Biomedical Signal Processing
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Lecture - 66
Tutorial - V (Contd.)

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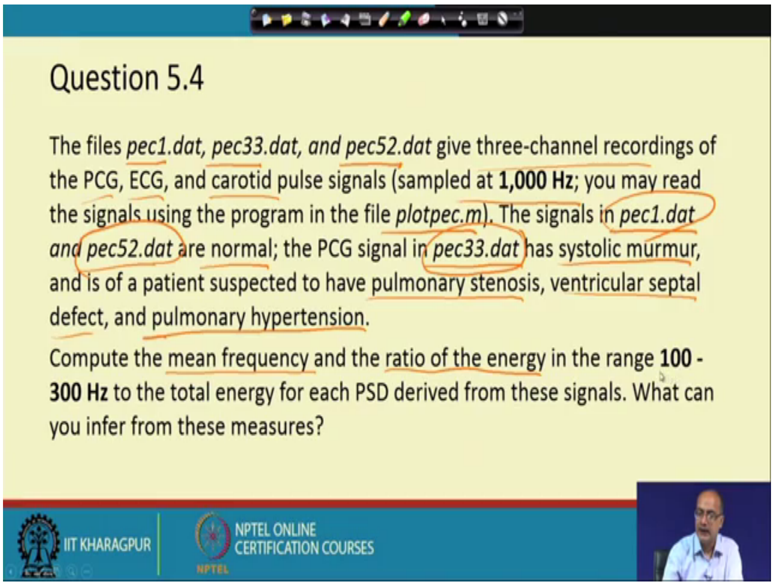

In the 4th experiment of the tutorial 5 we have three phonocardiogram signals pcg or pec1, pec33, pec52 ok. Three phonocardiam cardiograms signals are there; each on one of them they are three channel recording. The first one is PCG, second is ECG and third one is carotid pulse signal.

And all of this signals they are sampled at 1 Kilo Hertz and we are provided the MATLAB file to read it that plotpec dot m. The signal in pec1 dot dat and pec52 dot dat they are normal whereas, that pec 33 dot dat; it is having suffering from systolic murmur and if the patient suspected with pulmonary stenosis, ventricular septal defect and pulmonary hypertension ok. If you recall that we have gone through these phonocardiogram signals earlier in the experiment.

And here our job is to appreciate that how PSD can help to differentiate this abnormal signal pec33 from the other two that is pec52 and pec1. And how we can do that? That for that we have to compute the PSD first of all and then we from the PSD we can get the mean frequency. We can also compute the ratio of the energy in the range 100 to that in between 100 to 300 hertz in this bandwidth compared to the total energy of the PSD ok.

So, fractional energy within these band and we have to comment that what can we infer from these measures; that means, whether these measures that is mean frequency and the ratio of energy in the band can help us to differentiate the normal signals versus abnormal signal ok. So, that is the task given here.

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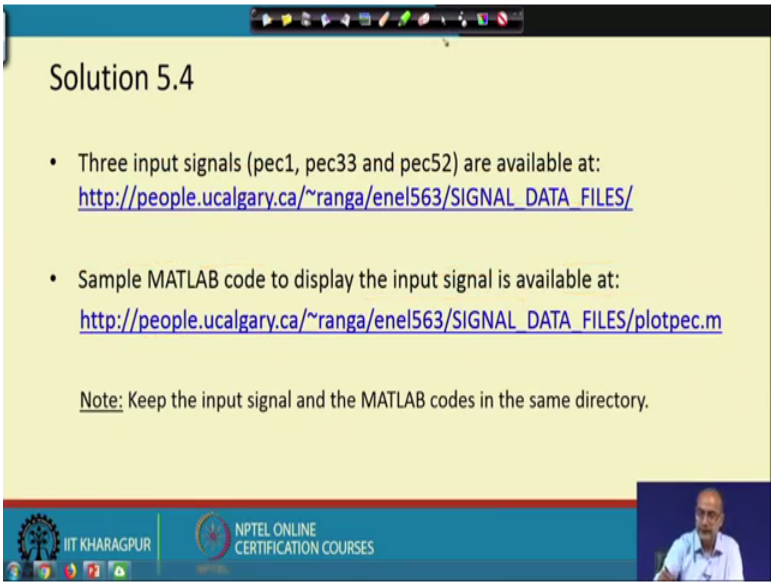

So, we proceed with that first we download the signals and that MATLAB file plotpec dot m what is required to read those files and we keep them in the working directory of MATLAB ok.

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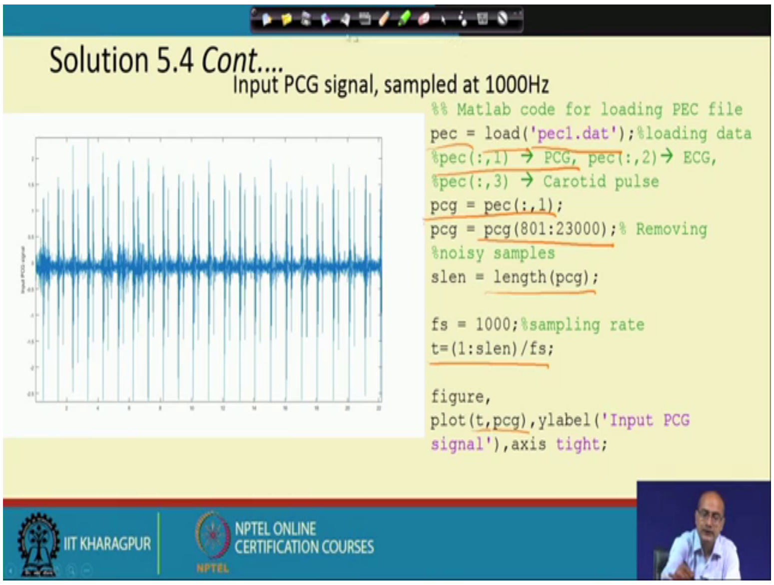

Now, first thing is to input that signal and first appreciate that by seeing that plot. So, for that; first we take that the signal pec1 dot dat we load that in the variable pec and we know that in the three channel signal the first channel is the PCG signal. So, we take that for further analysis, we take the samples from 801 to 23000. We take remove some part at the beginning to avoid some noisy samples ok. And then we compute that what is the length of the signal.

And that we can create the corresponding time axis here using that number of samples and the sampling frequency. And then we plot that signal that pcg with respect to the time ok. So, let us see how that signal looks like here. We get the PCG signal ok. In the time domain whatever we get I think we cannot infer much out of it. It looks like a lot of impulses and noise mingle together.

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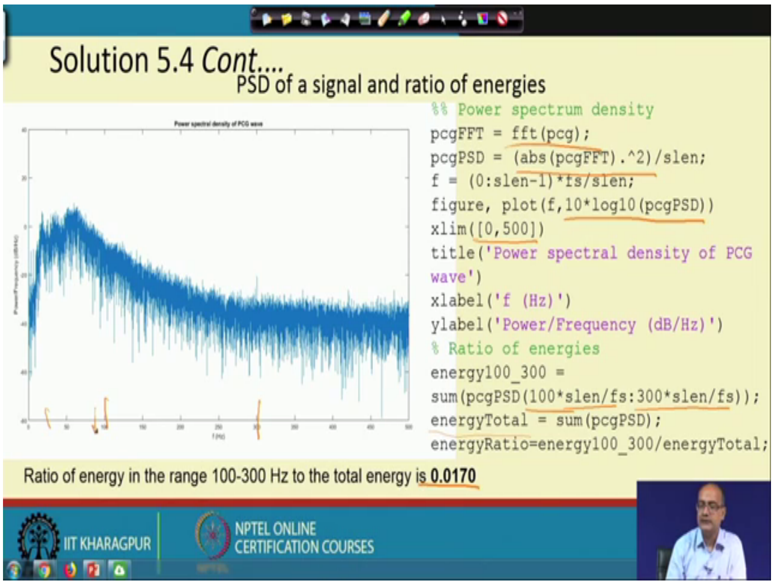

Now next we go for the PSD. So, for that what we have to do? We have to first take the Fourier transform of the signal. Then we need to take the energy. So, for that we have to take the absolute value and the square of it. And then we create the frequency axis and we take the plot of the PSD the dB scale. And as it is given that they are sampled from 0 to that it is 1 kilowatt; that means, we get the signal from minus 500 to plus 500.

So, we concentrate on the positive part of it that is 0 to 500 ok. We will limit that to get a better view of the signal ok. So, here we see the spectrum and then you also calculate the energy, how much energy is there between 100 and that 300 hertz ok. Within this range how much actually that energy is there we simply sum it up and with that we also calculate the total energy. So, we can take the ratio of the two. The ratio is given as that 0.017. So, very small number or we can say 1.7 percent energy is only there within this range; the range is 100 to 300.

Actually, most of the energy if you look it is concentrated in this part, less than 100 hertz in this signal ok. And this is the signal that pec1 we are talking about here.

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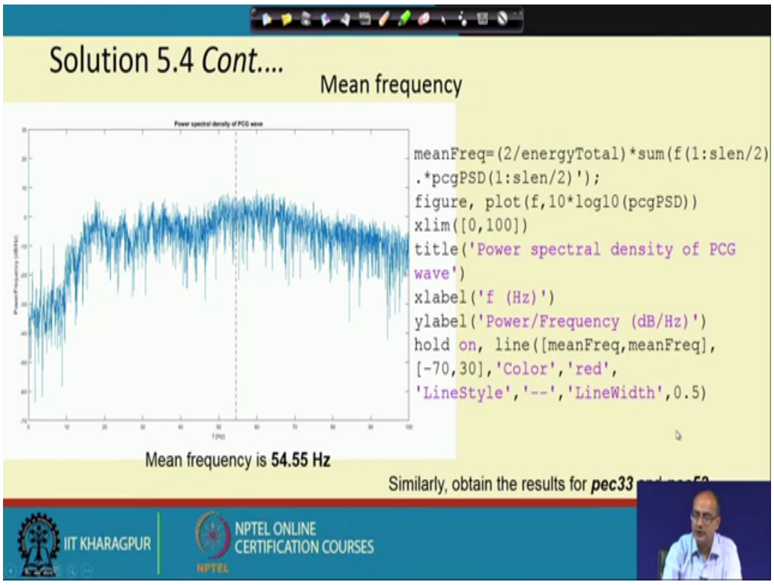

Now we go for the next task we need to find out the mean frequency and we know the formula we have used it earlier. So, we compute the mean frequency and show the plot of it ok. Mean frequency is at 54.55. Please keep in mind we have the spectrum 0 to 500 out of which we are we have taken the only the small part that is of our signal of interest that. We are just looking into up to 100 here so, that we can appreciate that this part better, but the span of the energy is from 0 to 500 hertz ok.

But compared to that the mean frequency is pretty low, it is lower one-tenth we can say that that part. The mean frequency is located. Now, let us go for the other signals to appreciate that how the spectrum and the mean frequency they change. And along with the spectrum how the energy of the spectrum within the band 100 to 300 also will change ok. So, we compute that all this variable for pec33 and pec52.

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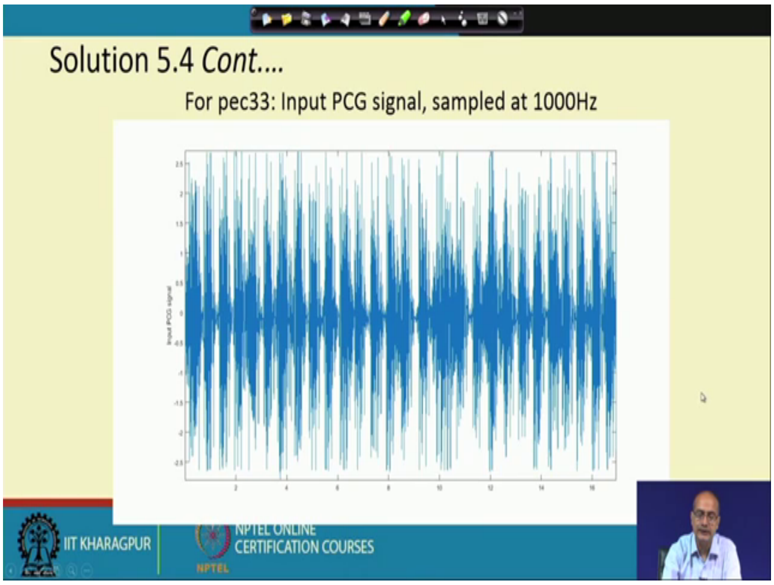

So, here is the pec33; it looks like that it has more jiggered or more random. However, that such visual measurements could be often wrong; so, let us not comment about it anymore.

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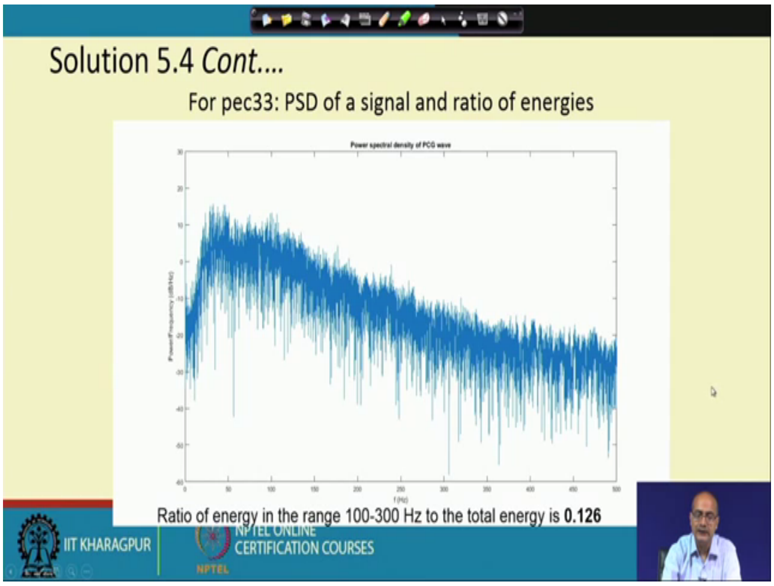

Let us look at that other parameters. What we get that we get the spectrum; here also we get the basic nature is there same, but most of the energy is below 100 hertz we can say like the previous signal ok. However, the probably that little more energy is there between 100 to 300 because what we get the energy ratio is 0.126 that means, 12.6

percent energy or the total energy is here ok. In the previous case it was about 1.7 percent ok; so, an order of magnitude change.

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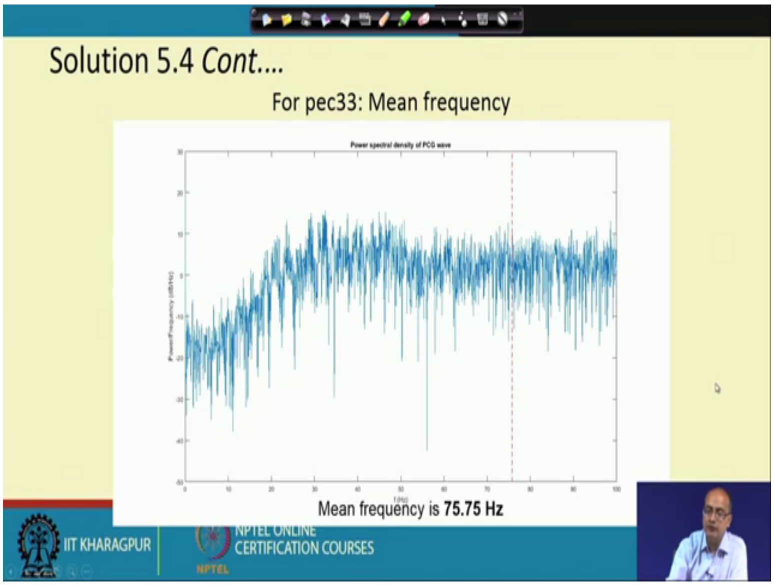

And if you compute the mean frequency for pec33, we get a mean frequency. We get at a little higher frequency that is 75.75 hertz ok. So, it is little higher than the previous case which was around 50 hertz in the previous case.

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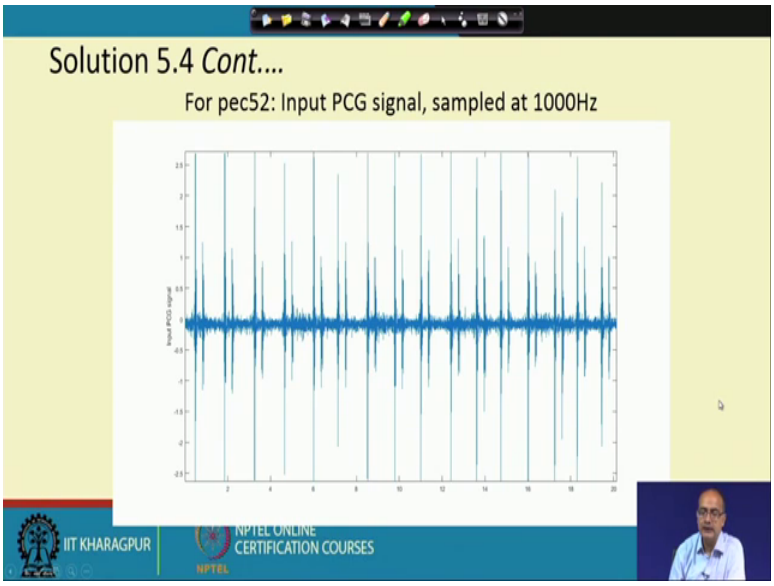

Now we go for the other normal signal that is pec52 and the corresponding the PSD we get here.

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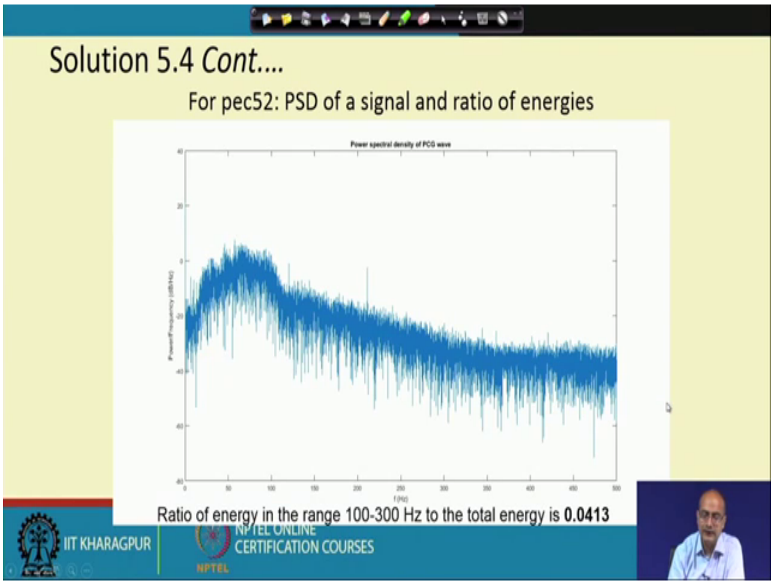

Again the nature is same in the sense that most of the energy is concentrated below 100 hertz or on in this band. And when you look at the energy between 100 and 300 hertz that we have, the ratio with respect to the total energy is pretty small. We have that 0.0413; that means, 4.13 percent energy is there ok.

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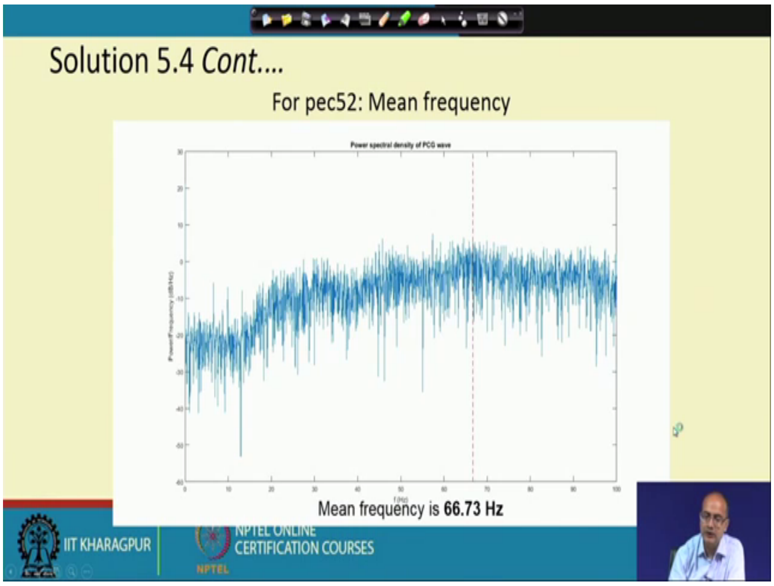

And now, if you look at the mean frequently we get. The mean frequency is lower than pec33. It is 66.73, but it is little more than that of that pec1 ok.

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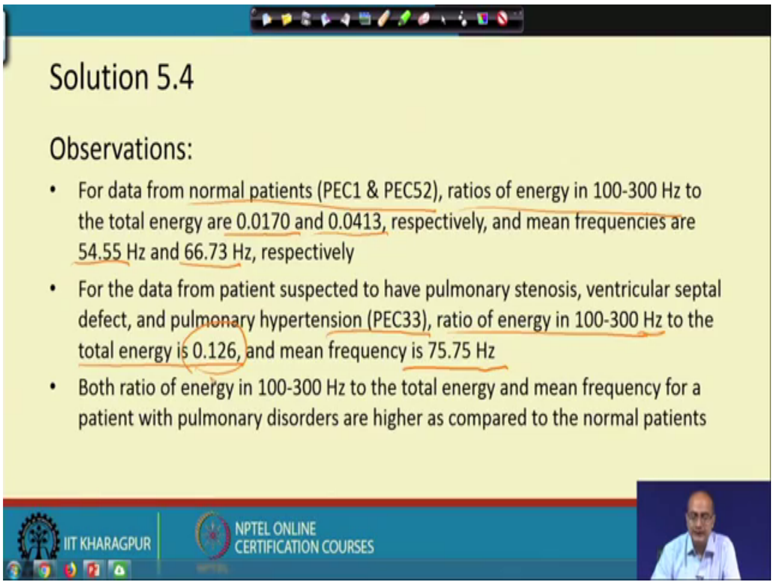

So, now as we have seen the PSD, the energy ratio and the mean frequency; now we go for the conclusion. First we state; that what are the, that energy ratios we get, here for the normal patients PEC1 and PEC52; we get the ratio of the energy between 100 and 300 hertz. It is 0.017 and 0.0413; that is 1.7 percent and 4.13 percent.

And the mean frequencies are 54.55 and 66.73. So, what we get? Among the normal patient there is some variation, it is not always you meaning the same. And now, when you go for the disease subject and the PEC corresponding to that PEC33; the ratio of the energy in the band 100 to 300 hertz, we get the total energy is 0.126 and the mean frequency is that 75.75.

So, from this what we can get? That the ratio of the energy and the mean frequency both are more when it is a pathogenic case because clearly the energy when we get it is 12.6 percent, energy is there which is order of magnitude higher than the normal cases ok. So, both the mean frequency as well as the; that the energy ratio taking the band 100 to 300 would be a good measure. And out of these two that features the ratio of the energy is giving better separation ok. So, it would be a better feature for classification of the; that pathogenic signal from the normal one.

Thank you.