Biomedical Signal Processing
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Lecture - 55
Tutorial – III (Contd.)

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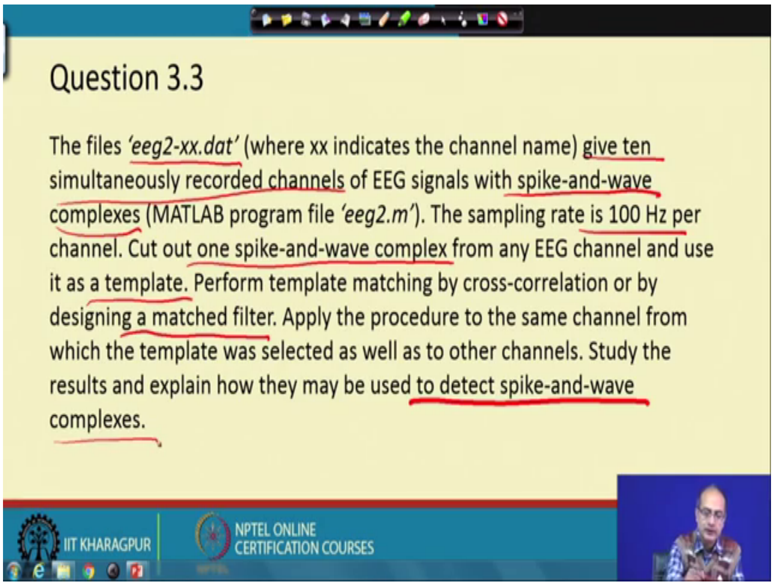

Now, that we get the third problem of tutorial 3. Again it is a EEG signal we get and we get 10 simultaneous recording of the eeg and here we get spike and wave complexes. We will see that how the spike and wave complex looks like. Again, sampling frequency is same as the previous 100 hertz and this spike and wave, one spike and wave complex is taken as a template and we have to use cross correlation or we need to use a match filter.

So, in this case we will take a match filter because already we have seen how to use the across correlation in the previous problem. And we apply the procedure in all the channels and study the result to detect the spike and wave complexes ok. So, let us see, how we are to proceed for that.

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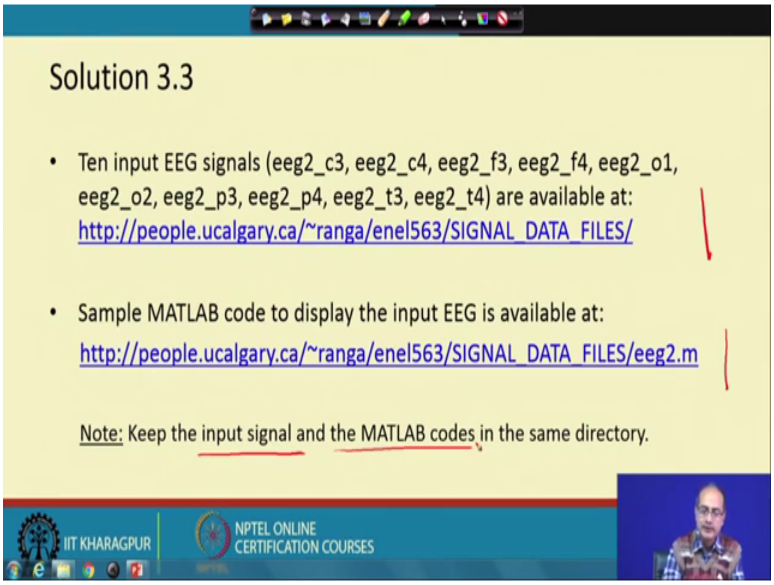

The first ritual is to get the data and then the corresponding MATLAB file which will tell us the format of the data and help us to read the data, then we have to keep the signal and the MATLAB file that in the same directory. There is a working directory of our MATLAB.

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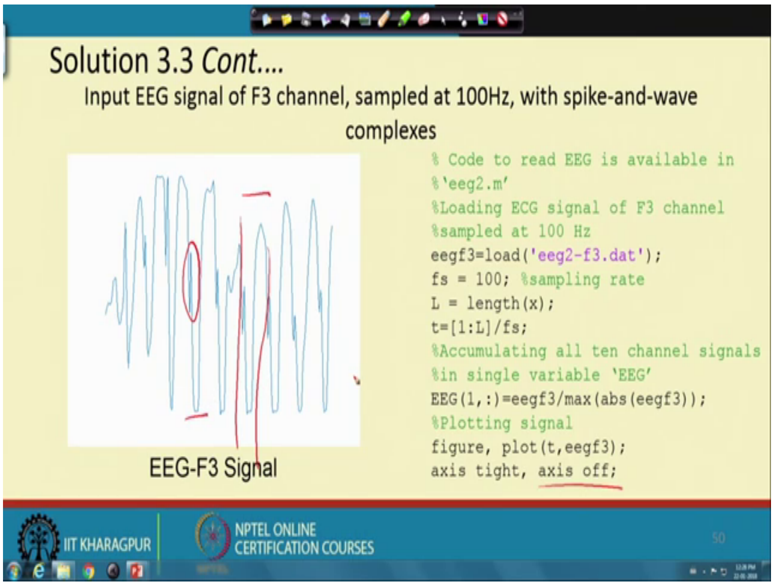

Now, the first seeing that, to view the signal, so for that, we have chosen the eeg to the f 3 channel. We have loaded that eegf 3 signal sampling frequency is noted. The length of the signal that is taken and that we have that length according to that we are calculating the value and we are taking the that signal, we are dividing it with the maximum value to normalize it and we are normalizing it and keeping it in the eeg 1, ok. We are keeping the all of them all the 10 channels into this variable at different rows.

The first row is fed with the channel f 3 and then we take the plot of that f 3. So, access type to makes it that took place keep only that area used by the graph ok. Now let us see the how the plot looks like ok. And access of make sure that x and y axis and not drawn and here we get this is the spike; this portion is the web ok. So, if we take that from here to here, we can get that this is the interval is a spike and wave is spike and wave, but repeated number of times in this signal.

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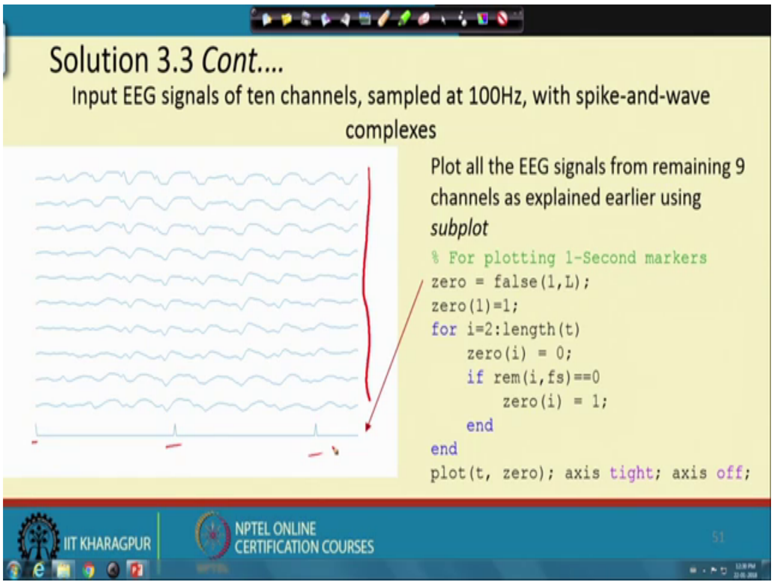

So, next thing is that we have to plot all of them. So, for that that, we have we can use the same command so many times which are plot and at the end would like to put actually a marker to show that one second mark ok. So, for that that 2, 2 that what we do, initially we put it 0, the first value is put has one and then when actually the count is matching with the that our sampling frequency that is 100 that the remainder is 0 in that case; that means, count is becoming 100 or multiple of that then only reminder would be 0 then we make it one.

So, in the other word every second passes will have one t? So, here is the signal that is shown that we have all the 10 channels and here this is sticks are showing that this is 0 second, this is 1 second, this is 2 second ok. So, that is the way all the channels has shown all together.

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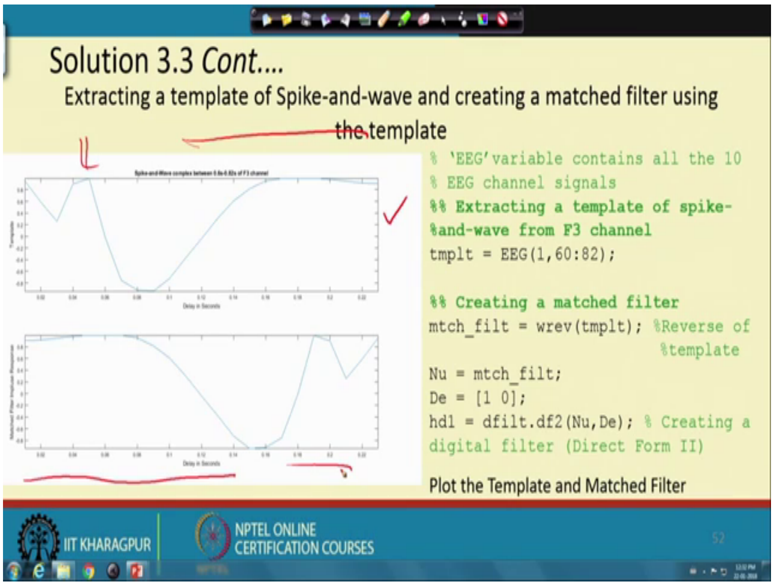

Now we need to find the template. Again the choice of template it is done manually that what it is done that for the first channel of that eeg that is, we have taken the f 3 there. So, there we are taking the part sample 60 to 82; that means, we have 23 samples are there in the template.

So, this is part we crop it and store it as the value template. Now once we have to create the match filter, the first thing what we have to do we need to flip this template and exactly that is done by this command wrev which reverses the template. So, if the template is something like this or let us draw something asymmetric say, if the temperate is like this, after the flipping it would look like this ok. So, we have done this reversal here and this is the impulse response of the match filter and we have actually initialize the use that to keep the ok, you keep that in the variable Nu.

The name is chosen just to keep in mind that this is a numerator of the filter because will use the filter command and we will define some denominator polynomial. That is nothing but 1 because it is an fir filter and with that numerator and the denominator polynomials. We create the filter handler hd 1 using the command dfilt dot d f 2 again direct form 2 we are using now this is the, let us look at the plot of the template and the that match filter that here at the top we are showing the template first the spike here and this is the part web.

So, after that flipping the match filter impulse response that is smooth wave will come fast followed by the impulse or the spike. So, this is the transfer function we get and let us proceed.

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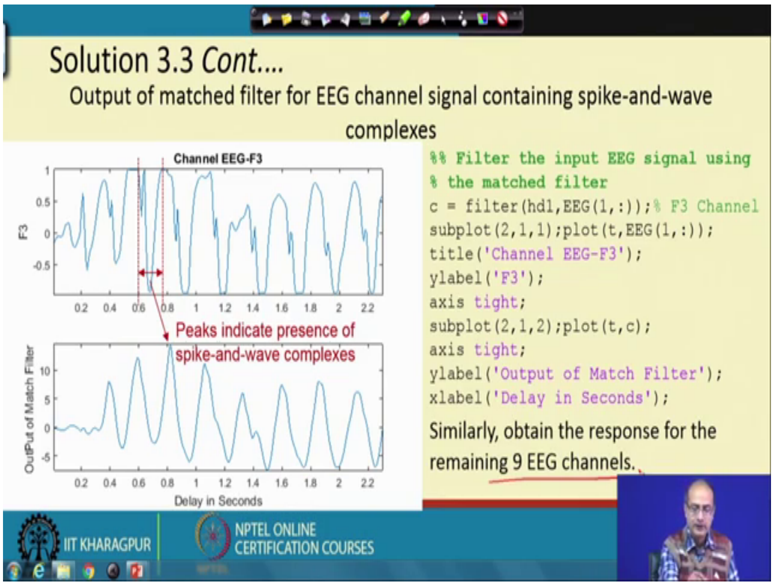

Let us see the how to get the match filter output. For that we are using the filter command with h d 1 is our filter and we are taking one channel at a time first we are starting with the channel one that is f 3, then we carry the same operation for the other channels and the output is given in the variable c 1 and for the plot, we have to issue that figure command for the brevity of the space we have drop that. So, if you do not give that command, it will rewrite on the previous plot and we divide the plot into 2 part sub plot 1 and plot the EEG signal first we write the title and the labels and then that what is the match filter output is given in the lower half and give the appropriate label for that.

So, here we see the output that this is the signal which spike and wave in f 3 and as we have taken one part from here as a match filter, we get the peaks here. So, all of them they are indicative of the presence of that spike and wave ok. So, so many peaks each one of them, are signifying that spike and wave is present in this channel. So, now we do the same operation in the remaining 9 eeg channels.

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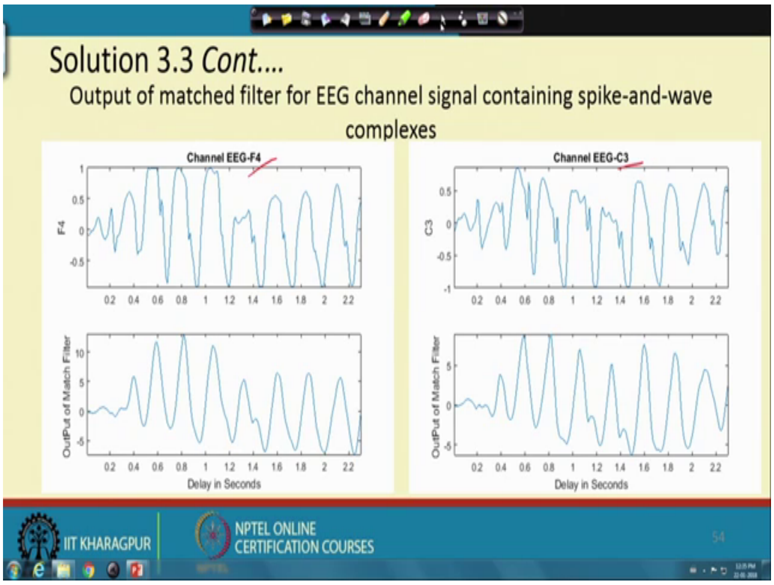

So, let us go ahead with that. Here we are showing it for f 4 and c 3.

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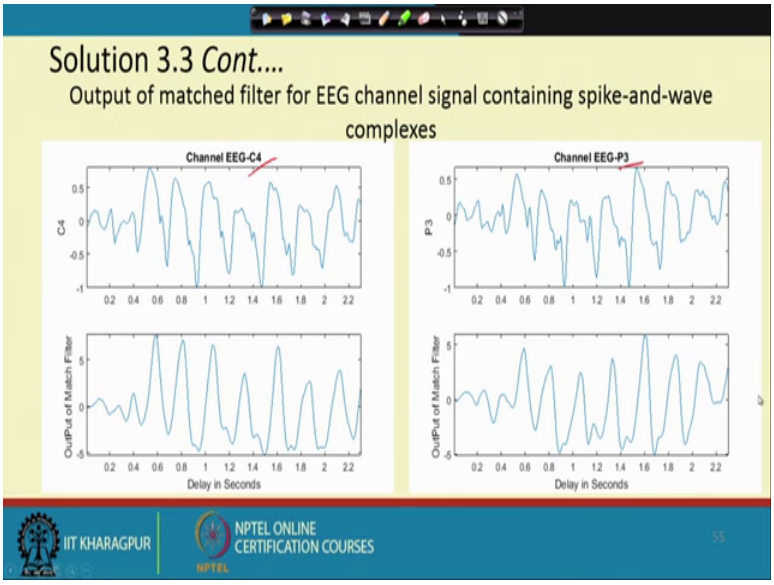

Next we get it for channel c 4 and v 3.

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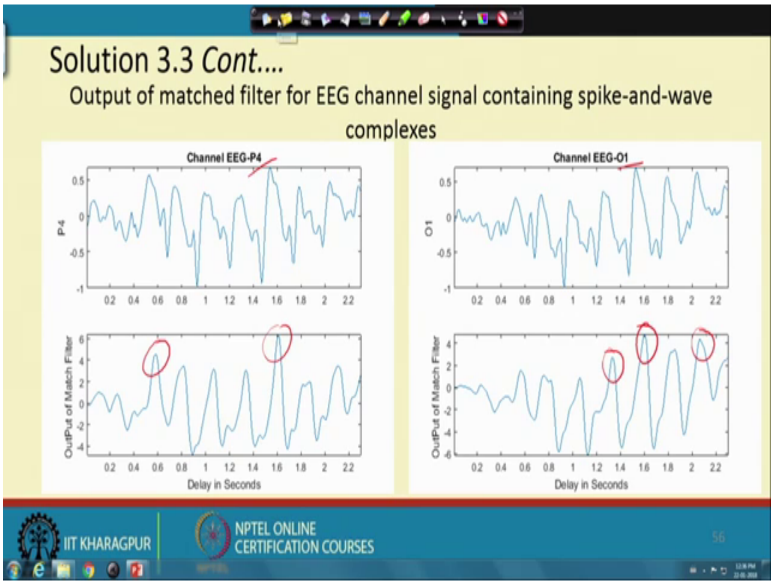

Then for p 4 and O 1; so, for all these cases, we are able to get that we have the peaks present, high peaks which signifies that our that spike and wave signal is present in all these channels.

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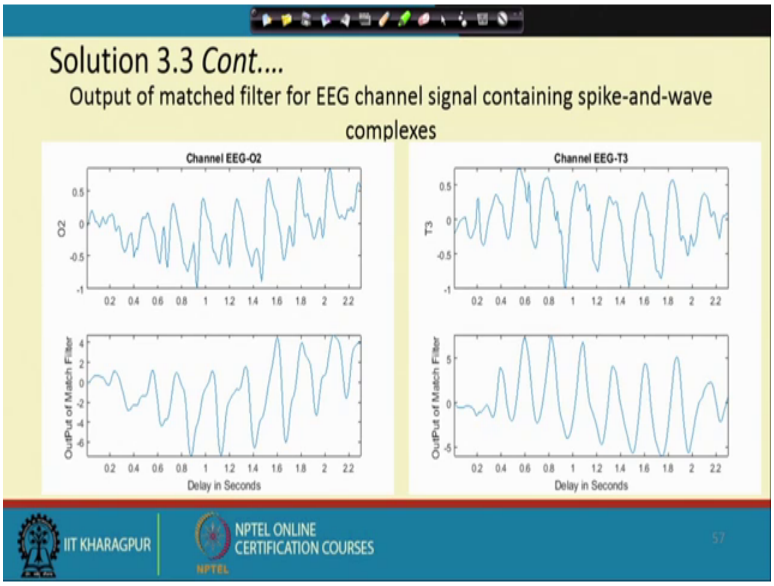

Now, we go for q 2 go sorry O 2 and T 3, again we are the same finding.

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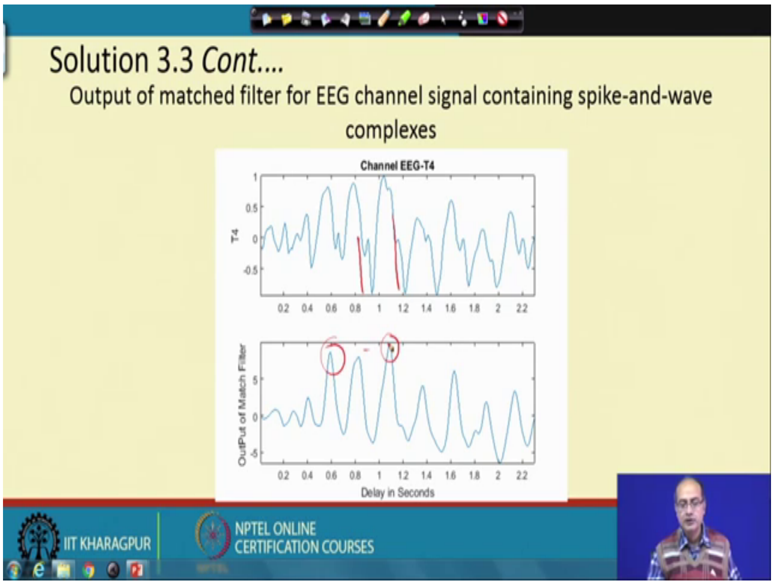

Then the last one, that is T 4 again we see the high peaks in the match filter output signifying that spike and wave is present.

So, now here we summarize it. The peaks in the filter operation that signifies that are we have the spike and wave complexes. However, another thing we should look at if we go for any of the signal, there is a lag that wherever the spike and wave is there, if you look at the spikes, will see that it is lagging the. Here is the complex that the peak is occurring little later that is because the leg introduced by the filter ok, that our template has a finite length and when we try to use it a use it as a causal signal that, we have to add some delay and that is the lag is responsible for this lag ok.

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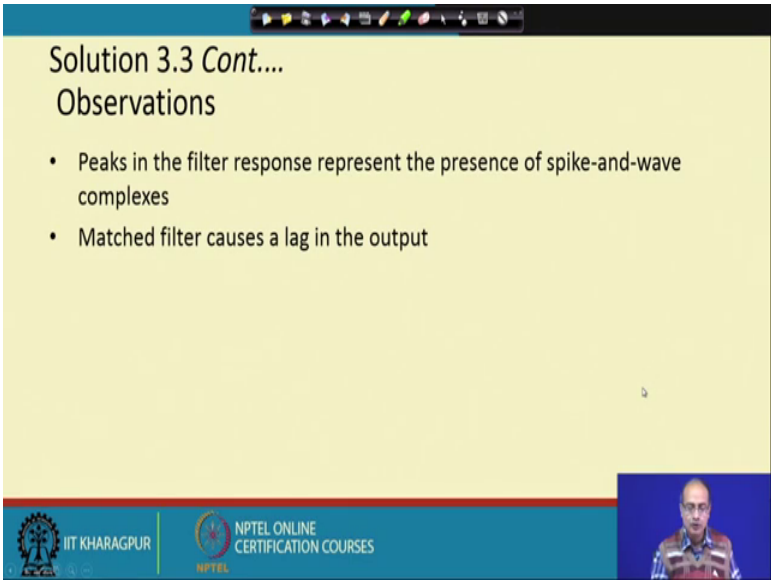

So, if we have to find out the location of that, then we need to be careful, we need to take care of this lag; however, that was not the task here. So, we will leave it here and we say that in the third problem of the tutorial 3 is completed.

Thank you.