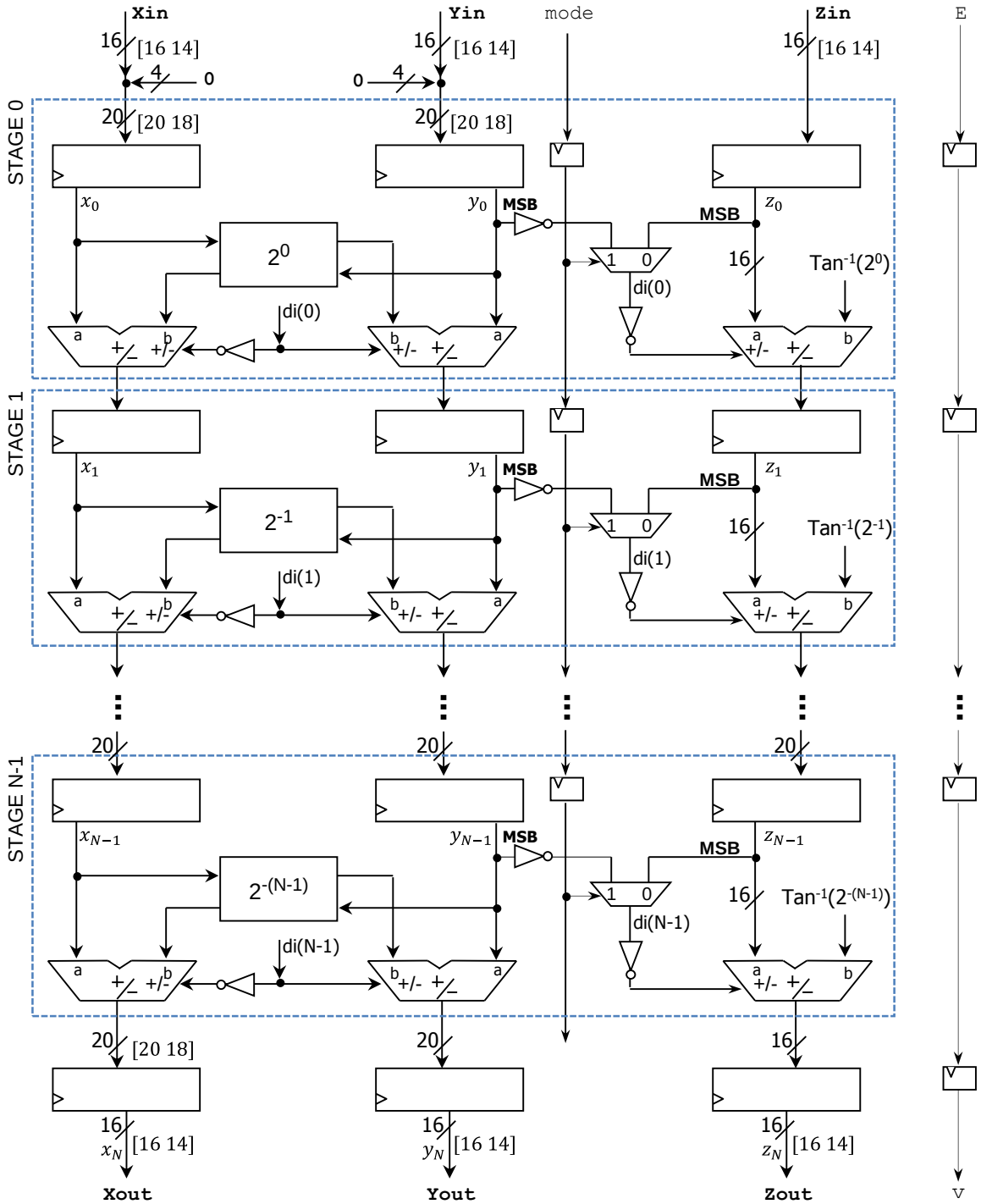
Homework 4

(Due date: December 4th @ 5:30 pm)
You can submit in groups of two (2) students.

PROBLEM 1 (60 PTS)

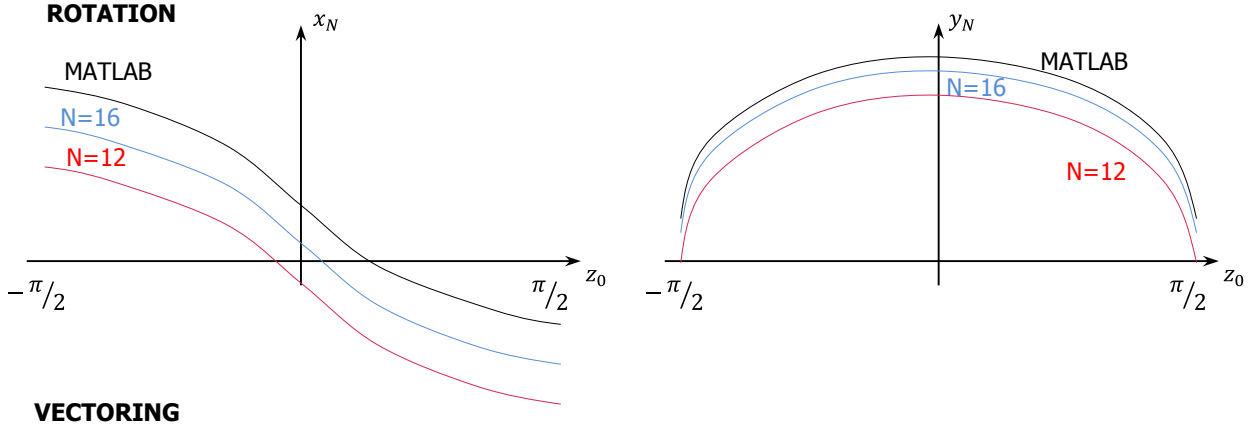
- Design the pipelined Circular CORDIC architecture (basic range of convergence) with N iterations shown in the figure below. In this circuit, rotation mode occurs when mode = '0', and vectoring mode occurs when mode = '1'.
- The circuit must be written in parametric VHDL code with N as the only parameter. $N = 4\ to\ 16$.
- Tip: Implement a stage i as a parametric component. Then on the top file, just instantiate N of those components.



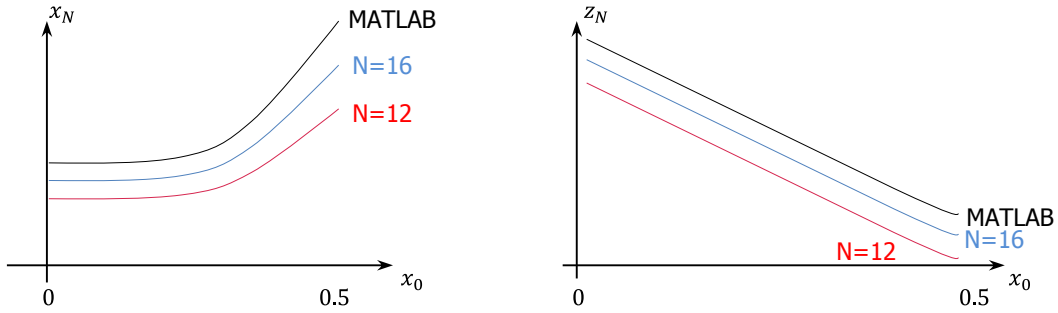
PROBLEM 2 (40 PTS)

- Simulate the circuit by reading input values (x_0, y_0, z_0) from input text files and writing output values (x_N, y_N, z_N) on output text files. We need to test the parameterized CORDIC circuit for $N = 12$ and $N = 16$. The testbench must:
  - ✓ Read input values (x_0, y_0, z_0) from two input text files:
    - `in_benchR.txt`: Data for Rotation Mode testing. Generate this file with MATLAB®.
      100 data points (x_0, y_0, z_0). Data format: [16 14]. Each line per data point written as hexadecimals: `|x0|y0|z0|`.
      Data set: $x_0 = 0, y_0 = 1/A_n, z_0 = -\pi/2 \ to \ \pi/2$. z_0: 100 equally-spaced values between $-\pi/2 \ to \ \pi/2$.
      With this data set in the rotation mode, note that $x_N \rightarrow -sin(z_0)$, $y_N \rightarrow cos(z_0)$.
    - `in_benchV.txt`: Data for Vectoring Mode testing. Generate this file with MATLAB®.
      100 data points (x_0, y_0, z_0). Data format: [16 14]. Each line per data point written as hexadecimals: `|x0|y0|z0|`.
      Data set: $x_0 = 0.0 \ to \ 0.5, y_0 = 1, z_0 = 0$. x_0: 100 equally-spaced values between $0.0 \ to \ 0.5$.
      With this data set in the vectoring mode, note that $x_N \rightarrow A_n\sqrt{x_0^2 + y_0^2}, z_N \rightarrow atan(y_0/x_0)$.
  - ✓ Write output results (x_N, y_N, z_N) on `out_bench_N12.txt` and `out_bench_N16.txt`. Data format: [16 14], each line per data point written as hexadecimals: `|xN|yN|zN|`. Each output text file should have 200 data points (100 from the rotation mode and 100 from the vectoring mode).
- Vivado tips:
  - ✓ Make sure that the input text files are loaded as simulation sources.
  - ✓ The output text file should appear in `sim/sim_1/behav`.
  - ✓ To verify that the output results are correct, you need to represent data as fixed-point numbers. Use `Radix → Real Settings` in the Vivado simulator window.
- MATLAB® (or Octave): Read data from the output text files and plot the results (rotation and vectoring modes for $N = 12,16$) along with the function values (Rotation: $x_N \rightarrow -sin(z_0)$, $y_N \rightarrow cos(z_0)$. Vectoring: $x_N \rightarrow A_n\sqrt{x_0^2 + y_0^2}, z_N \rightarrow atan(y_0/x_0)$ to which the CORDIC results should converge.
  - ✓ $atan$ in the CORDIC algorithm has a different definition, called $atan2$.

ROTATION



VECTORING



Deliverables:

- Printout of the plots (pdf).
- Upload the following files to Moodle (an assignment will be created):
  - ✓ VHDL code
  - ✓ VHDL testbench
  - ✓ Input text file for testbench
  - ✓ Output text file for testbench.