

SENG 457/CSC 557

Lab 1: Hello Quantum World

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- Engage in hands-on Qiskit/PennyLane programming sessions
- Participate in pen-and-paper exercises to practice concepts and notations in quantum computing
- Attendance contributes to the overall grade: 5% for undergraduates, 5% for graduate students

To-do list for today

- Install Anaconda Python, Qiskit, and PennyLane
- Run a sample Qiskit program on Jupyter notebooks
- Practice Circuit - Dirac - Matrix notations for one qubit
- Sign the attendance sheet!


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Programming tools

- Python 3.9 or newer (via Anaconda or standalone)
- Qiskit 2.0
- PennyLane 0.41.1

<https://www.anaconda.com/download>

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- Accept the user agreement
- Choose the destination for your Anaconda Python installation
- Optional: If you do not have Python 3.9 or newer installed, you may register it as the default (second in Advanced Options)
- Install

Create an environment

- Open Anaconda Navigator or Anaconda Prompt
- (OR) Command line access: Add anaconda to your PATH to access it from the command line
- Create and activate the environment
 - `conda create -n ENV_NAME`
 - `conda activate ENV_NAME`

Install Qiskit¹

- Type in the following:
 - `pip install qiskit`
 - `pip install qiskit --ibm-runtime`
 - `pip install qiskit [visualization]`
- Test your installation by importing Qiskit in a Python environment (e.g. a Jupyter Notebook):
 - `import qiskit`

¹<https://docs.quantum.ibm.com/start/install>

- Type in `pip install pennylane --upgrade`
- Test your installation by importing PennyLane in a Python environment (e.g. a Jupyter Notebook):
 - `import pennylane as pl`

²<https://pennylane.ai/install/>

Access Qiskit on cloud³

The screenshot displays the IBM Quantum Platform dashboard. At the top, there's a navigation bar with 'IBM Quantum Platform', 'Dashboard', 'Compute resources', and 'Jobs'. A search bar and user profile are on the right. Below the navigation bar, the 'IBM Quantum Platform' title is prominent. To the right, an 'API Token' is shown. The main content area is divided into several sections: 'Open Plan' with a 'View details' and 'Upgrade' link; 'Monthly usage' showing 'Used 0ms' and 'Remaining 10m'; 'Recent jobs' with a table of job details; 'Instance systems' showing '3' systems; 'Documentation' with a search bar; and 'Learning' with a 'New' badge. A 'What's new' section on the right lists recent updates and product changes.

Open Plan
[View details](#) | [Upgrade](#)
Up to 10 minutes/month

Monthly usage

Used	Remaining
0ms	10m

Recent jobs [View all](#)

Job ID	Status	Created	Completed	Compute resource
cnr8ehj5s870008xryh0	Completed	About 1 month ago	About 1 month ago	ibm_osaka
cg5o59d7vlubm7kb9b80	Failed	10 months ago	10 months ago	ibm_oslo
cg5nthnjktdep3h0	Failed	10 months ago	10 months ago	ibm_oslo
cfe055v5eonmr9ib89g0	Failed	11 months ago	11 months ago	ibm_oslo
63c725520cc8d44de61faf3d	Completed	12 months ago	12 months ago	ibmq_qasm_simulator

Instance systems →

3

Documentation [Open app](#)

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Hello World

Learning [Open app](#)

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What's new →

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- Product update
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About 1 month ago • [Read more](#)
- Product update
Qiskit.org redirects and content migration
About 1 month ago • [Read more](#)
- Product update
Journey toward utility: a new 127-qubit system for Open plan users
About 1 month ago • [Read more](#)
- Product update
New URL strategy on IBM Quantum
About 1 month ago • [Read more](#)
- Product update
Updates to our quality and speed metrics
About 2 months ago • [Read more](#)

³<https://quantum.ibm.com/>

- Navigate to a directory where you want to save your files
- Type `jupyter notebook` or `jupyter lab` in the environment you just created
- A Jupyter notebook environment should open in your browser

Export Jupyter Notebooks as PDF⁴

Export to PDF with nbconvert:

- This requires pyppeteer and Chromium to be downloaded (open Anaconda as an administrator)
- Navigate to your environment and:
 - `pip install nbconvert[webpdf]`
 - For the first notebook download:
`jupyter nbconvert --to webpdf --allow-chromium-download your-file.ipynb`
 - For subsequent downloads:
`jupyter nbconvert --to webpdf --no-input your-file.ipynb`

⁴<https://mljar.com/blog/jupyter-notebook-pdf/>

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- Sample notebooks on Brightspace (under Content/Labs/Lab 1)

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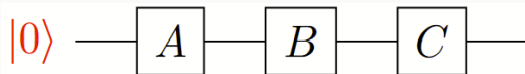
Draw the circuit corresponding to the following quantum state

- $X|0\rangle$
- $HX|0\rangle$
- $XH|-\rangle$

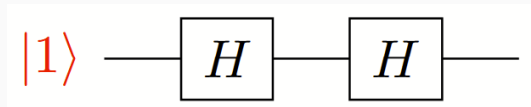
Represent the following with matrices (gates) and vectors (states)

- $X|0\rangle$
- $HX|0\rangle$
- $H|-\rangle$

Give the quantum state in dirac notation for:



What is the resulting quantum state for:



What is the resulting quantum state for:

$$\frac{\sqrt{3}}{2} |0\rangle + \frac{1}{2} |1\rangle \longrightarrow \boxed{H} \longrightarrow$$