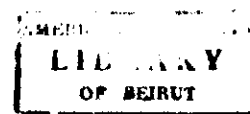




AMERICAN UNIVERSITY OF BEIRUT

Suliman S. Olayan School of Business



DCSN 200: Managerial Decision Making

Fall 2004-2005 Mid-term Exam

Date: November 12th, 2004; Time: 5:30 pm-7:00 pm.

Version B

This exam is administered in full observance of the Olayan School of Business Honor Code and the penalties it sets for violations of the standard of academic conduct. You are required to fully understand the code and to strongly adhere to it. In particular, cellular telephones, programmable calculators and computers of any shape or size are not allowed. No questions, no comments, no borrowing and no disturbance of the peace of any kind will be permitted or tolerated. You are required to stop working on the exam and hand it immediately when a proctor instructs you to do so. Any cheating or attempted cheating will subject the offender to a zero on the exam and a referral to the Student Affairs Committee for further penalties. Please, sign the following pledge and return these question sheets inside your answers' booklet.

"I fully understand and strongly adhere to the School of Business Honor Code."

Signature G. Cassob

Name Gerome Cassob 200301317

Question 1 (30points)

Consider the following linear programming model where the objective function represents a profit, the decision variables represent product quantities and the constraints express resource limitations or marketing restrictions:

$$\begin{array}{ll} \text{Profit} & \text{Max. } 2X_1 + 4X_2 \\ & \text{s.t.} \\ & \textcircled{1} \quad X_1 + 2X_2 \leq 6 + 4 \\ & \textcircled{2} \quad X_1 \leq 3 \\ & \quad X_1 + X_2 \geq 1 \\ & \quad X_2 \leq 2 \\ & \quad X_1, X_2 \geq 0 \end{array} \quad \begin{array}{l} X_1, X_2 \text{ Product quantities} \\ 3 - 1 = 2 \\ 2 - 1 = 1 \end{array}$$

- ☒ Draw the feasible region. [10]
☒ What is the optimal solution and its value? [5]
☒ Suppose the availability of the first resource increases by 4 units, by how much will the objective function increase? [5]
☒ If a technical breakthrough occurred that raised the per unit profit of the second product to 4, how would the solution be affected? [5]
☒ Within which range could the per unit profit of the second product vary, while all the other parameters of the model as well as the optimal solution remain unchanged? [5]

Question 2 (40 points)

Extel Medicines is a local pharmaceutical company that produces under license three versions of a medicine for the Lebanese market: Nevratine 10, Nevratine 20 and Nevratine 120. As far as production is concerned, the main costs are those of the three constituents: the coating, the active ingredient and the inactive ingredient. The table below describes their relative quantities in the different pills. For example, a package of Nevratine 120 requires one unit of the coating agent, ~~two~~ ³ units of the active ingredient and one unit of the inactive ingredient.

	<u>Coating Agent</u>	<u>Inactive Ingredient</u>	<u>Active Ingredient</u>
Nevratine 10	1	1	1
Nevratine 20	1	3	1
Nevratine 120	1	1	3

Nevratine 230 1 3 2 = 17,000 L

Each week, Extel receives 3500 units of the coating agent, 3000 units of the inactive ingredient and 4000 units of the active ingredient. These purchases represent sunk costs to Extel. The profit Extel makes from a package of Nevratine 10 is LBP 7400. It is LBP 14600 for a package of Nevratine 20 and LBP 12200 for a package of Nevratine 120.

The Operations Department manager noticed an opportunity to use analytical decision making tools in order to maximize Extel's profits.

Extel's optimal production plan, she figured, must be a solution to the following LP:

$$\text{Max. } 7400 X_1 + 14600 X_2 + 12200 X_3 + 13000 X_4$$

s.t.

$$\begin{aligned} X_1 + X_2 + X_3 &\leq 3500 && \text{(coating agent constraint)} \\ X_1 + 3 X_2 + X_3 &\leq 3000 && \text{(active ingredient constraint)} \\ X_1 + X_2 + 3 X_3 &\leq 4000 && \text{(inactive ingredient constraint)} \\ X_1, X_2, X_3 &\geq 0 \end{aligned}$$

where X_1 is the number of Nevratine 10 packages to produce,
 X_2 is the number of Nevratine 20 packages to produce,
and X_3 is the number of Nevratine 120 packages to produce.

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$B\$4	Nevratine 10	2500	0	7400	4800	700.0000001
\$C\$4	Nevratine 20	0	-2800	14600	2800	1E+30
\$D\$4	Nevratine 120	500	0	12200	2800	4800

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$F\$5	Coating Constraint Total	3000	0	3500	1E+30	500
\$F\$6	Active Ingredient Constraint Total	3000	5000	3000	500	1666.666667
\$F\$7	Inactive Ingredient Constraint Total	4000	2400	4000	5000	1000

She implemented the model in Excel and, in order to better analyze the situation, she also produced the sensitivity analysis report shown above. Could you help her in answering the following questions:

- (a) What should Extel's weekly production plan look like? How much weekly profit should Extel expect to make? [10]
- (b) Which of the three constituents are in excess? [5]
- (c) How the profit would change if Extel were to receive 3300 units of the active ingredient instead of 3000? [5]
- (d) Why is Nevratine 20 not recommended for production even though it is the most profitable version of the medicine? By how much do you have to change the profit in order to produce it? [5]
- (e) Would the optimal production plan change if the per package profit of Nevratine 10 were to drop by LBP 4000? Justify [5]

(f)

Extel is considering the introduction of Nevratine 230, which a competitor also produces but under a different brand name. A package of this version would use one coating agent unit, two active ingredients units and three inactive ingredient units. Its per package profit would be LBP 17000. If Extel is confident it will sell whatever Nevratine 230 quantity it produces, should it produce it? [10]

Question 3 (30 points)

Excel Logistics (EL) is the supply chain arm of Excel Industries (EI). Part of EL's function is to deliver products from the three EI manufacturing plants to the two EL distribution centers DC1 and DC2. The maximum supply capacity, the fixed operating cost and the delivery cost to DCs from each plant are given in the table below.

Plant	Maximum Daily Supply Capacity (tons)	Fixed Operating Cost	Delivery cost per ton to DC 1	Delivery cost per ton to DC 2
Plant 1	45	\$ 25000	\$ 200 x_1	\$150 x_2
Plant 2	55	\$ 30000	\$ 400 x_3	\$200 x_4
Plant 3	60	\$ 45000	\$ 300 x_5	\$100 x_6

The daily demands of each distribution center are as follows:

Distribution center	DC1	DC2
Demand (tons)	75	55

- a) Assume all plants are open. Write a linear programming model to determine the daily delivery from plants to DCs in order to minimize the total cost. [15]
- b) EI is experiencing tough competition and is considering the option of closing at least two of its three plants. How would you change the formulation in a) to determine which plants to close in order to minimize the total fixed and delivery costs while, at the same time, meeting the demand of each DC? [10]
- c) If, for managerial reasons, both or neither of plants 2 and 3 must be open. How would you modify the model in a) to satisfy this restriction? [5]

$$x_1 + x_2 = 75$$
$$x_1 = x_2$$
$$x_1 - x_2 = 0$$