**TASK 1: Born Rule - Measurement Probabilities**

**Aim**: To verify the Born Rule in quantum mechanics by calculating measurement probabilities for different superposition states.

1. **Theory:**

In quantum mechanics, the Born Rule states that the probability of measuring a quantum system in a particular basis state is given by the square of the magnitude of its amplitude in that state. For a quantum state |ψ■ = Σ i α i |i■, the probability of measuring |i■ is: P(i) = |α i |² and the total probability must satisfy ΣP(i) = 1. This rule is fundamental to quantum mechanics, as it connects the abstract state vector with measurable outcomes.

**2. Algorithm:**

1.Define quantum states as complex vectors.

2. Apply the Born rule formula P = |ψ|² to calculate probabilities.

3. Normalize the probability distribution.

4. Visualize measurement probabilities using bar graphs.

**3.program:**

import numpy as np

import matplotlib.pyplot as plt

# Program: print("\n" + "="\*50)

print("TASK 1: BORN RULE - MEASUREMENT PROBABILITIES")

print("="\*50)

def born\_rule\_probabilities(psi):

"""Calculate measurement probabilities using Born rule: P = |<basis|psi>|^2"""

probabilities = np.abs(psi)\*\*2 return probabilities / np.sum(probabilities) # Normalize

# Create superposition states

psi\_1 = np.array([1/np.sqrt(2), 1/np.sqrt(2)]) # |+⟩ stateuymm

psi\_2 = np.array([1/np.sqrt(3), np.sqrt(2/3)]) # Custom superposition

print("Superposition state 1: |ψ₁⟩ =", psi\_1)

print("Measurement probabilities:", born\_rule\_probabilities(psi\_1))

print("Superposition state 2: |ψ₂⟩ =", psi\_2)

print("Measurement probabilities:", born\_rule\_probabilities(psi\_2)) # Visualization states = ['|0⟩', '|1⟩']

probs\_1 = born\_rule\_probabilities(psi\_1)

probs\_2 = born\_rule\_probabilities(psi\_2)

plt.figure(figsize=(10, 4))

plt.subplot(1, 2, 1)

plt.bar(states, probs\_1, color='blue', alpha=0.7)

plt.title('State |ψ₁⟩ Probabilities')

plt.ylabel('Probability')

plt.subplot(1, 2, 2)

plt.bar(states, probs\_2, color='red', alpha=0.7)

plt.title('State |ψ₂⟩ Probabilities')

plt.ylabel('Probability')

plt.tight\_layout()

plt.show()

**4.result:**

The experiment verifies that measurement probabilities in quantum mechanics are determined by the square of the amplitude magnitudes of the state vector components, as described by the Born Rule.