Departamento de Engenharia Informática e de Sistemas

Operations Research 2017/2018

Date: 19/02/2018 **Exam – 2nd Call** **Duration: 2 horas**

Note: Present **all the calculations** that you perform and appropriately **justify** your answers.

1. Consider the following problem:

"The company PestExtermination of Coimbra, producer of pesticides, is responsible for much of the pollution verified in this region. For this reason, this company intends to study the possibility of reducing the emission of polluting waste but without compromising the economic objectives defined for the next year. In fact, the company produces three types of pesticides: KillCockroach, KillAnt and KillMouse. For each ton produced: of pesticide KillCockroach (which we will call P1) ***50*** *units of toxic waste are emitted; of pesticide KillAnt (which we will call P2)* ***40*** *units of waste are emitted; and of pesticide KillMouse (which we will call P3),* ***60*** *waste units are emitted.*

Profits obtained from the sale of the products are of ***€ 200****,* ***€ 100****, and* ***€ 200*** *per ton of pesticide P1, P2, and P3, respectively.*

It is known that in order to meet the aforementioned economic objectives, the monthly profit must not be less than ***200*** *thousand euros.*

On the other hand, the company has the capacity to produce a total of ***1500*** *tons of pesticides per month and it does not intend to work at less than* ***70%*** *of its maximum capacity."*

Formulate the problem in terms of a Linear Programming model in order to minimize the amount of toxic waste to emit during the next year. Indicate the meaning of the decision variables and of the objective function.

2. Consider the following linear programming model:

Minimize $z = 4x_1 + x_2$

subject to

$$-x_1 + x_2 \leq 2$$
$$x_1 \leq 1$$
$$3x_1 + x_2 \geq 3$$
$$x_1 \geq 0,\ x_2 \geq 0$$

a) Solve it by the dual Simplex method. In each iteration identify the basic solution and the corresponding extreme point, classifying them as "feasible" or "not feasible";

b) Explain the following statement: "*While the Simplex method maintains the feasibility of the primal solution, the dual Simplex method maintains the feasibility of the dual solution*."

Scores: 1 – 3,5 points 2 – 5,5 points 3 – 5,5 points 4 – 5,5 points

3. Consider the following linear programming model:

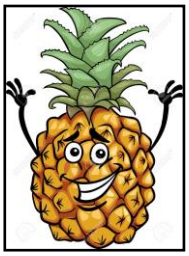
Maximize $z = 2x_1 + 8x_2$
subject to
$-x_1 + 2x_2 \geq 3$
$x_1 + 2x_2 \geq 12$
$x_2 \geq 5$
$x_1 \geq 0, x_2 \geq 0$

a) Solve it by the graphical method;

b) Formulate the dual problem corresponding to the problem presented above;

c) Without solving the dual problem, do you think it is possible to draw some conclusion about its optimal solution? Justify.

4. A given company which imports pineapples from Azores, has three warehouses (**A1**, **A2**, and **A3**) where the fruit is temporarily stored, and then it is transported to three points of sale (**P1**, **P2**, and **P3**). The warehouses **A1**, **A2**, and **A3** monthly dispose of **3**, **9**, and **3** pineapple containers, respectively. At the points of sale **P1**, **P2,** and **P3**, the requirements are of **6**, **4,** and **5** containers of this fruit, per month, respectively. The costs of transporting each container from the various warehouses to the various points of sale, are given by the following table:



	P1	P2	P3
A1	6	4	2
A2	1	3	4
A3	4	2	3

(Values expressed in monetary units - MU)

a) Obtain an initial basic feasible solution for the problem by the Penalties method;

b) Starting from the solution obtained in a) solve the problem by the transportation method;

c) Indicate the constraints of the primal problem corresponding to the dual variables **vj**, used in the resolution of b).

Scores: 1 – 3,5 points 2 – 5,5 points 3 – 5,5 points 4 – 5,5 points