Follow the instructions below:

1. The exam must be solved individually.
2. Submitting materials retrieved from the internet is plagiarism.
3. Solutions must be in a Jupyter notebook, with a Julia kernel.
4. You may use all Julia code posted on the course web site and your own code.
5. The questions are provided in a Jupyter notebook.
   You may use that notebook to formulate your answers to the questions.
6. Answers must be submitted before, or at the latest at 12:50pm.
7. Submit to gradescope.
8. Answers submitted before noon on Wednesday 4 March will receive homework credit.
9. Every question is worth the same amount of points.
10. During the exam no questions will be answered, so do not ask questions.

*Good Luck!*

1. Consider a composite product with three components.

   The product fails if the first component fails or if both the second and third component fail.

   The life span of the $i$th component $c_i$ is normally distributed with averages $\mu$ and standard deviations $\sigma$ listed in hours below:

   | | $\mu$ | $\sigma$ |
   |---|---|---|
   | $c_1$ | 500 | 100 |
   | $c_2$ | 400 | 150 |
   | $c_3$ | 300 | 200 |

   Define a Monte Carlo simulation to estimate the average life span of this composite product. Run at least 10,000 iterations in the simulation.

2. Let $f(t) = 5\sin(4 \cdot 2\pi t) + 2\sin(8 \cdot 2\pi t)$ represent a signal, for $t \in [0, 4]$.

   (a) Use the FFT to compute the spectrum.
   Explain how from the spectrum you can recognize the two components of $f$.

   (b) From the spectrum, remove the second component of $f$.

   (c) Compute the inverse FFT of the spectrum with the second component removed.
   Make a plot of the new signal, for $t \in [0, 4]$.
   Explain the differences with the original signal.

3. Let $f(t) = (\cos(2\pi t))^4$.

   Compute a least squares approximation for $f$ using a Fourier basis of sines and cosines.

   How many basis functions are needed for the largest error of the least squares approximation to be less than $10^5$ over $[-1, +1]$?

4. A sales manager needs to organize trips for three representatives to visit three different locations. Each representative can travel to each location, but their travel costs are different for each location, as listed in the table below:

   | | locations | | |
   |---|---|---|---|
   | representatives | $L_1$ | $L_2$ | $L_3$ |
   | $R_1$ | \$730 | \$728 | \$558 |
   | $R_2$ | \$984 | \$791 | \$1,033 |
   | $R_3$ | \$1,046 | \$670 | \$518 |

   The goal is to assign to each representative one location so that all locations are visited in the most economical manner.

   Set up a linear programming model for this problem.

5. Describe in one paragraph what you learned from *another* project presentation.