m.u. (monetary units) and the number of boxes requested by each supermarket are in the table below.

	S1	**S2**	**S3**	**Capacity** (no. boxes/week)
A1	5	2	9	1000
A2	2	4	5	800
Weekly demand (no. boxes)	900	300	400	

a) (2,0 points) Formulate the problem using an LP model.

b) (0,5 points) Justify if there is need to change the model to ensure that the optimal solution has integer values, if it is the case indicate the changes needed.

c) (2,0 points) Assume that the company has to decide if it should open a new warehouse (**A3**) with capacity for 2000 boxes that will work only with the three supermarkets. If the option is to open **A3**, warehouses **A1** and **A2** could be used to other purposes. The construction cost is 5000 m.u., and the unit transportation costs are equal to all the supermarkets, and equal to 0.5 m.u. Present one model that helps to find the best option for the new problem (without need to solve the problem formulated in a) alone).