

Math 408R: Calculus for Biologists
Mini-Project 4: due in class Monday, November 14

Please do a nice, neat, complete job. Explain your reasoning at every step. Write in complete sentences, draw careful graphs with axes labeled, etc. **You can use MATLAB for your graphing if you want to, but you don't have to.** (You can do it by hand.)

You will most likely want to print out the graphs on the last two pages, tape them together end to end (so that they form one continuous graph covering the 48-hour period in question), and draw some things (Riemann sums and so on) on top of them. You don't need to print out in color.

The graphs on the last two pages here depict power generation and power consumption at High Peaks Elementary School/Boulder Community School of Integrated Studies in Boulder. The green curve represents power **generated** from solar cells installed at the school. The red curve represents power **usage** at the school.

The vertical axis is the power axis. The range is 0-10 kilowatts (kW). The horizontal axis is the time axis. The domain is from 12 AM Monday, March 18 until 12 AM Wednesday, March 20, 2013. Each of the ticks on the time axis represents 1/2 hour. (The bolder ticks are spaced 3 hours apart.)

Here are the questions you need to answer. For any questions requiring Riemann sums, please use rectangles of baselength AT MOST one hour. (You can use shorter baselengths if you really want to.) Be consistent in your choice of points within each subinterval: use left endpoints, right endpoints, or midpoints, but don't mix and match. (If you want to do something clever like trapezoids, go ahead, but please explain what you're doing.)

1. Let's consider the green curve, between any two points in time on the domain, say $t = a$ and $t = b$. What quantity does the *area* under this curve, between these two points, represent? What are the units for this quantity?
2. Now let's consider the red curve, between any two points in time on the domain, say $t = a$ and $t = b$. What quantity does the area under *this* curve, between these two points, represent? What are the units for this quantity?
3. Let's now think of the *starting point* of the above 48-hour period as $t = 0$. For this two-day period, sketch the following two quantities, on the same set of axes (you'll need to draw a new picture; that is, don't do this on top of the graph supplied):
 - (a) A graph of cumulative energy *generated* since $t = 0$;
 - (b) A graph of cumulative energy *consumed* since $t = 0$.
4. Do the graphs in parts (a) and (b) of exercise 3 above intersect? If so, what does this signify?

5. If you were to sketch the *derivative* of the function you sketched in question 3(a) above, what would this derivative look like (roughly)? Please explain. (You don't actually have to sketch this derivative to answer; in fact, you've already seen the graph of this derivative, very recently!) Answer the same question for your graph in question 3(b).
6. Estimate the total amount of energy *generated* during (a) the first twenty-four hours of the above 48-hour period, and (b) the second twenty-four hours of the above 48-hour period.
7. Estimate the total amount of energy *consumed* during (a) the first twenty-four hours of the above 48-hour period, and (b) the second twenty-four hours of the above 48-hour period.
8. On which of the two days was the net energy into the grid (meaning energy generated minus energy consumed) greater?



