EC210 – Solid State Electronics
Lab 6
Quantum Electron Tunneling

Notes Prepared by: Eng. Nourhan Hazem (GTA)
Class : Solid State Electronics - EC210, Spring 2015
Lecturer: Dr. Amr Bayoumi

Outline

- The rectangular barrier
- FreeMat code for the quantum tunneling

The Rectangular Barrier

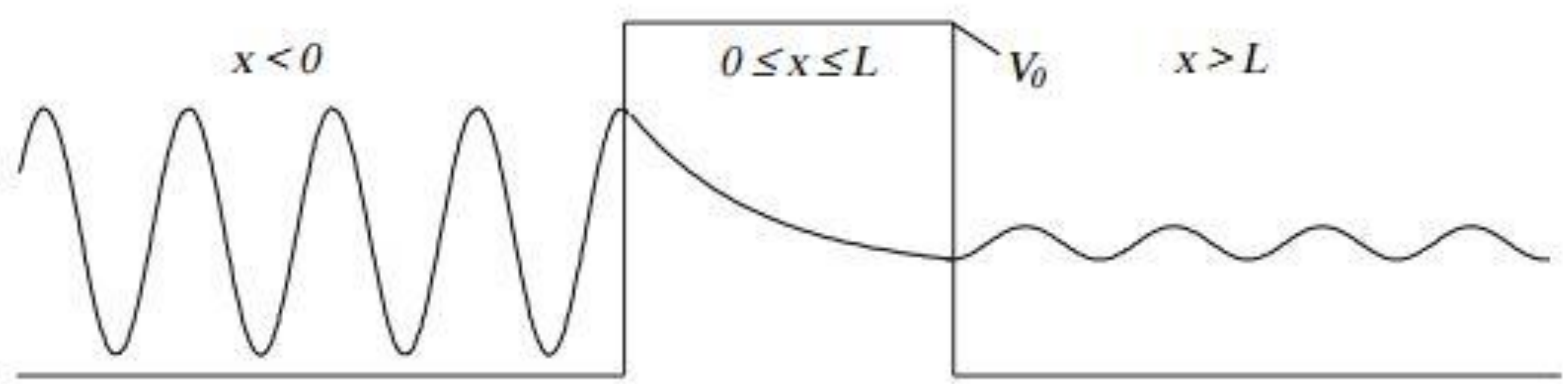

Figure 1: Illustrating the simple case of tunneling through a rectangular barrier.

- The electron is considered to travel from the left to the right along the x-axis.
- Between x=0 and x=L there is a potential barrier with a height energy of Vo and Energy E.

http://www.orc.soton.ac.uk/publications/theses/3280_hjm/Ch2_3280_hjm.pdf

The Rectangular Barrier (Cont.)

- Left hand side of barrier (x<o):.

$$\Psi_1 = e^{i(kx-\omega t)} + Ae^{-i(kx+\omega t)} \quad \text{where} \quad k^2 = \frac{2mE}{\hbar^2}$$

- Right hand side of barrier (x>o):.

$$\Psi_3 = De^{i(k(x-L)-\omega t)} \quad \text{where} \quad k^2 = \frac{2mE}{\hbar^2}$$

The Rectangular Barrier (Cont.)

- In the barrier (o ≤ x ≤ L):.

$$\frac{-\hbar^2}{2m}\frac{d^2\Psi_2}{dx^2} + V_0\Psi_2 = E\Psi_2$$

$$\text{where } k'^2 = \frac{2m(V_0 - E)}{\hbar^2}$$

$$\psi_2(x) = B_1 e^{\alpha x} + B_2 e^{-\alpha x}$$

$$\alpha^2 = \frac{2m}{\hbar^2}(V_o - E)$$

Code

```
%% Intiallization
clc
close all
clear all
%% Defining Constant
m= 0.067*(9.8*10^-34);         % Effective mass of the electron
h= 6.63*10^-34;                % Plank's man constatnt
h2=h^2;                        % Square of the Plank's man constant
v0=0.3;                        % Height of the potenial barrier
E=3;                  % Energy needed for the electron
L=3;                           % Length of the barrier
kd2=((2*m.*(v0-E))./h2);       % Square of wave number in the barrier
kd=sqrt(kd2);                  % Value of wave number in the barrier
%% Defining Variables
x=[0:0.01:L];
Sh_2=(exp(kd.*x)+(exp((-kd).*x)));% Shoredinger equation
%% Plotting
figure(1)
plot(x,Sh_2)
title('Quantum Tunneling')
xlabel('x-axis')
ylabel('Power')
axis([ -3 6 -2 2])
```

Thank you for your attention