ECE770-T14/QIC 885: Quantum Electronics & Photonics

Lecture 3

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Abstract and Objectives of Lecture 3

The objective of this lecture is two fold; First solution of time-independent Schrodinger equation (TI-SE) for simple quantum structures to show the bound and scattering states of electron and second is to engineer the confinement and propagation of single electron in various quantum confined structures. I will show the bound states of quantum well, wire (waveguide) and dot by characterizing their eigenfunctions, energy and Density of States (DOSs). To show an illustrative example of how we might observe purely quantum effect, I will talk about quantum conductance in quantum wire. In the second example of bound states, I will treat the simple harmonic oscillator and highlight its importance for future treatment of EM field quantization.

I will investigate the scattering states of electron in a finite potential barrier and discuss tunneling effect. At the end, the general formulation for electron propagation/scattering from an arbitrary one dimensional localized potential based on S-matrix and transfer matrix methods will be presented.

Topics of lecture 3

2-3 Solutions to TI-SE in Simple Quantum Structures

2-3-1 1D Infinite Potential Square Quantum Well

2-3-2 Density of States for Quantum Structures

2-3-3 Planar Quantum Slab

2-3-4 Quantum Wire (Quantum Waveguide)

2-3-5 Quantum Conductance in Quantum Wire

2-3-6 Quantum Dot

2-3-7 Finite Potential Quantum Well

2-3-8 Simple Harmonic Oscillator (SHO)

2-3-9 Finite Potential Barrier & Tunneling Effect

2-4 Electron Propagation/Scattering from a 1D Localized Potential

References & Suggested Readings

1- D.J. Griffith, *Introduction to Quantum Mechanics*, 2^{nd} ed., PH, 2005, Chapter 2.

2- H. Kroemer, *Quantum Mechanics: For engineering, material sciences and applied physics*, JWS, 1994, Chapters 2 and 3

3- P. Harrison, *Quantum Wells, Wires and Dots*, 2^{nd} ed., JW&S, 2005, Chapters 2 and 8 .

4- N. Zettili, *Quantum Mechanics, Concepts and Applications*,2^{nd} ed., JW&S, 2009, Chapter 4.

5- A.F.J. Levi, *Applied Quantum Mechanics*, 2^{nd}*ed.*, Cambridge Press, 2006, Chapter 3, Section 5-7, Chapter 6.