Homework 1 - Mach Zehnder Interferometers (20pts)

Please complete this assignment with pencil and paper
Submit via Gradescope (Entry Code: D32PYP)

1. Draw a diagram for a Mach Zehnder Interferometer (MZI) with two beam splitters and two mirrors (like in lecture) but with light entering from the bottom port of the first beam splitter. Draw diagrams showing the two paths that light could exit the right port of beam splitter 2.

2. Calculate the electric field exiting out of the right port of beam splitter 2 in terms of E_{in}. *Assume that the two paths of the photons are equal ($l_a = l_b$)*

3. What is the relative phase of the electric field exiting the top port of beam splitter 2?

4. Draw a diagram of a MZI but introduce a phase shift of π (180°) into the lower path. Which port of beam splitter 2 in the MZI with a phase shift does the light exit? Why?

5. Draw the single qubit quantum circuit that is equivalent to the MZI with a phase shifter.