



Practical 2 - Single Qubit Gates and Bloch Sphere Visualization

```
In [1]: !pip3 install qiskit
!pip3 install qiskit-ibm-runtime
!pip3 install qiskit[visualization]
!pip3 install qiskit-aer
!pip3 install matplotlib
```

Requirement already satisfied: qiskit in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (2.1.1)

Requirement already satisfied: rustworkx>=0.15.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (0.16.0)

Requirement already satisfied: numpy<3,>=1.17 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (2.3.2)

Requirement already satisfied: scipy>=1.5 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (1.16.1)

Requirement already satisfied: dill>=0.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (0.4.0)

Requirement already satisfied: stevedore>=3.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (5.4.1)

Requirement already satisfied: typing-extensions in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (4.14.1)

Requirement already satisfied: pbr>=2.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from stevedore>=3.0.0->qiskit) (6.1.1)

Requirement already satisfied: setuptools in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pbr>=2.0.0->stevedore>=3.0.0->qiskit) (80.9.0)

Requirement already satisfied: qiskit-ibm-runtime in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (0.41.0)

Requirement already satisfied: requests>=2.19 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-ibm-runtime) (2.32.4)

Requirement already satisfied: requests-ntlm>=1.1.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-ibm-runtime) (1.3.0)

Requirement already satisfied: numpy>=1.13 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-ibm-runtime) (2.3.2)

Requirement already satisfied: urllib3>=1.21.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-ibm-runtime) (2.5.0)

Requirement already satisfied: python-dateutil>=2.8.0 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from qiskit-ibm-runtime) (2.9.0.post0)

Requirement already satisfied: ibm-platform-services>=0.22.6 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-ibm-runtime) (0.68.1)

Requirement already satisfied: pydantic>=2.5.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-ibm-runtime) (2.11.7)

Requirement already satisfied: qiskit>=1.4.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-ibm-runtime) (2.1.1)

Requirement already satisfied: packaging in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-ibm-runtime) (23.2)

Requirement already satisfied: ibm_cloud_sdk_core<4.0.0,>=3.24.2 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from ibm-platform-services>=0.22.6->qiskit-ibm-runtime) (3.24.2)

Requirement already satisfied: PyJWT<3.0.0,>=2.10.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from ibm_cloud_sdk_core<4.0.0,>=3.24.2->ibm-platform-services>=0.22.6->qiskit-ibm-runtime) (2.10.1)

Requirement already satisfied: six>=1.5 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from python-dateutil>=2.8.0->qiskit-ibm-runtime) (1.17.0)

Requirement already satisfied: charset_normalizer<4,>=2 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from requests>=2.19->qiskit-ibm-runtime) (3.4.2)

Requirement already satisfied: idna<4,>=2.5 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from requests>=2.19->qiskit-ibm-runtime) (3.10)

Requirement already satisfied: certifi>=2017.4.17 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from requests>=2.19->qiskit-ibm-runtime) (2025.8.3)

Requirement already satisfied: annotated-types>=0.6.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pydantic>=2.5.0->qiskit-ibm-runtime) (0.7.0)

Requirement already satisfied: pydantic-core==2.33.2 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pydantic>=2.5.0->qiskit-ibm-runtime) (2.33.2)

Requirement already satisfied: typing-extensions>=4.12.2 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pydantic>=2.5.0->qiskit-ibm-runtime) (4.14.1)

Requirement already satisfied: typing-inspection>=0.4.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pydantic>=2.5.0->qiskit-ibm-runtime) (0.4.1)

Requirement already satisfied: rustworkx>=0.15.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.4.1->qiskit-ibm-runtime) (0.16.0)

Requirement already satisfied: scipy>=1.5 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.4.1->qiskit-ibm-runtime) (1.16.1)

Requirement already satisfied: dill>=0.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.4.1->qiskit-ibm-runtime) (0.4.0)

Requirement already satisfied: stevedore>=3.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.4.1->qiskit-ibm-runtime) (5.4.1)

Requirement already satisfied: cryptography>=1.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from requests-ntlm>=1.1.0->qiskit-ibm-runtime) (45.0.6)

Requirement already satisfied: pypng>=0.4.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from requests-ntlm>=1.1.0->qiskit-ibm-runtime) (0.11.2)

Requirement already satisfied: cffi>=1.14 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from cryptography>=1.3->requests-ntlm>=1.1.0->qiskit-ibm-runtime) (1.17.1)

Requirement already satisfied: pycparser in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from cffi>=1.14->cryptography>=1.3->requests-ntlm>=1.1.0->qiskit-ibm-runtime) (2.22)

Requirement already satisfied: sspilib>=0.1.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pypng>=0.4.0->requests-ntlm>=1.1.0->qiskit-ibm-runtime) (0.3.1)

Requirement already satisfied: pbr>=2.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from stevedore>=3.0.0->qiskit>=1.4.1->qiskit-ibm-runtime) (6.1.1)

Requirement already satisfied: setuptools in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pbr>=2.0.0->stevedore>=3.0.0->qiskit>=1.4.1->qiskit-ibm-runtime) (80.9.0)

Requirement already satisfied: qiskit[visualization] in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (2.1.1)

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Requirement already satisfied: numpy<3,>=1.17 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (2.3.2)

Requirement already satisfied: scipy>=1.5 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (1.16.1)

Requirement already satisfied: dill>=0.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (0.4.0)

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Requirement already satisfied: matplotlib>=3.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (3.10.5)

Requirement already satisfied: pydot in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (4.0.1)

Requirement already satisfied: Pillow>=4.2.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (11.3.0)

Requirement already satisfied: pylatexenc>=1.4 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (2.10)

Requirement already satisfied: seaborn>=0.9.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (0.13.2)

Requirement already satisfied: sympy>=1.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (1.14.0)

Requirement already satisfied: contourpy>=1.0.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (1.3.3)

Requirement already satisfied: cycler>=0.10 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (0.12.1)

Requirement already satisfied: fonttools>=4.22.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (4.59.0)

Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (1.4.8)

Requirement already satisfied: packaging>=20.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (23.2)

Requirement already satisfied: pyparsing>=2.3.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (3.2.3)

Requirement already satisfied: python-dateutil>=2.7 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from matplotlib>=3.3->qiskit[visualization]) (2.9.0.post0)

Requirement already satisfied: six>=1.5 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from python-dateutil>=2.7->matplotlib>=3.3->qiskit[visualization]) (1.17.0)

Requirement already satisfied: pandas>=1.2 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from seaborn>=0.9.0->qiskit[visualization])

ion]) (2.3.1)

Requirement already satisfied: pytz>=2020.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pandas>=1.2->seaborn>=0.9.0->qiskit[visualization]) (2025.2)

Requirement already satisfied: tzdata>=2022.7 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pandas>=1.2->seaborn>=0.9.0->qiskit[visualization]) (2025.2)

Requirement already satisfied: pbr>=2.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from stevedore>=3.0.0->qiskit[visualization]) (6.1.1)

Requirement already satisfied: setuptools in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pbr>=2.0.0->stevedore>=3.0.0->qiskit[visualization]) (80.9.0)

Requirement already satisfied: mpmath<1.4,>=1.1.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from sympy>=1.3->qiskit[visualization]) (1.3.0)

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Requirement already satisfied: numpy>=1.16.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-aer) (2.3.2)

Requirement already satisfied: scipy>=1.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit-aer) (1.16.1)

Requirement already satisfied: psutil>=5 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from qiskit-aer) (6.1.1)

Requirement already satisfied: python-dateutil>=2.8.0 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from qiskit-aer) (2.9.0.post0)

Requirement already satisfied: six>=1.5 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from python-dateutil>=2.8.0->qiskit-aer) (1.17.0)

Requirement already satisfied: rustworkx>=0.15.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.1.0->qiskit-aer) (0.16.0)

Requirement already satisfied: dill>=0.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.1.0->qiskit-aer) (0.4.0)

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Requirement already satisfied: pbr>=2.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from stevedore>=3.0.0->qiskit>=1.1.0->qiskit-aer) (6.1.1)

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Requirement already satisfied: contourpy>=1.0.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib) (1.3.3)

Requirement already satisfied: cycler>=0.10 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib) (0.12.1)

Requirement already satisfied: fonttools>=4.22.0 in c:\users\vinay\appdata\local

l\programs\python\python312\lib\site-packages (from matplotlib) (4.59.0)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib) (1.4.8)
Requirement already satisfied: numpy>=1.23 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib) (2.3.2)
Requirement already satisfied: packaging>=20.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib) (23.2)
Requirement already satisfied: pillow>=8 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib) (11.3.0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib) (3.2.3)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from python-dateutil>=2.7->matplotlib) (1.17.0)

```
In [2]: from qiskit import QuantumCircuit
        from qiskit_aer import Aer
        from qiskit.visualization import plot_bloch_multivector

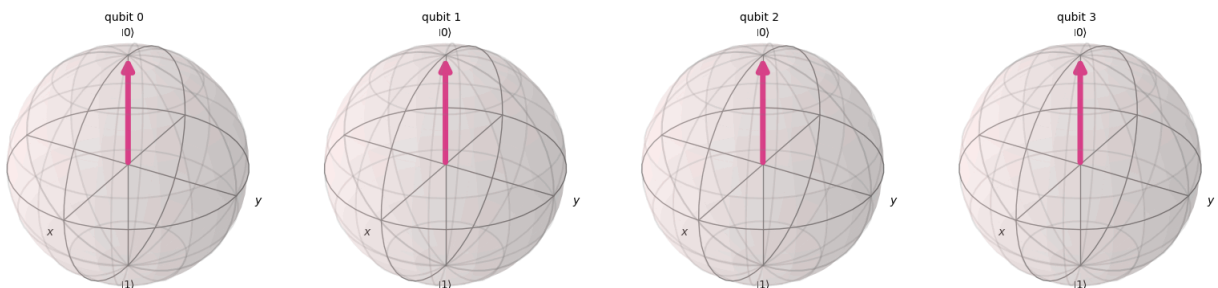
        import matplotlib.pyplot as plt
        %matplotlib inline
```

1. Use the Aer backend simulator - Simulate Quantum circuit on local machine
2. Save the current state-vector
3. Execute the quantum circuit
4. Retrieve the current state vector
5. Visualize the statevector on a Bloch Sphere.

```
In [7]: qc = QuantumCircuit(4)
```

```
In [8]: sim = Aer.get_backend("aer_simulator")
        qc.save_statevector()
        result = sim.run(qc).result()
        state = result.get_statevector()

        fig = plot_bloch_multivector(state)
        # fig
```



```
In [9]: qc_gates = QuantumCircuit(4)
```

```
In [10]: qc_gates.h(0)
qc_gates.x(1)
qc_gates.y(2)
qc_gates.z(3)
```

```
Out[10]: <qiskit.circuit.instructionset.InstructionSet at 0x2022913e7d0>
```

```
In [11]: sim = Aer.get_backend("aer_simulator")
qc_gates.save_statevector()
result = sim.run(qc_gates).result()
state_gates = result.get_statevector()

fig = plot_bloch_multivector(state_gates)
# fig
```

