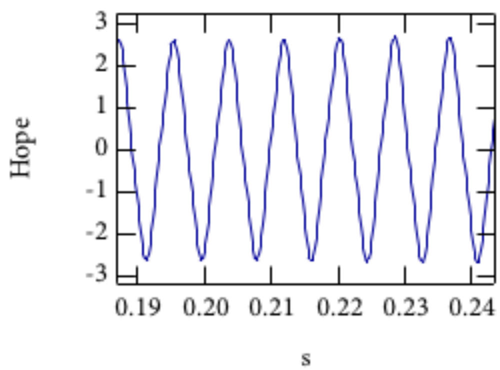
August 23 Summary

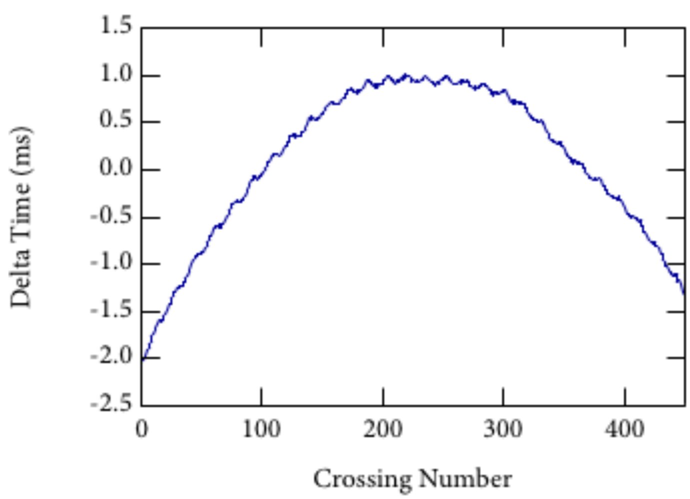
(13:08) In the shaking building experiment, I noticed that the frequency of the drive motor for fixed supply voltage varies more when the building is vibrating a lot (near resonance). This variation caused a lot of scatter in the frequency response data near resonance. Using the LabJack U3-HV, it would be possible—in principle—to use PID control to monitor the instantaneous rotation frequency of the motor and to alter the drive voltage to counteract the variations in rotation speed caused by coupling to the shaking tower. [*I think they talk about PID control in Engr 59.*] However, if the variation in angular velocity occurs within each revolution, PID won't be fast enough.

(13:14) To investigate whether the angular velocity does vary significantly in each revolution, I set the drive voltage at a constant value to produce a rotation frequency of 15 Hz (I should have written down that voltage). I used the GW Model GPS-1850 power supply (HMC tag). I wrote a simple Python program to record streaming data from the LabJack, which was connected to the tachometer output of the motor. The sample frequency was 5000 Hz.



After sampling for several seconds, the data were written to a file and analyzed in Igor.

(13:18) The tachometer frequency is 8 times the rotation frequency of the motor. The output is *not* sinusoidal; it looks almost triangular. An example is shown in the figure at right. To figure out the "instantaneous" rotation speed, I decided to monitor the times of the zero crossings of the tachometer signal. The Igor command **FindLevels** produced a wave of the times of all the zero crossings (16 per revolution). These were fitted to a straight line (sorry, no uncertainties). I then examined the residuals, which are shown in the second figure.



(13:28) The figure plots the residual time (compared to the linear trend) vs. crossing number. The residuals show two obvious trends. First, there is the slow, roughly parabolic variation. This takes place on a tSime scale of something like 500 / (15 Hz) (16 crossings/rev) = 2 s. However, there is a clear fast ripple. Furthermore, it has a period of 16 crossings, just what we expect for variations within each revolution. *So, there is noticeable variation in angular velocity within a revolution.*

(13:43) Next time, I would like to see if I can figure out a way to alter the applied voltage at the right cadence to eliminate this variation. This will probably be tricky, because I can't see the variations until after they have happened, but have to change the voltage *before* they happen. Then I will implement a PID controller to stabilize the frequency of the drive motor.