Practice Problems

1) Use the problem description for the Muffin Mania problem from Module 3 and add the following requirement: Make at least twice as many double chocolate muffins as banana nut (due to anticipated demand) – and re-solve graphically.

2) Solve the following Linear Programming Model – you may recognize the problem attributes!

To supplement your income, you use your skills as a caterer to make banana nut and double chocolate muffins. Your goal is to minimize the cost of producing the banana nut and double chocolate muffins (in dozens). Banana Nut cost $4/dozen, Double Chocolate costs $5/dozen.

Constraints in your production of muffins include:

- Make no more than 15 dozen total.

- Make at least 6 dozen Banana Nut.

- Make at least 4 dozen Double Chocolate.

- Use at least 12 units of flour – each Banana Nut dozen uses 1 unit, each Double Chocolate uses 0.75 units.

Find the optimal product mix of muffins graphically.

3) Solve the following Linear Programming Model – you may recognize the problem setting!

Norman Bates is the General Manager of the Bates Motel. Each evening, he visits people in their rooms and offers complimentary Peanut Butter (PB) and Peanut Butter and Jelly (PBJ) sandwiches to tired travelers who didn't go into town for dinner. He also tried to indulge them in conversation to help pass the time.

Each day, Norman wants to make at least 25 sandwiches of both kinds combined. Based on known past demand, he also wishes that however many he should make, at least 60% of them must be PBJ's. For this day, he has 60 slices of bread, and each sandwich requires 2 slices.

Norman measures his peanut butter and his jelly by 'units', of which for this day, he has 40 units of peanut butter and 20 units of jelly available to make sandwiches. Each PB sandwich uses 1.5 units of peanut butter, and each PBJ uses 1 unit of peanut butter and 1 unit of jelly.

Finally, based upon the effort to create the sandwiches and their respective ingredients, Norman assesses the per unit cost of a PB sandwich to be $0.25, while the PBJ sandwich is estimated to cost $0.40.

Find the optimal number of sandwiches of each kind to make that satisfy the requirements of this situation and minimize cost.

4) **<u>Buffets Army</u>** – The Willy Buffett Foundation (WBF) each summer hires local high school and college students with local ties to staff its many camp and outreach activities around the upper Midwest. For the upcoming summer, based on cost and demand for student worker help, it can target to hire up to 600 high school (HS) students and college students (CO) combined. The Foundation will NOT target to hire more than 600, but could target to hire less depending upon other factors (described below).

Because the Foundation has been doing this for a number of summers, they have developed a metric that measures the 'attractiveness' of the HS and CO hires. This metric combines productivity and cost. Higher levels of this measure (call it a Buffetmeter) is better than lower levels. For this summer, assume that the Buffetmeter for a HS student is 300, while the Buffetmeter for a CO student is 700.

Due to local arrangements with the area high schools, the WBF has agreed that no more than 40% of the total students hired this summer can be college students (CO's). Additionally, history has also shown that some students who agree to come invariably never show up. This 'drop-out' rate tends to be 5% for the HS students and 10% for the CO students. WBF wishes to target students such that the total expected number of 'drop-outs' is no greater than 35.

The WBF wishes to find the optimal number of high school students (HS) and college students (CO) to <u>target to hire</u> such that the overall Buffetmeter measure is maximized, and that the hiring constraints of the situation described above are met.

Note that you are deciding on how many students of the two types to TARGET to hire. Drop out information constrains the decisions of the models, but don't make the problem more complex than it is.

Part II: Mechanics. Given the following LP models (represented abstractly with decision variables X and Y), find the optimal solution using the 'graphing' approach.

Your solution MUST show the following:

A) Graph
   a. Plotting all 3 constraints
   b. Shading in the feasible region of the entire LP model
   c. Identification of the relevant extreme points
B) Relevant Extreme Points
   d. Calculate the (X,Y) values of each relevant Extreme Point
   e. Show the algebraic calculations of how the (X,Y) values of the Extreme Points were calculated (eyeballing a picture is not sufficient).
C) Optimal Solution
   f. Evaluate each Extreme Point by the objective function
   g. Identify which extreme point is the 'best'.

5)

Minimize $17X + 8Y$

Subject to:

$$2X + 3Y \geq 72$$
$$4X + 2Y \geq 80$$
$$X + 2Y \leq 68$$

And non-negativity, of course.

6)

Minimize $7X + 5Y$

Subject to the following constraints:

$$6X + 8Y \geq 96$$
$$2X + 3Y \leq 54$$
$$4X + 2Y \geq 40$$

And non-negativity, of course.