

**Homework #10**  
**Engineering Optimization (ISyE 4231) - Spring 2001**  
**Due April 20, 2001**

Show all your steps to get full credit.

**Reading assignment:** Read Chapter 7.

1. (30 points) Answer questions 7 and 8 of the case. In question 7 write a formulation using indexing and the symbols given in Table 1 to represent the data. Then using Lingo, create a model with the actual data given in the case and solve this model using Lindo. Follow the same steps in question 8.

2. (40 points) BWM manufactures cars and sports utility vehicles (SUV). Each car contributes \$6000 to profit and each SUV contributes \$8000. The resources required to produce a car are 8 hours on machine 1, 6 hours on machine 2 and 2 tons of steel. The resources to produce an SUV are 10 hours on machine 1, 7 hours on machine 2 and 3 tons of steel. Currently, Carco has 73 type 2 machines and 260 tons of steel available. The company can rent up to 98 type 1 machines at a cost of \$1000 per machine. Marketing constraints dictate that at least 88 cars and at least 26 SUVs be produced. Assume that a workday has 10 hours. The company wants to develop a production schedule to maximize its profits. Let

$x_1$  = number of cars produced daily

$x_2$  = number of SUVs produced daily

$m_1$  = number of type 1 machines rented daily

(a) (5 points) Explain how this problem can be modeled by the following linear program.

Max  $6000x_1 + 8000x_2 - 1000m_1$

Subject to

$$0.8x_1 + x_2 - m_1 \leq 0$$

$$m_1 \leq 98$$

$$0.6x_1 + 0.7x_2 \leq 73$$

$$2x_1 + 3x_2 \leq 260$$

$$x_1 \geq 88$$

$$x_2 \geq 26$$

(b) (10 points) Convert this problem into standard form by adding or subtracting slack variables  $s_1, \dots, s_6$ . In the optimum solution,  $x_1=88$ ,  $x_2=27.6$  and  $m_1=98$ . Using this information, determine which variables are basic in the optimum solution and create the simplex tableau that corresponds to the optimum basis. (If you need to compute the inverse of the basis matrix, you can use a calculator or a software package if you like.)

(c) (5 points) Carco is considering producing motorcycles. Producing a motorcycle will require 4 hours on machine 1, 6 hours on machine 2 and 1 ton of steel. What is the minimum price Carco should charge for a motorcycle such that it would be profitable to produce it?

(d) (5 points) Solve this problem using Lindo.

Answer the following questions using the Lindo output.

- (e) ( 4 points) If Carco had the opportunity to rent additional type 1 machines, what is the maximum price they would be willing to pay for each additional machine? How many machines would they be willing to rent at that price?
- (f) (3 points) Do you think marketing's decision of producing at least 88 cars is a good one? Why? How would the profits be affected if this restriction was reduced to 85?
- (g) (3 points) What is the impact of the marketing constraint about SUVs on the optimum solution? How would the optimum solution and the profits be affected if the minimum quantity of SUVs was reduced to 23? What if the minimum quantity was increased to 30?
- (h) (2 points) What is the minimum price Carco could charge for an SUV such that the current basis would still remain optimum?
- (i) (3 points) One of Carco's type 1 machines will not be available for half a day, due to maintenance problems. How would this impact the optimum production plan? What if that machine is down for a whole day?
- (j) (2 points) The daily rental fee for type 1 machines might increase to \$2000. How would this price increase impact Carco's production plan?
- (k) (3 points) Should Carco invest in acquiring additional type 2 machines? Why?