Math 320 Programming Project I - Fall 2025

Please submit all project parts on the Moodle page for MAT320. You should include all necessary files to recompile, a working executable, and a README.txt, all in a zipped folder (one file for upload). The README should contain: C++ version information if necessary, suggested command line compile and run commands, any other information needed to compile or run. Time-stamp determines the submit time, due by midnight on the due-date.

For each part below, you will need to write a command line program in C++ with text input and output. Parts can also be combined into one program with a clearly defined interface to run separate parts. A user interface is not required, however since more students are adopting JUCE for audio projects, it is reasonable to do this sequence of projects with JUCE also. The basic requirements remain the same: text input and output.

Input files of complex numbers should be one number per line of the form: $-1.23 + 4.56789i$ or $-1.23 - 4.56789i$ but not $-1.23 + -4.56789i$.

1.
   - input: command line args: N (number of complex values), x (angle multiplier), input.txt (text file of N complex numbers)
   - output: the complex numbers rotated by $2\pi x$ (counterclockwise for $x > 0$ and clockwise for $x < 0$)
2.
   - input: command line args: positive integers N and k
   - output: complex number sum of the first k powers of the Nth root of unity $e^{i2\pi/N}$

$$1 + e^{i2\pi/N} + (e^{i2\pi/N})^2 + \cdots + (e^{i2\pi/N})^{k-1}$$

3.
   - input: command line arg N, and two text files of N complex numbers each
   - output: the complex inner product of the two vectors given by the text files
4.
   - input: command line arg N, and text file of N complex numbers
   - output: the complex inner product of the vector given by the text file with the complex vector of roots of unity:

$$(1, e^{i2\pi/N}, (e^{i2\pi/N})^2, \cdots, (e^{i2\pi/N})^{N-1})$$

Note: The complex inner product of two vectors is given by:

$$(z_1, z_2, \ldots, z_n) \bullet (w_1, w_2, \ldots, w_n) = z_1\bar{w}_1 + z_2\bar{w}_2 + \cdots + z_n\bar{w}_n.$$