QMDA Homework 7

Fourier Analysis

The file 'Files/Homework/QMDA_HW_07.mat' on CourseWorks contains one year of tide data from the Battery in New York City. It defines two vectors of N elements each: time in days 'ti' and sea surface elevation in meters 'hi'.

A) Do a standard "look at the data" by plotting hi versus ti and convince yourself that the data make sense.

B) Determine the sampling interval and verify that the data are sampled at an equal increment of time.

C) Compute the fast Fourier transform of the data with the 'fft' function of Matlab. Define a vector of frequencies that is of length N and has both positive and negative frequencies. See Section 2 of 'Files/Lecture Notes/fourier.pdf' on CourseWorks or p. 114, Section 6.3 of the textbook. See also 'Files/Matlab examples/fftdemo.m'.

D) Compute the periodogram as the squared magnitude of the complex Fourier transform coefficients (use the 'abs' function of Matlab). To see periodic components in the data, plot the logarithm of the periodogram versus frequency (use the Matlab function 'semilogy') for positive frequencies up to about 15 cycles/day. Do not plot the periodogram for the zero frequency, which is just the squared mean value of the data.

E) You should see peaks where the values of the spectrum are markedly higher than at surrounding frequencies, showing large periodic components in the tidal data. Make a table of the frequencies (in cycles/day) and corresponding periods (in days) where you see major periodicities.

F) Comment on the following questions:

- Is there a peak in the spectrum that is more prominent than others? At what frequency and period?
- Can you explain the numeric value of the frequency and period of the most prominent peak? (Hints: How many high or low tides occur in a day at the Battery? Do high and low tides occur at the same time every day? Check this NOAA website: https://oceanservice.noaa.gov/education/tutorial_tides/tides05_lunarday.html)
- Can you explain the numeric value of the frequency and period of the other peaks in the periodogram?