
Name: (please print) SOLUTIONS

Quiz 2

Linear Programming and Sensitivity Analysis
BUAD 311/311T– Operations Management
Spring 2016

Professor Ashok Srinivasan

Time: 20 minutes

There are 3 pages, including this page. All together the quiz has a maximum of 50 points.

This is a closed-book closed-notes quiz.

You may use a simple calculator.

No laptops. No PDAs. No cell phones.

You may receive partial credits unless otherwise noted. Show your work and write legibly.

Do not be tempted to seek “inspiration” from a neighbor’s quiz. Poor scores can be overcome, but cheating will be dealt with harshly!

Please sign here to indicate that you have adhered to university policies regarding ethical behavior in preparing for and completing this quiz.

“I hereby certify that I have adhered to the university policies regarding ethical behavior in preparing for and completing this quiz.”

Sign here: _____

Aeroloc Coatings makes three types of special anti-corrosion paint at their factory in Mexico: Regular, Greater, and Worse, which have different levels of protection. When the paint is applied, as it dries, it releases chemical pollutants called VOC's into the atmosphere. Environmental laws require that Aeroloc coatings release no more than 2400 lbs. of VOC into the air each month. The net profit per gallon, the labor hours required in production, and the VOC produced per gallon for the three products are as follows:

Product	Profit (\$/gallon)	Labor required (hours/gallon)	VOC produced (lbs/gallon)
Regular	100	4	0.3
Greater	120	3	0.2
Worse	80	2	0.1

Because of machinery limitations, Aeroloc can produce at most 2000 gallons of Greater next month. To meet a large order, they must produce at least 7000 gallons of Regular next month, despite it being a big polluter. They worry this will require a huge increase in production of low-profit Worse to meet the VOC requirement. So they want to limit the production of Worse to no more than 35% of next month's total output.

Aeroloc has a total of 35,000 labor hours available next month. They can easily sell everything they produce. Your boss has asked you to develop a linear programming model to optimize production for next month.

a. (6 points) Define all your decision variables.

R = amount of regular to produce in gallons [3] point each
G = amount of greater to produce in gallons
W = amount of worse to produce in gallons

b. (6 points) Formulate an objective function that will maximize profits.

Maximize $100R + 120G + 80W$

c. (16 points) Formulate all the constraints.

$4R + 3G + 2W \leq 35000$ (labor hours)
 $0.3R + 0.2G + 0.1W \leq 2400$ (VOC limit)
 $G \leq 2000$ (machinery limitation)
 $R \geq 7000$ (minimum to meet order) [3] points each, partial credit
 $W \leq .35(G + R + W)$
non-negativity (1 point)

The Excel solution is shown below:

WARNING! Some key information has been deliberately erased!

Sensitivity Report

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$B\$3	Regular	7000	0	100	140	1E+30
\$B\$4	Greater	0	-40	120	40	1E+30
\$B\$5	Worse	3000	0	80	1E+30	20

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$B\$11		34000	0	35000	1E+30	1000
\$B\$12	VOC produced		800	2400	50	300
\$B\$13	limitation	0	0	2000	1E+30	2000
\$B\$14	minimum	7000	-140	7000	1000	217.3913043
\$B\$15		3000	0	0	1E+30	500

d. (8 points) What is the optimal solution? What is the optimal profit? How much VOC will be produced?

Make 7000gals R, 0gals G, and 3000gals W. (4.5; 1.5 points each)

Profit is \$940,000. (1.5 points)

The VOC produced is 2400 lbs. (2 points)

e. (8 points) In each of the following cases, indicate in one sentence how the profit will change: increase, decrease, or stay the same, **and by how much**.

(i) (4 points) The number of available labor hours is increased by 1000:

Labor hours constraint not binding; shadow price is zero. Optimal profit will stay the same.

(ii) (4 points) Market conditions allow us to raise the price of Regular by \$10:

Profits will increase by \$70,000. Profit margin increase is +10; within range. Current optimal solution remains the same so profit due to Regular increases by $7000 \times 10 = 70,000$.

f. (6 points) Suppose the government regulators propose to tighten the limit on VOC by 10%. Realizing that firms may not be able to change their processes immediately, they allow Aeroloc the alternative of simply paying a penalty of \$500 per lb. of VOC released above the new limit. What should Aeroloc do?