Compulsory assignment in MAT3420, Spring 2020

The solutions must be submitted via Canvas by 14:30 on Tuesday, March 31, 2020.

The goal of the assignment is to get a better, hands-on understanding of standard quantum gates and simple quantum circuits. You first need to create an account at IBM Quantum Experience, read Composer Guide and Gates Glossary.

For every problem you will have to create the required circuit, run it on a simulator (or actual quantum computer if you don't mind waiting!) and export the corresponding OpenQASM file. The OpenQASM code and short explanations why the results suggest that your circuits do the right things is what you have to upload as a solution of the assignment.

Problem 1.
The input is one qubit in the state $|0\rangle$. Change the state of the qubit into

$$\frac{1}{\sqrt{2}}(|0\rangle + |1\rangle).$$

Problem 2.
The input is one qubit in the state $|0\rangle$. Change the state of the qubit into

$$\cos\frac{\pi}{10}|0\rangle + \sin\frac{\pi}{10}|1\rangle.$$

Problem 3.
The input is two qubits in the state $|00\rangle$. Change the state of the qubits into

$$\frac{1}{2}(|00\rangle + |01\rangle + |10\rangle + |11\rangle).$$

Problem 4.
The input is two qubits in the state $|00\rangle$. Change the state of the qubits into

$$\frac{1}{\sqrt{2}}(|00\rangle + |11\rangle).$$

Hint: how about using the Hadamard and CNOT gates?

Problem 5.
The input is two qubits in the state $|00\rangle$. Change the state of the qubits into

$$\frac{1}{\sqrt{2}}(|01\rangle - |10\rangle).$$