

# Operations Research

## Homework 4

Due via Moodle (Pyomo) or Mailbox (Question 1)  
on Tuesday, September 29, 2020

1. Use the simplex method to solve the WYNDOR company problem: *Maximize*

$$z = 3x + 5y$$

*subject to*

$$\begin{aligned}x &\leq 4, \\2y &\leq 12, \\3x + 2y &\leq 18, \\x, y &\geq 0.\end{aligned}$$

(First convert the problem to standard form!)

2. Reconsider Problem 1 from Homework Sets 1 & 2: *Minimize*

$$z = 8x + 12y$$

*subject to*

$$\begin{aligned}5x + 2y &\geq 20, \\4x + 3y &\geq 24, \\y &\geq 2, \\x, y &\geq 0.\end{aligned}$$

- (a) Take your Pyomo program from Homework 2. Pyomo can return the values of slack variables via the `lslack()` and `uslack()` attributes on each constraint. Re-run your code, call `lslack()` and `uslack()` on each constraint, and explain the numbers which are returned.
- (b) Pyomo can return the dual variables as shown in class. Compute the dual variables. What do you notice in relation to the values of the slack variables from part (a)?

- (c) Write out the dual of this problem explicitly and solve it in Pyomo. Compare to your result from part (b).
- (d) Give an interpretation of the meaning of all parameters and decision variables in the primal and dual problem. (E.g., in terms of unit profit, capacities, capacity requirement per unit, shadow prices, and number of units produced. Note that these are just suggestions; it is certainly possible to give alternative interpretations from completely different problem domains.)
3. (*This is a variation of Exercise 6.8-8 from HL.*) David, LaDeana, and Lydia are the sole partners and workers in a company which produces fine clocks. David and LaDeana each are available to work a maximum of 40 hours per week at the company, while Lydia is available to work a maximum of 20 hours per week. The company makes two different types of clocks: a grand-father clock and a wall clock. To make a clock, David (a mechanical engineer) assembles the inside mechanical parts of the clock while LaDeana (a woodworker) produces the handcarved wood casings. Lydia is responsible for taking orders and shipping the clocks. The amount of time required for each of these tasks is shown below.

<b>Task</b>	<b>Time Required</b>	
	<b>Grandfather Clock</b>	<b>Wall Clock</b>
Assemble clock mechanism	6 hours	4 hours
Carve wood casing	8 hours	4 hours
Shipping	3 hours	3 hours

Each grandfather clock built and shipped yields a profit of \$300 while each wall clock yields a profit of \$200.

- (a) Formulate and solve the problem in Pyomo, and ask Pyomo to compute shadow prices (dual variables) for each activity. Please submit a printout of your Ipython notebook showing code and output.
- (b) Occasionally, someone stops by asking for help with restoring antique clocks. How much should David charge per hour for mechanical repairs and how much should LaDeana charge per hour for wood restoration assuming that they do not wish to add more working hours and also do not wish to reduce company profit if one of them is taking on a repair job?