

MATH 190: MATHEMATICS IN SUSTAINABILITY

Emory University

Spring 2026

Prof. Mitchell Scott

Homework # 3: Linear Programming

Due: March 18, 11:30 am

1. **Agricultural Problem:**¹ A farmer owns a farm that produces corn, soybeans, and oats. There are 12 acres of land available for cultivation. Each crop that is planted has certain requirements for labor and capital. These data along with the net profit figures are given in the accompanying table.

Crop (per acre)	Labour (hr)	Capital (\$)	Net profit (\$)
Corn	6	36	40
Soybeans	6	24	30
Oats	2	18	20

The farmer has \$360 available for capital and knows that there are 48 hr available for working these crops. How much of each crop should be planted to maximize profit?

2. **Air Pollution Problem:**¹ Consider an airshed in which there is one major contributor to air pollution—a cement-manufacturing plant whose annual production capacity is 2,500,000 barrels of cement. Figures are not available to determine whether the plant has been operating at capacity. Although the kilns are equipped with mechanical collectors for air pollution control, the plant still emits 2.0 lb of dust per barrel of cement produced. There are two types of electrostatic precipitators that can be installed to control dust emission. The four-field type would reduce emissions by 1.5 lb of dust/barrel and would cost \$0.14/barrel to operate. The five-field type would reduce emissions by 1.8 lb of dust/barrel and would cost \$0.18/barrel to operate. The EPA requires that particulate emissions be reduced by at least 84%. How many

¹Set up a linear programming model of the situation described. Determine if the model is in OUR standard form. If it is not, state what must be changed to put the model into OUR standard form.

barrels of cement should be produced using each new control process to minimize the cost of controls and still meet the EPA requirements?

3. **Solving Linear Programming Problems:** Consider the LPP:

maximize $z = 3x + 4y$ subject to

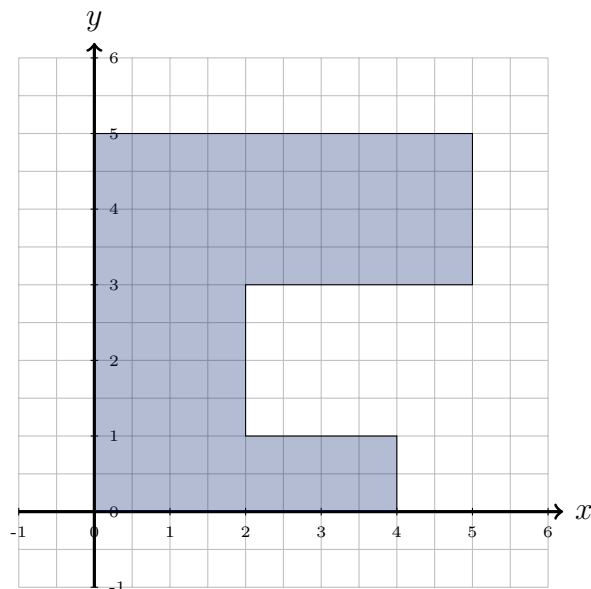
$$x + 3y \leq 6$$

$$4x + 3y \leq 12$$

$$x \geq 0$$

$$y \geq 0$$

- (a) sketch the set of feasible solutions to the given linear programming problem,
 - (b) draw the objective function $z = \mathbf{c}^\top \mathbf{x} = k$, for $k = 6, 8, 10$, and 12 , and
 - (c) conjecture the optimal value of z .
4. **Identifying Convex Shapes:** Is the below shape convex? Explain why or why not with specific points.



5. **Reflection** How long did this assignment take you (be honest)? Do you feel that this is too short or long? How is the material going? How can I help you?