Mth 21, Homework 12 on sections 8.9, 12.0, 12.1

Due by Wed, Dec 6.

Please use lots of space and explain your answers, showing clearly any work you had to do. Each question is worth 3 points.

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(1) Draw the first steps of the Koch snowflake fractal as follows:

- **(a)** Draw an equilateral triangle (all sides equal).
- **(b)** Divide each edge into three parts and add an equilateral triangle to the middle parts.
- **(c)** Do the same again: divide each outside edge into three parts and add an equilateral triangle to the middle parts.

(2) **(a)** Draw a rectangle of length 2 and width 1.

- **(b)** If you make it three times bigger, how many copies of the original rectangle fit inside?
- **(c)** Use the formula $s^d = n$ to compute the dimension d of the original rectangle (the scaling factor s is 3 and n is the number of copies).

(3) The Mandelbrot set is a famous fractal shape. Google it to find amazing videos of what happens as you zoom in on this shape. When was it discovered?

(4) Draw the x and y axes and carefully mark off and number them. Then plot these three points: $(4, 1)$, $(0, -2)$, $(-2, 3)$

(5) **(a)** Graph the line $x + 3y = 3$

- **(b)** Graph the inequality $x + 3y \leqslant 3$

(Hint: a simple way to graph a line is to put $x = 0$ and then $y = 0$ to see where it crosses the axes. For the inequality shade the side of the line corresponding to the solutions.)

(6) Find the point where these two lines meet:

$$\begin{aligned} 2x - 3y &= 1 \\ 3x + y &= 7 \end{aligned}$$

(Hint: to get the ys to cancel, multiply the second equation by 3 (every part) and add it to the first. Find x and then use that x in one equation to find y. Now you have the coordinates of the point where the lines meet.)

(7) **(a)** Graph the triangular region bounded by the inequalities:

$$\begin{aligned} x &\geqslant 0 \\ y &\geqslant 0 \\ 2x + y &\leqslant 2 \end{aligned}$$

(b) Give the coordinates of its three corner points.

(8) Maximize the objective function $z = 3x + 2y$ subject to the constraints in question 7.

(Hint: the key idea of linear programming is that any maximum (or minimum) must be at a corner point. So work out z at each of the three corner points you found and use the biggest.)

(9) A carpenter makes x tables and y chairs from a supply of 200 kilograms of wood every week. Suppose she has time to make at most 12 items per week, and each table needs 30 kg and each chair 10 kg of wood. Give the 4 inequalities that describe this situation.

(10) Maximize $z = x + y$ subject to the constraints:

$$\begin{aligned} x &\geqslant 0 \\ y &\geqslant 0 \\ x + 3y &\leqslant 9 \\ 2x + y &\leqslant 8 \end{aligned}$$

(11) Minimize $z = 4x + 3y$ subject to the constraints:

$$\begin{aligned} x &\geqslant 0 \\ y &\geqslant 0 \\ x + y &\geqslant 4 \\ x + 2y &\geqslant 6 \end{aligned}$$

(Hint: graph the corresponding region - it is infinitely large and does not have $(0, 0)$ as a corner. Since we are minimizing, find the corner point that makes z smallest.)

If you get stuck on a question or aren't sure if you understand it:

- Go over the relevant class notes and section in the textbook.
- Check if you get the right answer for a similar odd-numbered question in the textbook (answers at the back of the book).
- Ask me about it after class.
- Come to my office hours: Mon 11:30 - 12:30, Wed 11:30 - 12:30 in CP 317.
- Go to the Math Tutorial Lab in-person in CP 303 or online.