Homework #1, ENGR 100-430, W24. Due **Fri. Feb. 2, 5PM**

Notes

- Each HW is due at 5PM and that time will be set on Canvas. The due time on Gradescope will be set to 11PM, giving you a 6 hour grace period to get your HW scanned and uploaded properly there with proper matching of your uploaded documents to the problems. To ensure equity, *only solutions that are uploaded on time and properly submitted will earn credit.* Be sure to review the gradescope submission process well before the HW deadline.
- You must write the Engineering Honor Pledge on your exams in this class for them to be graded. To review the honor pledge, visit `https://ecas.engin.umich.edu/honor-council`.
- This is an individual assignment, not a group project. Refer to the course syllabus for the collaboration policies.
- Submit your answers to Gradescope. Submitting properly is required to earn credit.
- This homework is worth 10 points, for the first 5 problems. The "challenge problems" are optional, but each one you solve correctly will add to your score (up to 10) so if you make a mistake on one of the basic problems then you could get those points back with a correct solution to one of the challenge problems. So attempting all the challenge problems is in your best interests both educationally and in terms of points.
- Neat hand-written work is fine. Provide brief explanations, not just the final answer.

Basic Problems

1. [2] A sinusoidal signal is sampled at $S = 8192\ \frac{\text{Sample}}{\text{Second}}$ and a few of the samples recorded are $x(7/S) = 50,\ x(8/S) = 80,\ x(9/S) = 30$. Determine the frequency of the sinusoid.

2. [2] List three practical limitations of the arccos method for frequency estimation.

3. [2] A sinusoidal signal is sampled at $4000\ \frac{\text{Sample}}{\text{Second}}$ yielding the digital signal $x[n] = 7\cos((\pi/4)n + \pi/9)$. What was the period of the original (analog) sinusoid?

4. [2] A student drops a ball from 9 different heights and measures the velocity of the ball when it hits the ground for each height. To display the resulting data as a scatter plot that looks like a straight line, should she use a semilog plot or a log-log plot? Explain.

5. [2] This problem is to check your understanding of `Julia` array indexing. Try to do it *without* using `Julia`. What would `Julia` display if you enter the following: `x = 10:5:50; k = [3, 1, 2]; println(x[k])`

Challenge problems

6. [2] Refer to the arccos plot in the lecture notes for Lab 2. Considering this plot and the arccos method for finding the frequency of a sinusoid, what is the *highest* possible frequency that will be computed by the arccos method if the sampling rate is $S = 44.1$ kHz?

7. [2] A signal is sampled at $S = 1000$ Hz and the samples are $x(7/S) = 50,\ x(8/S) = 20,\ x(9/S) = 30$. Could this signal be a pure sinusoid?

8. [2] A signal $x(t)$ is known to be sinusoidal with frequency 100 Hz. It is sampled by an A/D converter, and the following two sequential values are observed: $x(0.001) = 10,\ x(0.002) = 7$. Determine the value of $x(0.003)$.

9. [2] A signal is sampled at $S = 44.1$ kHz and four of the sample values recorded are $x(1/S) = 10,\ x(2/S) = 40,\ x(3/S) = 30,\ x(4/S) = 0$. Could this signal be a sinusoidal signal? If so, give its frequency. If not, explain why not.