Fundamentals of Wavelets, Filter Banks and Time Frequency Analysis.
Professor Vikram M. Gadre.
Department Of Electrical Engineering.
Indian Institute of Technology Bombay.
Demonstration: Constructing Scaling and Wavelet Function.

Hello everyone, today we will be looking at how we generate the wavelet and scaling function for the whole Haar filter bank.

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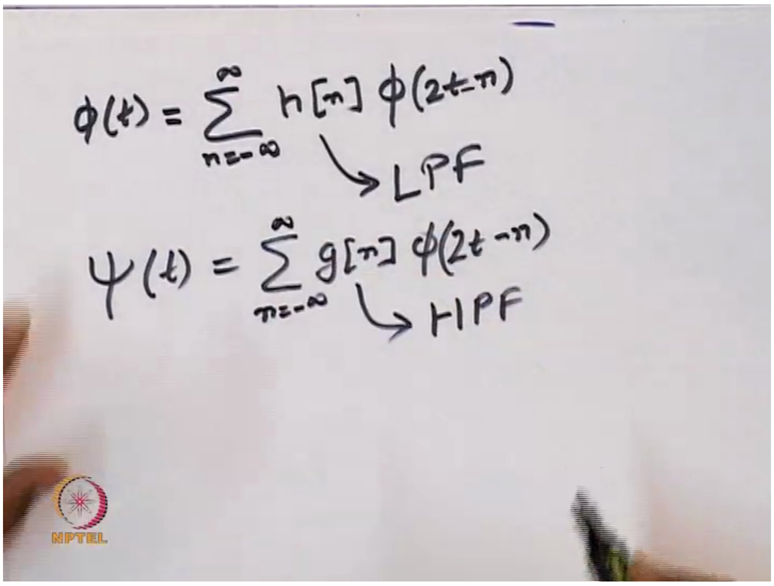

As we can recall from lecture 9 that the scaling function phi of t is given by summation ngoing from - infinity to infinity H of n phi of 2t – n where H of n denotes the low pass filter response. Similarly, the wavelet function is given by summation g of n phi of 2t - n where g of n denotes the high-power filter response. And yes, goes from - infinity to infinity. So today in this demonstration we will see how we generate the scaling and wavelet function using these expressions.

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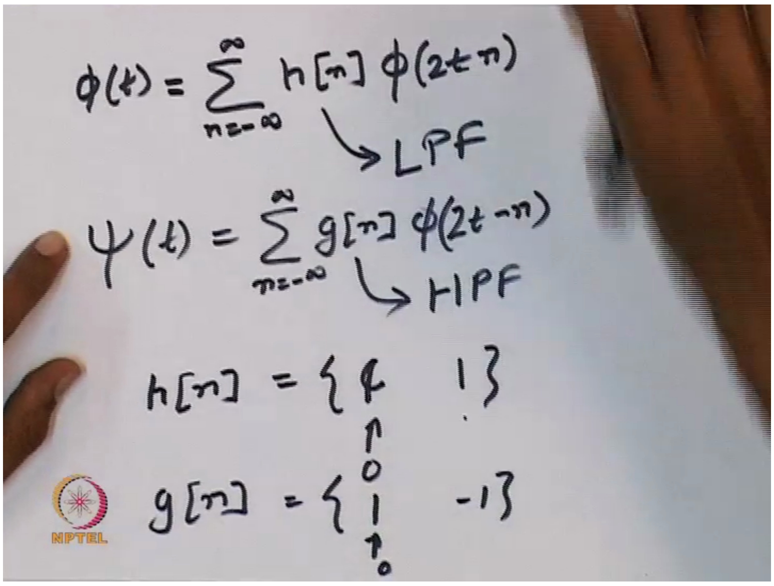

Again, recalling from the lecture, for the haar filter bank case, we have H of n given by a 2 length sequence which is 1 and 1 at 0th and 1st sample and the g of g n sequence is given by 1 and -1. We will use this we will try to generate the scaling and wavelet function.

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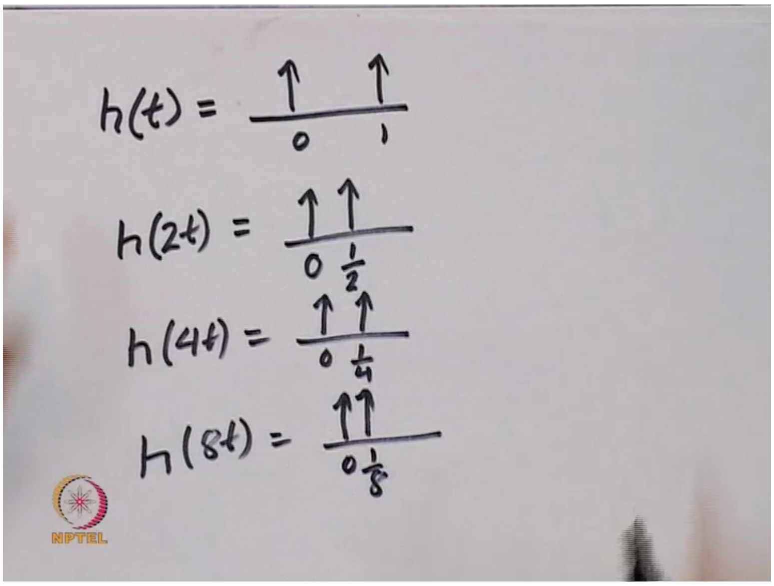

Our H of t if we try to draw, it has 2 impulses at 0 and at 1. If you draw H of 2t, it will look like this, there will be 2 impulses, one at 0 and 1 at half. And H of 4t and similarly will look like this and H of 8t will look like this. And similarly we can draw more dilates for H of t.

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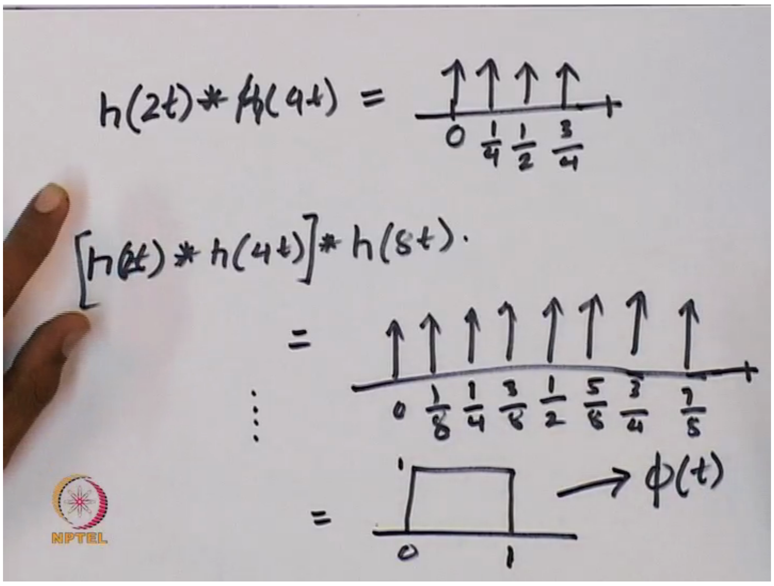

Now we have H of 2t convolved with H of 4t which is a sequence which looks like this. It is a 4 length sequence and now we try to convolve this with H of 8t and this will look like a train of impulses, there are 8 impulses in this going from 0. So as you can see, the support for this is from 0 to 1 even now, I mean in every case but the impulses are becoming denser and denser, they are becoming closer and if we keep continuing in this way, we get a signal which looks like this. And this is exactly what we called as our scaling function which is phi of t.

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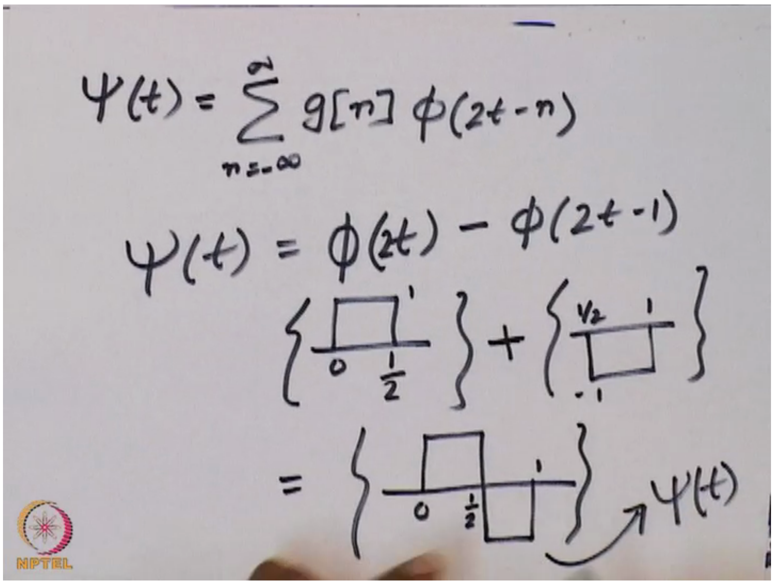

Next, we will move on to how we generate the wavelet function. So we have the wavelet function given by this expression H of t and going from - infinity to infinity g of n phi of 2t -

n. And phi of t we can find, psi of t we can find from phi of 2t - phi of 2t - 1. Let us try to draw these 2 signals. These will give us, sorry, so this will give us a function that will look like this. And this is our wavelet function which we called psi of t. Now we will have a look at some simulation demos and to see how we can use more dilates of phi of 2t to get a better approximation for phi of 2t and how it converges to an exact brickwall sequence.

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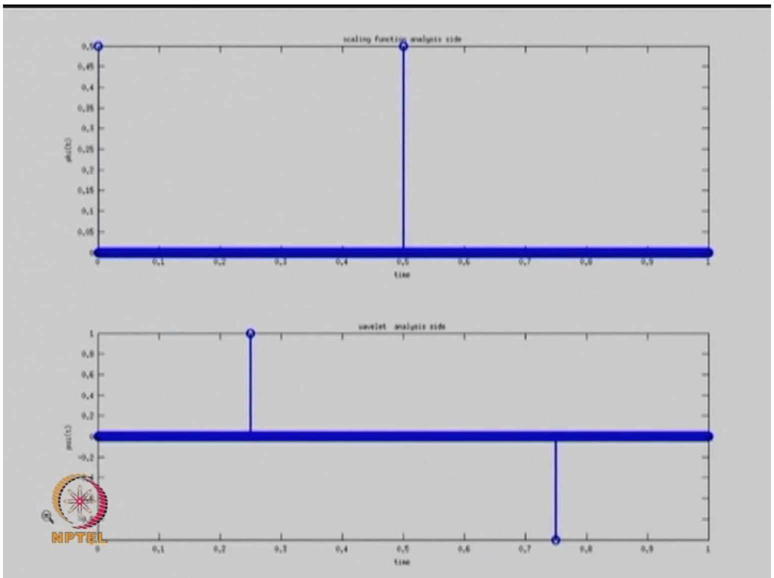

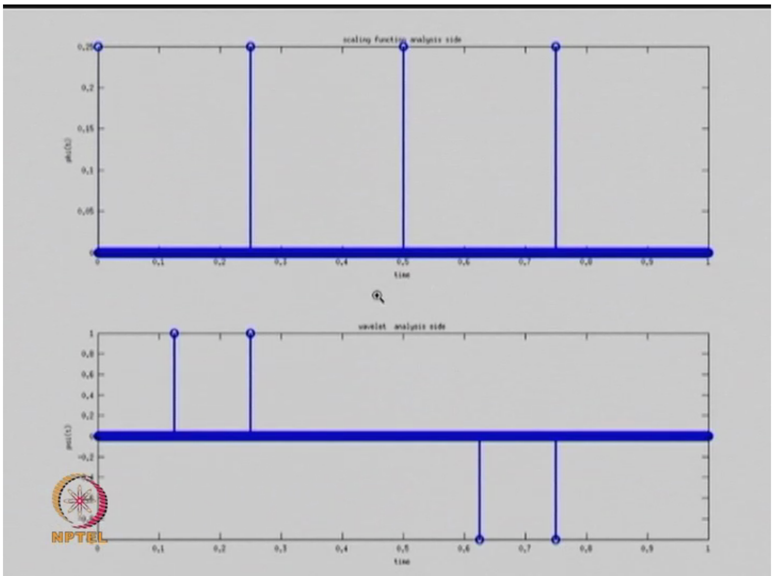

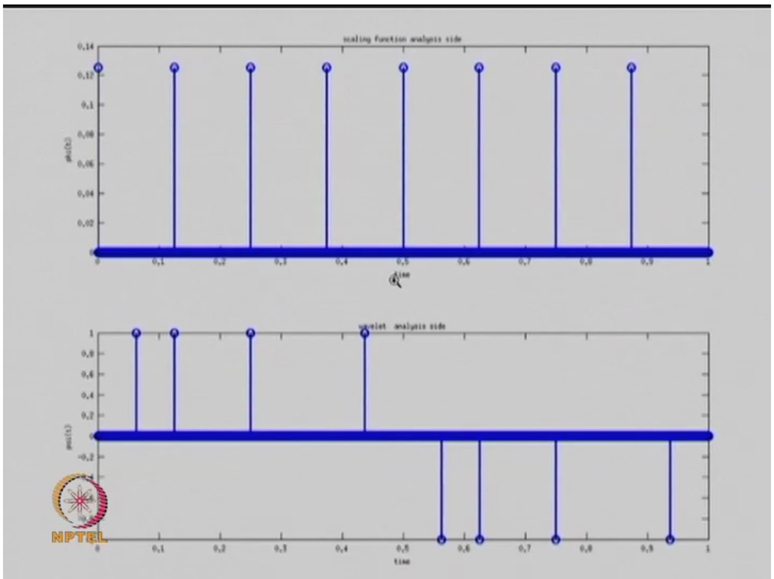
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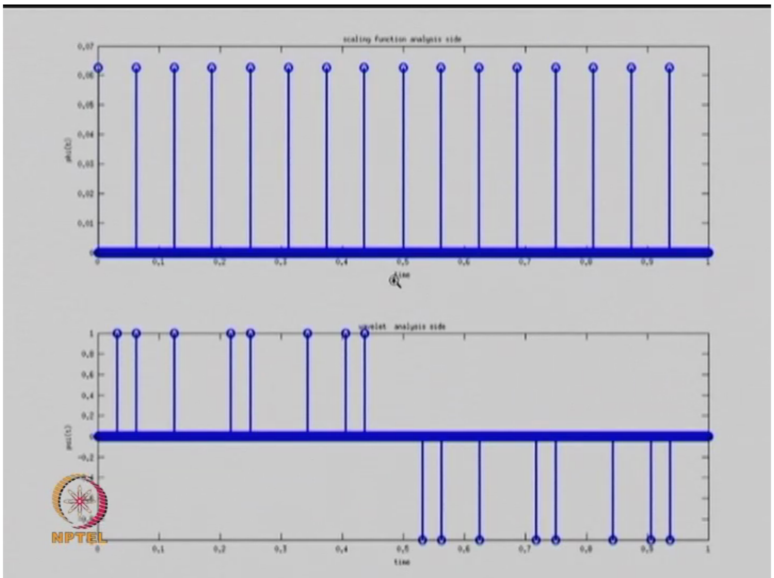
time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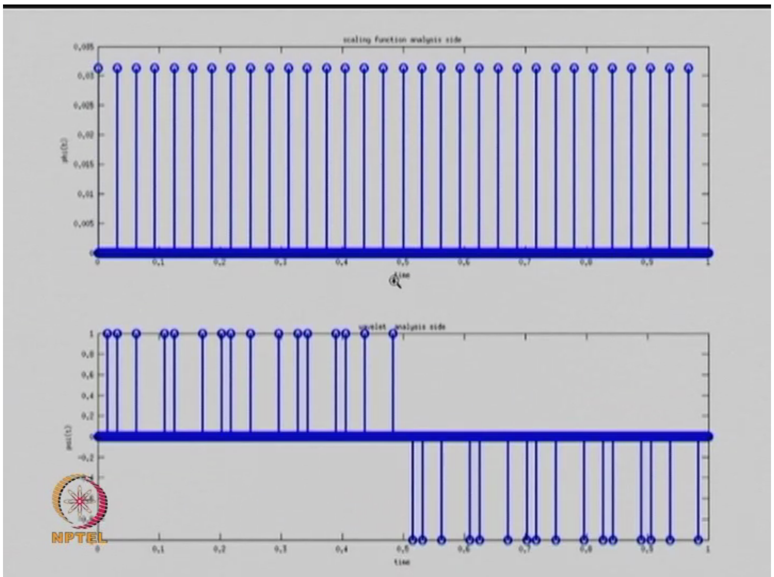
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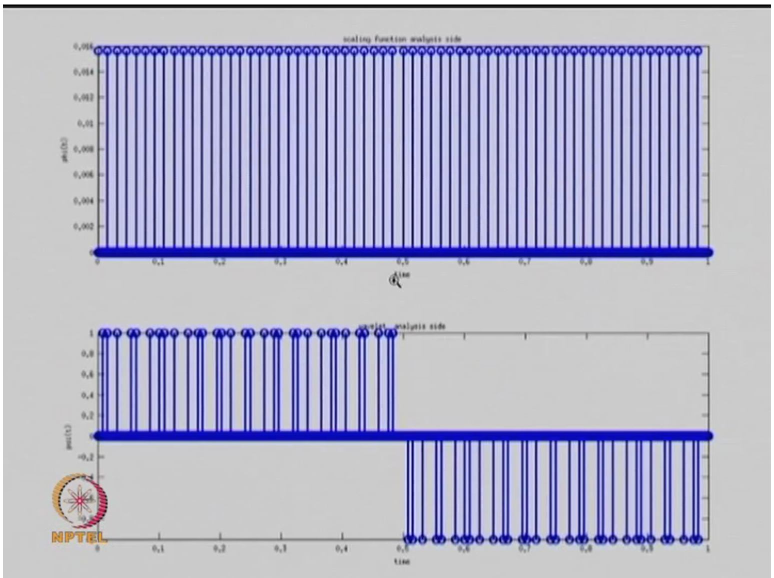
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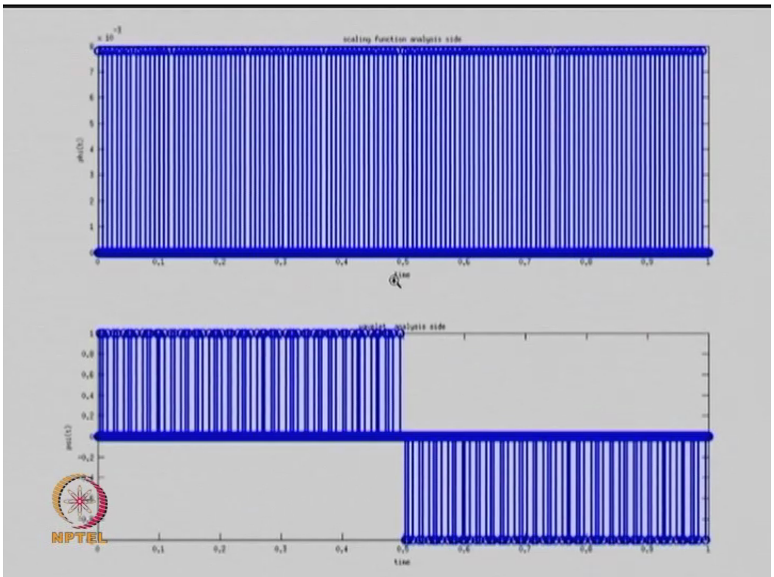
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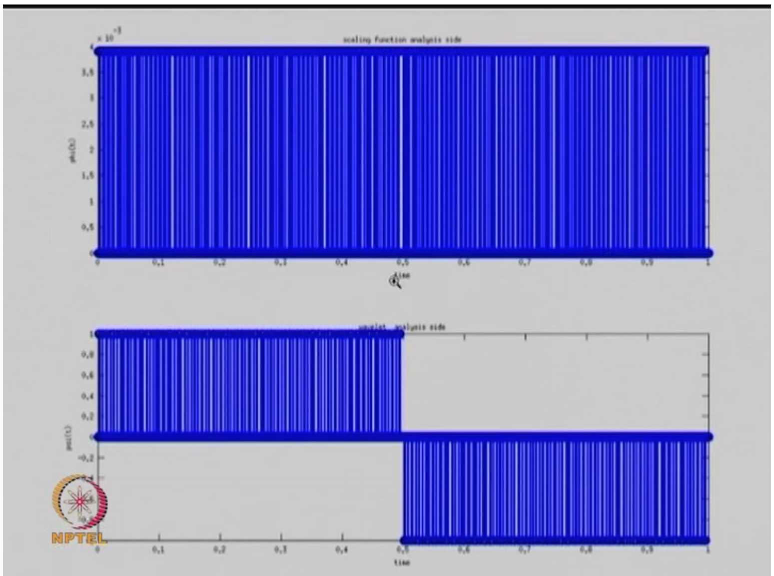
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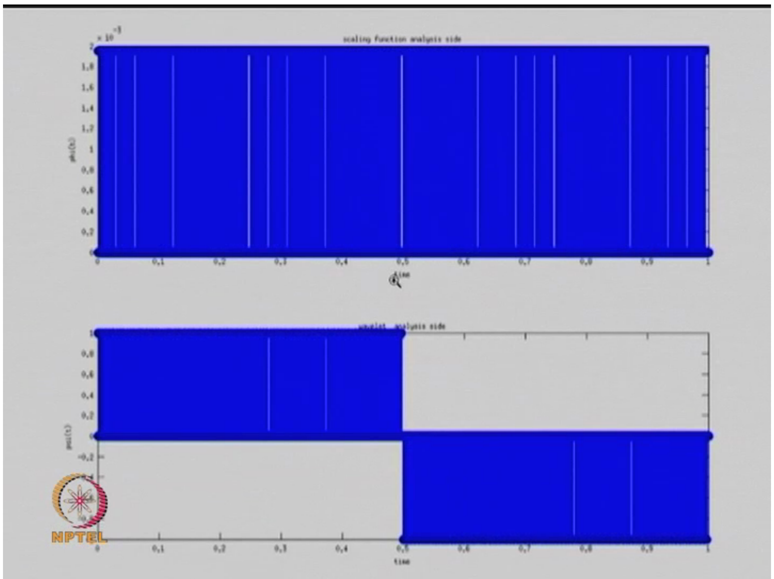
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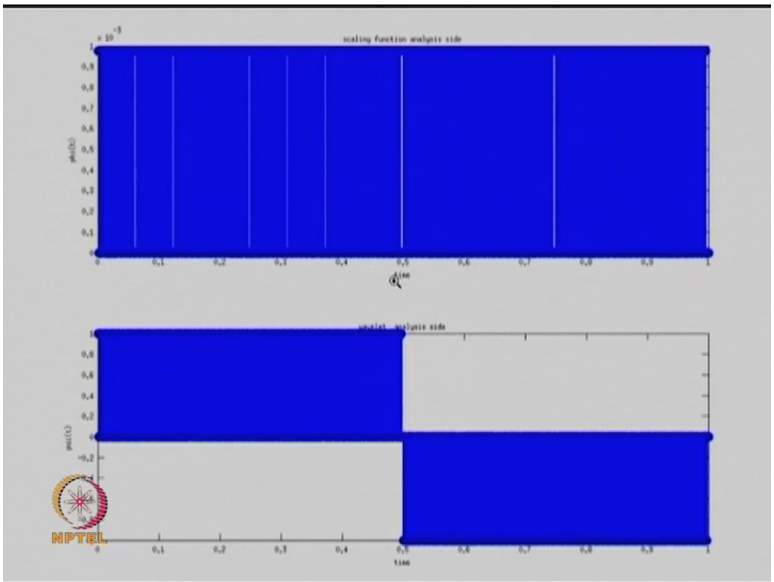
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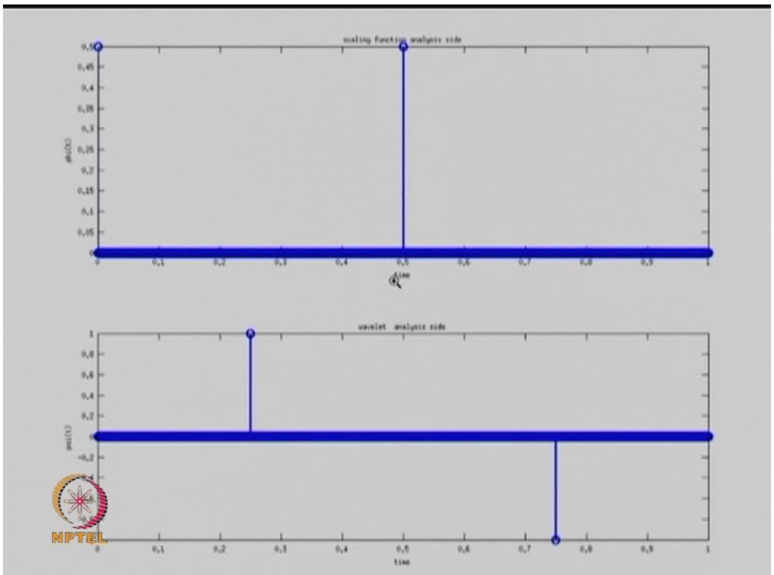
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So as you can see here, there are 2 impulses, one at 0 and 1 at half and once we convolve this with phi of 4t, we get 4 impulses, 1 at 0, half, 1 by 4 and 3 by 4 as I have just explained. So going this way what we get is a better approximation for phi of t. And the simulation below shows how we get wavelet function. So, wavelet function essentially looks like this and once we keep adding more and more dilates of phi of t, we get a better approximation for it. So this is how we construct the wavelet and scaling function for the haar filter bank, thank you.