

# Quantum Computing Project

2019 fall

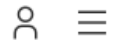
# Project research

- Individual project
- Study and perform quantum computing on line.
- mid-term report on Nov 6
- Poster presentation on Dec 27
- Term paper before Jan 10

# IBM Q



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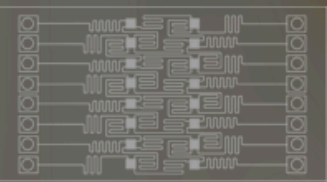
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# IBM quantum processors

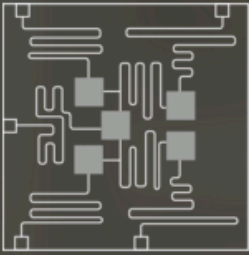
**ibmqx3**

BETA MAINTENANCE



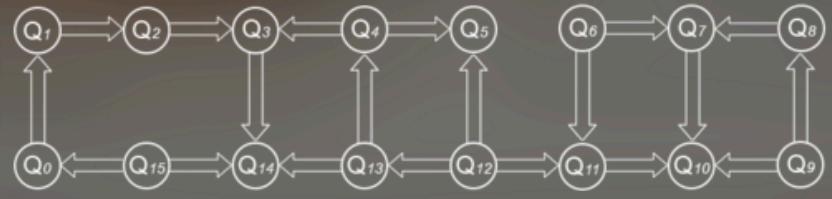
	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Gate Error ( $10^{-3}$ )	1.83	2.30	3.66	2.09	1.73	3.52	1.39	1.61	1.07	1.40	1.93	2.24	8.84
Readout Error ( $10^{-2}$ )	3.64	10.34	2.75	3.91	8.82	4.66	4.20	5.38	6.63	9.71	4.60	4.97	7.76
MultiQubit Gate Error ( $10^{-2}$ )	<b>CX0_1</b>	<b>CX1_2</b>	<b>CX2_3</b>	<b>CX3_14</b>	<b>CX4_3</b>		<b>CX6_7</b>	<b>CX7_10</b>	<b>CX8_7</b>	<b>CX9_8</b>		<b>CX11_10</b>	<b>CX12_11</b>
	3.90	4.22	3.66	4.00	3.43		2.57	3.27	4.34	2.70		2.77	8.75
					<b>CX4_5</b>		<b>CX6_11</b>			<b>CX9_10</b>			<b>CX12_13</b>
				5.09		2.54			2.95				5.37
													8.15

MAINTENANCE **ibmqx2**



**Date Calibration**  
2017-08-25 19:40:45

**Fridge Temperature**  
0.0149251 K



Looking for more details? See more here!

# QC composer

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Name: '5Q Complete Superposition Circuit' [New](#) [Save](#) [Save as](#)

ibmqx2

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Gates Properties QASM My Units

GATES  Advanced



BARRIER



OPERATIONS



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<https://quantumexperience.ng.bluemix.net/qx/editor>

# Perform QC using IBM Q

- Do the following tasks :
- Understand quantum logic gates and algorithms
- Compose your code and run results
- Calculate the ideal result using python program
- Contains at least 3 qubits and 20 gates including 2-bit gates.
- Copy code is not allowed!

# Summary of quantum gates

Table of Quantum Gates and what they do				
State	Gate sequence to prepare the state	Transformation on Bloch sphere	Gates to measure in the respective basis	Name of measurement basis
$ 0\rangle$	(none, ground state)	None		Z, "standard"
$ 1\rangle$		$\pi$ rotation around X		Z, "standard"
$ +\rangle$		$\pi$ rotation around X + Z	 	X
$ -\rangle$	 	$\pi$ rotation around X + $\pi$ rotation around X + Z	 	X

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Gate	Transformation on Bloch sphere (defined for single qubit)
X	$\pi$ -rotation around the X axis, $Z \rightarrow -Z$ . Also referred to as a bit-flip.
Z	$\pi$ -rotation around the Z axis, $X \rightarrow -X$ . Also referred to as a phase-flip.
H	maps $X \rightarrow Z$ , and $Z \rightarrow X$ . This gate is required to make superpositions.
S	maps $X \rightarrow Y$ . This gate extends H to make complex superpositions. ( $\pi/2$ rotation around Z axis).
$S^\dagger$	inverse of S. maps $X \rightarrow -Y$ . ( $-\pi/2$ rotation around Z axis).
T	$\pi/4$ rotation around Z axis.
$T^\dagger$	$-\pi/4$ rotation around Z axis.

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# 2-bit gate



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[Full User Guide](#) / Quantum Algorithms

## Quantum Algorithms

In this section we embark on more complex scores and explore the components it takes to construct real quantum algorithms. We go beyond simply defining entanglement and begin to use it in computation, in order to perform some well-known algorithms (with more to come in the future):

- Grover's algorithm
- Deutsch-Jozsa algorithm
- Learning parity with noise
- Phase estimation algorithm
- Shor's Algorithm

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# Why do this project

- A full controllable quantum system for one to manipulate and measure.
- Understand quantum superposition and quantum uncertainty with real experiment.
- Understand the matrix formalism of quantum physics.