Quantum Tunneling Calculator

A COMPUTATIONAL SIMULATION OF QUANTUM TUNNELING

PROJECT AIM:

- TO DEMONSTRATE QUANTUM TUNNELING USING SCHRODINGER EQUATION
- TO VISUALIZE WAVE FUNCTION AND TUNNELING PROBABILITY

Quantum Tunneling – Physical Background

- In quantum mechanics, particles behave as waves
- A particle can penetrate a potential barrier even if $E < V_0$
- • This phenomenon is forbidden in classical mechanics

Equation:

- $-(\hbar^2/2m)\ d^2\psi/dx^2 + V(x)\psi = E\psi$

Outputs of the Tunneling Calculator

- Transmission (Tunneling) Probability
- Wave function $\psi(x)$
- Probability Density $|\psi(x)|^2$
- Rectangular Potential Barrier
- Transmission Probability:
- $T = [1 + (V_0^2 \sinh^2(\kappa L)) / (4E(V_0 - E))]^{-1}$

How the Code Works

- User inputs: Energy, Barrier Height, Barrier Width
- Unit conversion to SI units (eV → J, nm → m)
- Solution of Schrödinger equation

Key Parameters:

- $k = \sqrt{(2mE)}/\hbar$
- $\kappa = \sqrt{(2m(V_0 - E))}/\hbar$
- Wave function constructed in three regions

Applications

- Shows clear difference between classical and quantum physics
- Exponential decay of wave function inside barrier
- Finite transmission confirms tunneling

Applications of Quantum Tunneling:

- Scanning Tunneling Microscope (STM)
- Flash memory devices
- Nuclear fusion and alpha decay