

# Math 530, Spring 2010. Homework 1

## Due Monday, January 31

NAME -----

### Problem 1

Some state water-right agencies require from communities data on the rate of water use, in gallons per hour, and the total amount of water used each day. Many communities do not have equipment to measure the flow of water in or out of the municipal tank. Instead, they can measure only the level of water in the tank, within 0.5% accuracy, every hour. More important, whenever the level in the tank drops below some minimum level  $L$ , a pump fills the tank up to the maximum level,  $H$ ; however, there is no measurement of the pump flow either. Thus, one cannot readily relate the level in the tank to the amount of water used while the pump is working, which occurs once or twice per day, for a couple of hours each time.

Table below gives the real data from an actual small town for one day. Water tank levels over a single day for a small town (time is in seconds and level is in 0.01 ft)

Time	Level	Time	Level	Time	Level
0	3,175	35,932	pump on	68,535	2,842
3,316	3,110	39,332	pump on	71,854	2,767
6,635	3,054	39,435	3,550	75,021	2,697
10,619	2,994	43,318	3,445	79,254	pump on
13,937	2,947	46,636	3,350	82,649	pump on
17,921	2,892	49,953	3,260	85,968	3,475
21,240	2,850	53,936	3,167	89,953	3,397
25,223	2,797	57,254	3,087	93,270	3,340
28,543	2,752	60,574	3,012		
32,284	2,697	64,554	2,927		

The table gives the time, in seconds, since the first measurement and the level of water in the tank, in hundredths of a foot. For example, after 3316 seconds, the depth of water in the tank reached 31.10 ft. The tank is a vertical circular cylinder, with a height of 40 ft and a diameter of 57 ft. Usually, the pump starts filling the tank when the level drops to about 27 ft, and the pump stops when the level rises back to about 35.50 ft.

Estimate the flow out of the tank  $f(t)$  at all times, even when the pump is working, and estimate the total amount of water used during the day.

## Problem 2

Apply the 2-dimensional Fourier analysis to some image (you can, for example, use one of face images at [www.nmt.edu/~olegm/530/faces](http://www.nmt.edu/~olegm/530/faces)).

“Compress” the image by applying inverse FFT and using only 50% and 25% of all nontrivial Fourier coefficients available.