

**15.066j System Optimization and Analysis**  
**Summer 2003**  
**Professor Stephen C. Graves**

**Group Problem Set 2**

**This problem set is due at the end of recitation on 26<sup>th</sup> June.**

*Please work in groups and hand in only ONE copy for each group. The problem set can be handwritten, but please make sure what you hand in is NEAT and CLEAR. Please also attach an Excel spreadsheet printout if you are required to solve the LP using the Excel Solver.*

**Problem 1:** During the next four quarters Dorian Auto must meet (on time) the following demands for cars: 4000 in quarter 1; 2000 in quarter 2; 5000 in quarter 3; 1000 in quarter 4. At the beginning of quarter 1, there are 300 cars in stock. The company has the capacity to produce at the most 3000 cars per quarter. At the beginning of each quarter, the company can increase (but not decrease) its production capacity. It costs \$100 to increase production capacity by one unit. For example, it would cost \$10,000 to increase production capacity from 3000 cars per quarter to 3100 cars per quarter. It also costs \$50 per quarter to maintain each unit of production capacity (whether it is used or not). The variable cost of producing a car is \$2000. A holding cost of \$150 per car is assessed for each quarter's ending inventory. It is required that at the end of quarter 4, plant capacity must be at least 4000 cars. Determine how to minimize the total cost incurred during the next four quarters.

There is a concern that due to rising material and labor costs the variable cost in the fourth quarter may increase by 10%. Should you change your production plan if you believe this increase will occur? What would you do if you believed that there would be a 20% increase in variable costs in the fourth quarter?

**Problem 2:** Wivco produces two products: 1 and 2. The relevant data is shown below. Each week, up to 400 units of raw material can be purchased at a cost of \$1.50 per unit. The company employs four workers, who work 40 hours per week (their salaries are considered a fixed cost). Workers can be asked to work overtime and are paid \$6 per hour for overtime work. Each week 320 hours of machine time are available.

In the absence of advertising, 50 units of Product 1 and 60 units of Product 2 will be demanded each week. Advertising can be used to stimulate demand for each product. Each dollar spent on advertising product 1 increases its demand by 10 units, each dollar spent on product 2 increases its demand by 15 units. At most \$15 can be spent on advertising.

	<b>Product 1</b>	<b>Product 2</b>
<b>Selling price</b>	\$15	\$8
<b>Labor required</b>	0.75 hours	0.5 hours
<b>Machine time required</b>	1.5 hours	0.8 hours
<b>Raw material required</b>	2 units	1 unit

(a) Formulate an LP to maximize Wivco's weekly profit. Solve it using Excel.

Use the answer and the sensitivity analysis report to answer the following questions:

- (b) If overtime were only \$4/hour, would Wivco use it?
- (c) If each unit of product 1 sold at \$15.50, would the current solution still remain optimal? What would the new solution be?
- (d) What is the most that Wivco would be willing to pay for another unit of raw material?
- (e) How much would Wivco be willing to pay for another hour of machine time?
- (f) If each worker were required (as part of their regular work week) to work for 45 hours per week (with their salary remaining the same as in the original problem, so in essence Wivco gets five extra hours from each employee for free), what would the company's profit be?
- (g) Wivco is considering producing a new product (product 3). Each unit sells for \$17 and uses 2 hours of labor, 1 unit of raw material, and 2 hours of machine time. Should Wivco produce any of product 3?
- (h) If each unit of product 2 sold for \$10, would the current solution remain optimal?

**Problem 3:** Exercise 11 on page 2.33 of textbook

**Problem 4:** Exercise 5 on page 3.21 of textbook

**Problem 5:** Exercise 6 on page 3.22 of textbook