INSTITUTO SUPERIOR DE AGRONOMIA

Exam of Applied Operations Research - Part IV - 12 June 2018

Number: Name:

---

1. (10val.) A forest products company is considering building new pulp mills, linear board mills, and newsprint mills. Suitable locations for each kind of mills have been identified in Coimbra and Viseu. The company can not spend more than 900 million euros on new mills. The cost of construction and the expected net present value of operation for each new mill are shown in the table. The problem is to determine which mills should be built (from the six possible mills shown in the table) in order to maximize the total net present value of their future operation.

Mill	Construction cost $(10^6\ €)$	Net present value $(10^6\ €)$
1. Coimbra pulp mill	500	25
2. Viseu pulp mill	450	22
3. Coimbra linear board mill	260	12
4. Viseu linear board mill	270	10
5. Coimbra newsprint mill	150	14
6. Viseu newsprint mill	170	14

a) Formulate the problem in integer linear programming

(Hint: Consider the variables $x_i = \begin{cases} 1 & \text{if mill } i \text{ is built} \\ 0 & \text{otherwise} \end{cases}$, for $i = 1, ..., 6$).

b) Consider the following condition: the company must build one and only one mill for pulp and one mill at the most for each of the other two kind of mills.

   i) Formulate the constraints for this condition.

   ii) Determine a feasible solution of the problem with the new constraints and calculate the corresponding total net preset value.

c) Consider two variables that express the decision to build or not to build mills in Coimbra and Viseu, respectively,

$y_j = \begin{cases} 1 & \text{if mills are built in region } j \\ 0 & \text{otherwise} \end{cases}$, for $j = 1(\text{Coimbra}), 2(\text{Viseu})$.

   i) Formulate constraints that establish the relationship between these variables and the variables defined in a).

   ii) Formulate the constraint for the following condition: if Coimbra will have new mills, Viseu must also have new mills.