



Practical 4 - Quantum Teleportation

```
In [1]: !pip3 install qiskit
!pip3 install qiskit_aer
!pip3 install qiskit[quantum_info]
!pip3 install qiskit[visualization]
```

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_aer in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (0.17.2)

Requirement already satisfied: qiskit>=1.1.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit_aer) (2.1.1)

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)

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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)

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Requirement already satisfied: qiskit[quantum_info] 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[quantum_info]) (0.1

6.0)

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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[quantum_info]) (80.9.0)

WARNING: qiskit 2.1.1 does not provide the extra 'quantum-info'

Requirement already satisfied: qiskit[visualization] 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[visualization]) (0.16.0)

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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)

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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[v

isualization)) (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]) (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)

```
In [2]: from qiskit import QuantumCircuit, transpile
        from qiskit_aer import AerSimulator
        from qiskit.quantum_info import state_fidelity, partial_trace, Statevector
        from qiskit.visualization import plot_histogram
```

```
In [3]: # Step 1: Prepare the initial state to teleport on qubit 0
        initial_qc = QuantumCircuit(1)
        initial_qc.h(0)
        initial_qc.t(0)
        initial_state = Statevector.from_instruction(initial_qc)
```

```
In [4]: # Step 2: Create quantum circuit with 3 qubits and 3 classical bits
        qc = QuantumCircuit(3, 3)
```

```
In [5]: # Step 3: Prepare qubit 0 to be teleported (T gate)
        qc.h(0)
        qc.t(0)
```

```
Out[5]: <qiskit.circuit.instructionset.InstructionSet at 0x1df0c9331c0>
```

```
In [6]: # Step 4: Create entangled Bell pair (qubits 1 & 2)
        qc.h(1)
        qc.cx(1, 2)
```

```
Out[6]: <qiskit.circuit.instructionset.InstructionSet at 0x1df0c931b70>
```

```
In [7]: # Step 5: Teleportation protocol
        qc.cx(0, 1)
        qc.h(0)
```

```
Out[7]: <qiskit.circuit.instructionset.InstructionSet at 0x1dfa6b8c640>
```

```
In [8]: # Step 6: Measure qubits 0 & 1 and store results
qc.measure([0, 1], [0, 1])
```

```
Out[8]: <qiskit.circuit.instructionset.InstructionSet at 0x1dfa6a52110>
```

```
In [9]: # Step 7: Conditional corrections based on measurement outcomes
qc.cx(1, 2)
qc.cz(0, 2)
```

```
Out[9]: <qiskit.circuit.instructionset.InstructionSet at 0x1dfa6b8e5f0>
```

```
In [10]: # Step 8: Save the statevector before measuring qubit 2
qc.save_statevector()
```

```
Out[10]: <qiskit.circuit.instructionset.InstructionSet at 0x1df0c9323e0>
```

```
In [11]: # Step 9: Measure the destination qubit (qubit 2)
qc.measure(2, 2)
```

```
Out[11]: <qiskit.circuit.instructionset.InstructionSet at 0x1dfa6b1e9e0>
```

```
In [12]: # Step 10: Remove final measurements for statevector output
qc_no_meas = qc.remove_final_measurements(inplace=False)
```

```
In [13]: # Step 11: Create AerSimulator with statevector method
sim = AerSimulator(method='statevector')
qc_compiled = transpile(qc_no_meas, sim)
```

```
In [14]: # Step 12: Run simulation and get statevector
result = sim.run(qc_compiled).result()
final_state = result.get_statevector()
```

```
In [15]: # Step 13: Partial trace to get qubit 2 state
rho_out = partial_trace(final_state, [0, 1])
```

```
In [16]: # Step 14: Calculate fidelity
fidelity = state_fidelity(initial_state, rho_out)
print(f"Fidelity between input and teleported qubit: {fidelity:.1f}")
```

Fidelity between input and teleported qubit: 1.0