Introduction to Semiconductor Devices

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Lecture - 09
Energy levels in Infinite and Finite Potential Wells (Short Demo)

(Video Starts: 00:17) Hello, welcome back. This is the demo that I was talking about. So, the interface that you are seeing is what is called as a Python one, IPython notebook. So, it is done using Jupiter. And in Anaconda platform, we will share the details, you know, when we will post this on Github, you will be able to download it and actually run it, if you are interested.

So, this particular thing is actually showing you how the wave functions are calculated. Let me do this. So, the wave functions are calculated for finite and infinite potentials. This is taken from this paper, basically, it is by Srnec and others. Basically, it is called a Python programme for solving Schrodinger equation. The reference is provided and the link is there.

So, you can actually go through it, it has a lot of interesting things that we were talking about. So, these details will be useful for a master's level student. I just want wanted to add it, just to make it complete. For an undergraduate student, I do not think you need to understand what is there; how the code is done, you just you know, can observe what is happening. So, here, what we are doing is, we are taking a potential value you know, the details are all hidden from you.

You do not have to worry about it. So, what we are doing is we represented this potential well of a certain width and there are certain energies. So, we saw that the width is in the denominator, L square is in the denominator. So, what happens if I increase my width? So, if you look at, you just, these are some numbers basically arbitrary units. So, right now, the width is 3 and n is 4.

n is basically the number of Eigen states allowed, so, calculated so, 1,2,3, 4. You can actually calculate more Eigen states, there is no problem. This is an infinite potential. Well, I mean, we cannot show infinity in a graph, but it just, it goes up. So, as we increase the number of energies, you can get more and more, you know, of wave functions.

You see the wave functions, you know, the first 3 wave function, you will see. They are exactly what we said they will be right, like a sign of wavelength, a full sign and then this is third state and so on. And the energy for example, let us take the reference of 4.9 eV. Let us say g arbitrary 4.95. So, right now, it is 5, the top most state. So, you will be able to actually play around on your own and analyse it that is why we want to post it.

So, now, if I decrease my width, what happens? Energy should increase and that is exactly what you see. So, from 5 became 11. And if you increase the width, it should become lower energy. And you could actually compute these energies and what is the difference in, know, energy want to do? What is the difference in energy? Just like we mentioned the absorption.

You can have an absorption from first level to the second level and all that you can compute these things. This is basically the infinite potential well and we have also done this for a finite potential well. Finite potential well means, there is a certain depth you can mention. And so, in this case, we saw that let us just take 2 wave functions, but it is not a wave function, the number is not there.

So, basically, A is basically width of the well and D is the potential depth. So, let us say if I have the depth as 30. It is arbitrary units; I take it as eV. So, you see that there are these wave functions and the top most wave function is actually penetrating into the barrier, just as we showed in the graphs. So, you can play around with this. Let us say I reduce my width, what happens?

What do you expect if the width reduces? I will say that there will be more penetration. And you see this, the bluish colour is actually penetrating more into the barrier, or you know, you come back and then now, you say that I will actually increase the width. You increase it of course, you know, there is I mean, there are more levels, which are showing up and then there is less penetration into the barrier.

Similarly, the depth will change. If you increase the depth, they will be more penetration, let us go back to. So, it is penetrating more, but if you increase the depth for the corresponding energy, it will be actually deeper into the well and it will not penetrate that much. So, there are all kinds of interesting things. If you some of you are interested to work deeper into these areas and want to do research or something, you could always you know, email me.

We will talk about. We can do one project based on some of these things and we can actually do more work. There is also a small self-assessment phase, which we added into this. So, I mean, you just have to run this once and you will have options, you know, basically eigen energies of electronic infinite well or continuous discrete insufficient, you could simply submit and cross check for yourself. Is it continuous? No, right?

Eigen energies of electronic infinite well, discrete, they are not continuous that is what we said. Similarly, some simple things, these are not really complicated questions, but it will give you know, Eigen functions penetrate outside the walls of an infinite well, will they? Of course, not, they do not; only for a finite well, they penetrate. So, some simple, you know, just sanity checks for you. So, this is the short demo that I wanted to do.

And I will put it on Github, you know, it will be an open resource, get a repository, which you can use and download. We will also add a note on how to run it. Alright, if you guys are interested in coding, you could check it out **(Video Ends: 05:49)**. Thank you so much. We will meet you next week. Bye.