Noise Management & Its Control
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Lecture – 36
Classification of Microphones – III

Hello, welcome to noise control and its management. Today is the last day of this particular week, which is the sixth week of this course. And we have discussing a lot about microphones. So, what we have discussed till so far are different ways to classify microphones, the first classification is based on how they work, the second classification we discussed was based on what kind of requirements we have, the third classification could be based on directionality.

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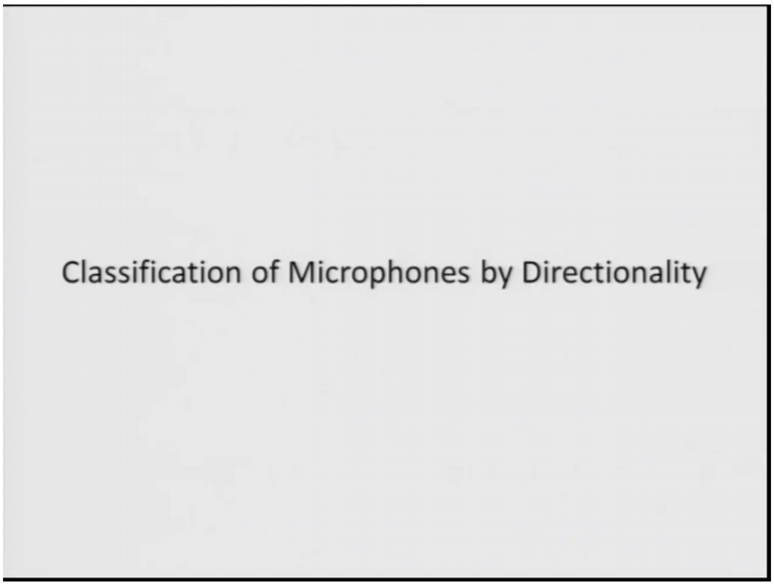

So, what does directionality mean? What it means is that how sensitive microphone is to a particular direction. Suppose this is a microphone, and this is the tip, which is sensing the sound; and there are certain types of microphones, which are very sensitive noise which is coming from the front side. So, if noise is or sound is coming from the front end they will pick that sound very well. But if the noise is coming from this side, they will not be sensitive to that sound or from this side. So, there is lot of design which happens when people make microphones. So, this is known as directionality or directionality of a microphone. There are some microphones if noise or sound comes from the front side, they will sense it; if it comes from the backside, they will still sense it, but not to that same level.

So, it depends there could be a situation where you are interested in noise may be only coming from this side, and you are not interested in sound or noise coming from the back side, then you may have to take select particular type of microphone which meets that particular requirement. So, this feature of a microphone that it is sensitive to specific types of directions is known as its directionality. And it can be quantified in different ways and one way to quantify it is known as directivity index. Now, we will not discuss a lot about directivity index, but we will see different types of microphones in how they behave in terms of directionality, and these microphones have specific names.

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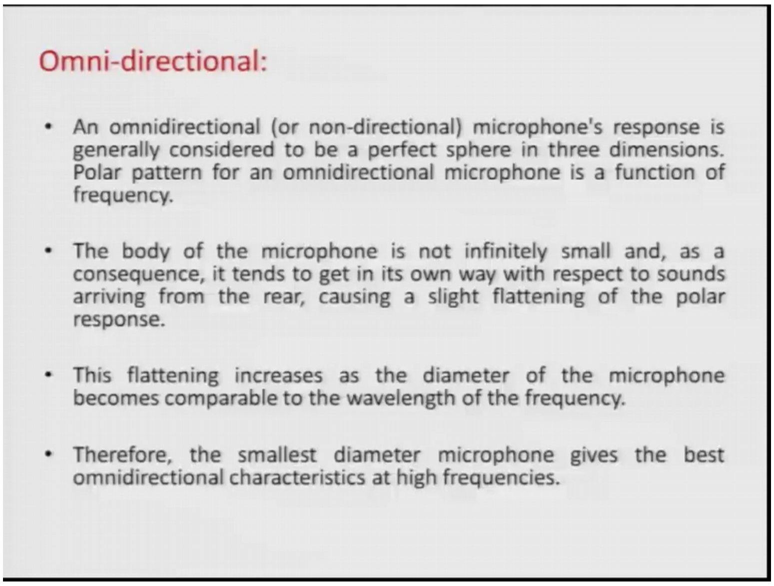

So, the first one is omni-directional. If a microphone is sensitive to sound equally sensitive to sound which comes from any direction, then it is a omni-directional microphone. So, this is there are some three important bullet us about their omni-directional microphone I will just read that it says that an omni-directional or some microphones are called as non directional. Omni-directional or non directional microphones response is considered to be a perfect sphere in three dimensions polar pattern for omni-directional microphone is a function of frequency we will see that. And we will not worry about the remaining three points, but because I will come and cover them may be later in the class.

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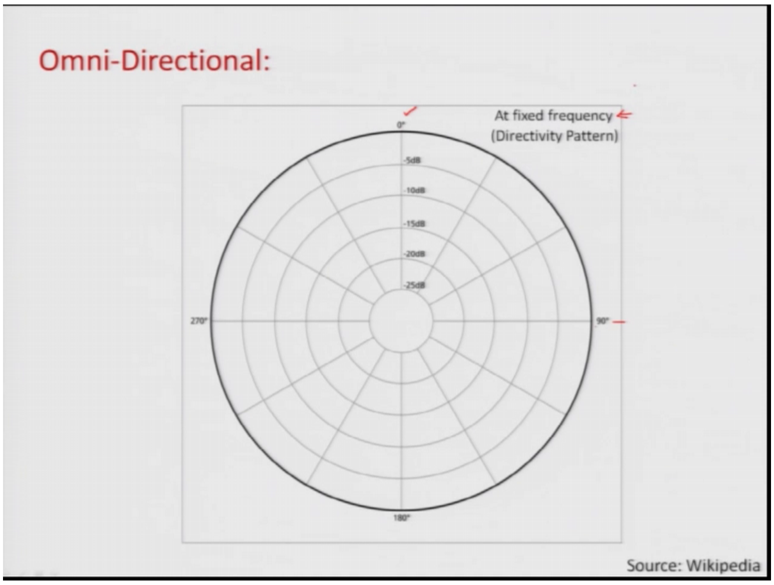

But this is how the pattern of often omni-directional microphone looks. So, what do you have in this picture what it shows is this is the zero degree angle. So, if the sound is coming from 0 degree angle, let us look at this dark line and let us say that the noise level is 0 dB. So, let us say this dark line if I am closer to the centre, then I have lesser dB;s if I am far away from the centre then I have more dBs. So, because this is a uniform circle then at 0 degrees, if the noise is coming from 0 degrees microphones senses at 0 dB. If the noise comes from 90 degrees it still senses at 0 dB; 180 and 270 also same because it is a uniform regular circle. And then of course, there is minus 5, minus 10, what this means is that as you bring the source away then as you take the source away it the noise level goes down and so on and so forth. So, this is the directivity pattern of an omni-directional microphone, because it is equally sensitive to noise or sound from in terms of all directions.

Now one thing to remember is that this directivity pattern can change from frequency to frequency may be a microphone is omni-directional at 300 hertz, but it may not be omni-directional at 3,000 hertz there are several factors, which influence it. So, whenever we are interested in looking at directivity patterns we should also think about the frequency of interest so that is why it is written at fixed frequency.

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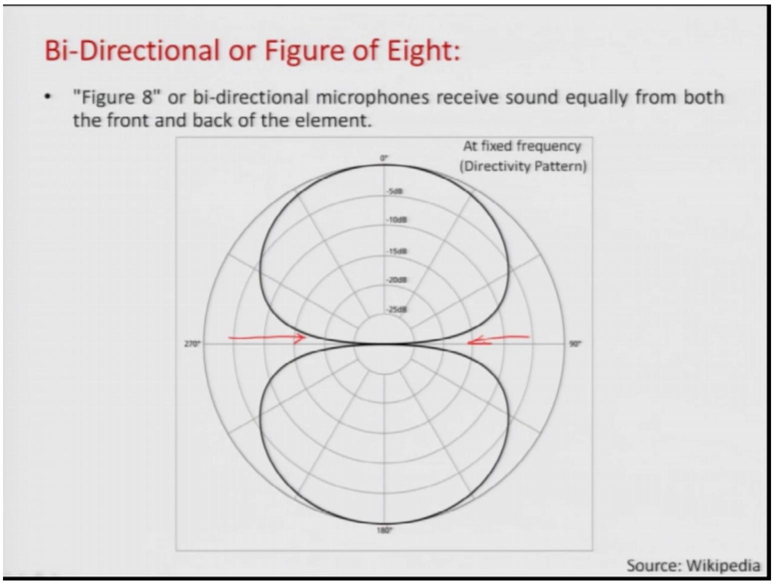

Now, let us look at another microphone. So, this is a bidirectional microphone. What does it mean that in the zero direction and in the 180-degree direction the microphone is highly sensitive to sound. So, if the sound is coming from 0 degrees or its coming from back, it is highly sensitive to sound. But if sound is coming from this direction, it will not sense a lot of pressure it may still sense something theoretically it is a 0, but in reality it will not be exactly 0 it may but it will be significant less. So, if I am not interested in sound coming from the sides then this is the type of microphone which may be of used to me bidirectional.

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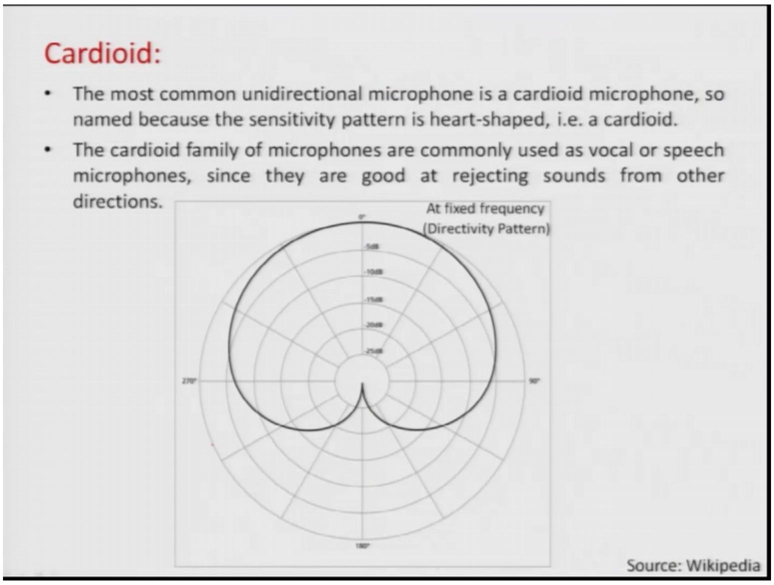

Again, these are all frequency specific patterns these are frequency specific patterns. So, this is bidirectional. This is a cardioid mic; cardioid this is very popular mic and the lot of times these types of microphones also used on stages. See, because on stage what are you interested in transmitting all the sound which is being emitted by the singer and the musicians and all that you do not want the sound coming from the audience to the microphone and getting amplified. So, here the sensitivity of the microphone is very less is very less if the sound is coming from 180 degrees; and it is very sensitive at 0 degree and of course, at 90 and 270 it is somewhat sensitive, but it is very less at 180 degree. So, this is cardioid and it is known as cardioid because it looks like kind of it looks like a heart, so that is why it is cardioid.

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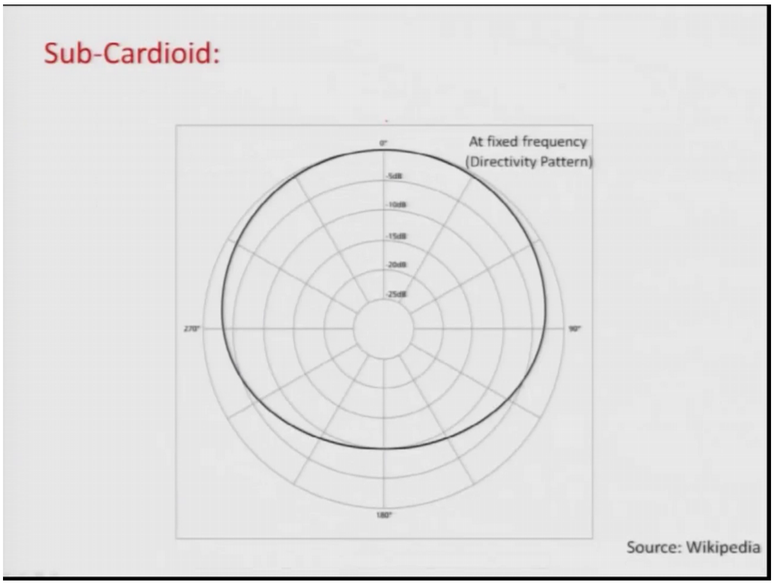

This is a sub cardioid mic. So, again it is less sensitive with respect to 180 degrees, but it is not as extreme as a cardioid. But then look at this, so this is sub cardioid its performance is slightly inferior to cardioid.

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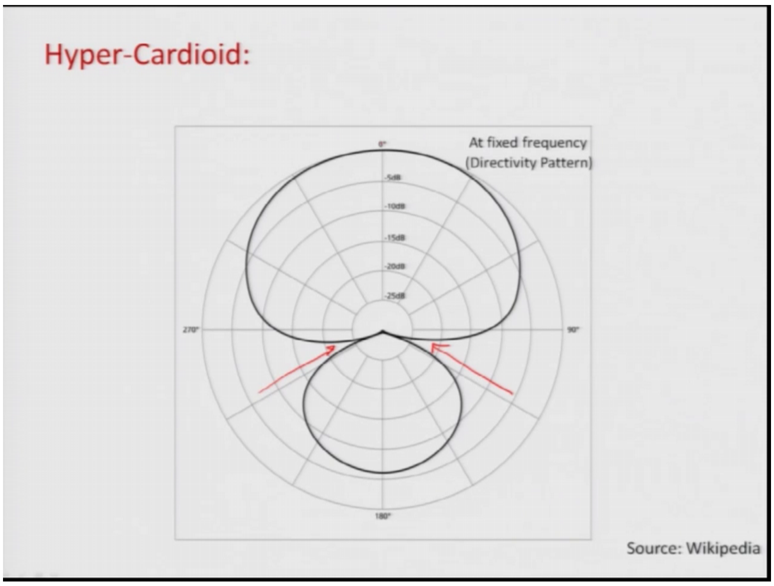

But this is hyper cardioid. So, it has two loops; this is one loop, this is another loop, and it is not sensitive with respect to these directions. And it has some sensitivity in 180, but its maximum sensitive in 0 degree. So, hyper cardioid.

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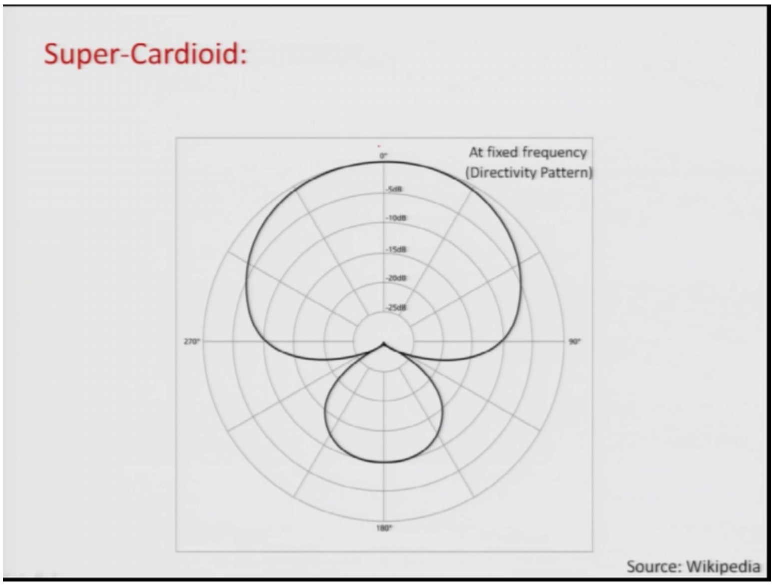

This is super cardioids. So, they have all sorts or names. So, the point is you should be aware of these terms and basically you should know what kind of directivity pattern you want from your microphone.

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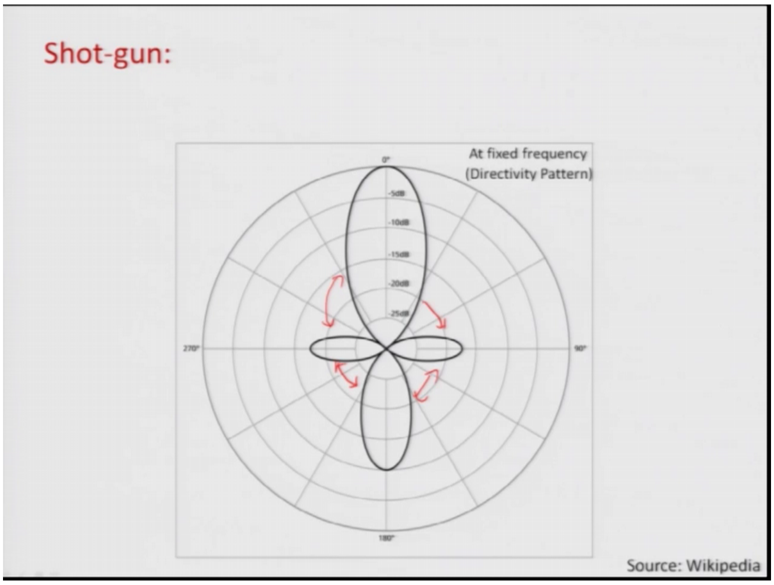

This is a short gun mic. So, here you have extreme sensitivity in 0 and 180, and very less sensitivity in other directions, very less sensitivity. And actually in these directions large values of theta, the sensitivity is virtually 0. So, this is what I wanted to discuss in context of directionality. And now what we plan to do is we will discuss as to what are the important features of a good microphone. So, suppose you want to go to market and you are interested in buying a television, what are you interested in, you are interested in screen size, you are interested in resolution and clarity of pictures all these things. What makes a good television, how clear the picture is how small the pixels are, what how good the colours are how good the sound is. So, now, what we are going to discuss is what makes a good microphone.

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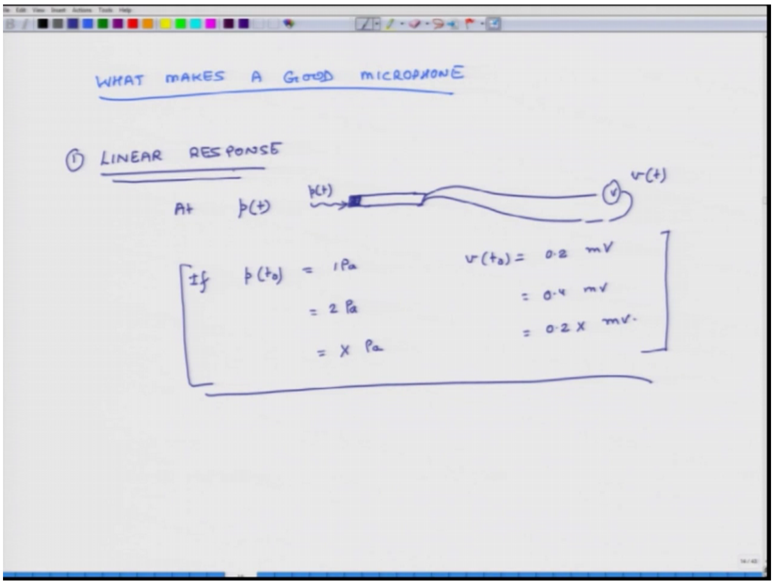

What makes a good microphone. So, this is very important to understand I mean which microphone is a great microphone and which microphone is a bad microphone, which you would like to avoid for making scientific measurements. So, the first thing you want a microphone to be and does not matter whether it is a free field microphone or pressure field or a random incidence, whatever I am going to discuss applies to all microphones. So, first thing is that it has to be linear response, linear response the microphone should be a linear device, it should be a linear device what does that mean. What it means is that suppose at so what does a microphone sense, it senses pressure as a function of time. So, let us say and what does it give, so you have a microphone and this is your sensing device and it senses p as a function of time and then eventually whether it is a capacitive microphone or whatever ultimately we convert everything into voltages.

So, I will so essentially we measure volts as a function of time. So, what is a linear system. A linear system would be that if so this I am giving an example that if p at t is equal to t naught is equal to 1 pascal let us say V at t t naught is 0.2 volts or this unrealistic let us say its milli volts. Then if pressure is doubled, so suppose this becomes 2 pascals this should be just twice of that. And this if it is one times x pascals, now I say x pascals then this should be 0.2 times x milli volts. So, this linear relationship between input and output should be preserved by the microphone; for all frequencies and all amplitudes, it should not be that for only some frequencies. So, this is very important because if it is not linear then you will not know my voltage went up by a factor of 100, but I do not know whether in reality pressure really went up by 100 or it went up by 200 or 50 because it is not a linear system. So, your calculations of pressure will not be correct. So, you want the linearity to be very high, linear response, this is very important.

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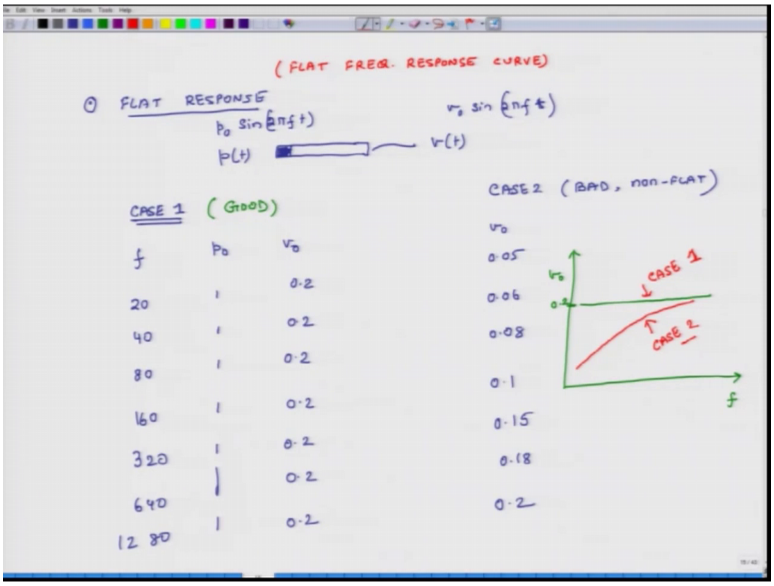

The second thing you want from a good microphone is that it should be having a flat response, it should be having a flat response. What do I mean by flat response? So, I will explain that. So, suppose I have a microphone, and it is sensing pressure as a function of time. And what does it give out, it gives out voltage as a function of time same picture. Now, suppose I have a microphone case one. So, what I am subjecting this microphone is to different frequencies. So, let us say I am subjecting this to this microphone to p naught sin 2 pi f t signal this is my input and frequency could change frequency. So, if it is linear system it will give what is the output it will give V naught sin 2 pi f t plus some phase difference plus some phase difference for a linear system. Or to make things simpler at in context of this course I will say that input is p naught sin 2 pi f t output of the microphone is V naught sin two pi f t.

Now, what I will do is I will make a table case 1. So, I have two microphones a good microphone and a bad microphone a good microphone has a flat response and the bad microphone has a non flat response and I will show you how it will look like. So, suppose I excite, so I will make a table f and p naught and v naught. So, let us say f is 20 hertz, 40 hertz, 80 hertz, 160 hertz, 320, 640, 1280 let us say and we can go on and on further. And let us say p naught is one pascal in each case, p naught is one pascal in each case. So, this case one is good microphone; and then the case two is bad microphone why because it has a non flat response non flat response, it can be bad because of several reasons. This microphone is bad because it has a non flat response.

So, what I am doing for both the microphones, I subjecting it to different frequencies. First experiment 20 know p naught sin 2 pi f t, where f is 20 hertz. Then in the second experiment, I am subjecting good microphone to 40 know one times 40 sin two pi f t at 40 hertz then 80 hertz like and so on and so forth. And I am measuring what is the value of v naught. So, may be a good in a good microphone this will be 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2. For a bad microphone the frequencies, so I am not going to repeat columns for volt pressure and voltage; pressure and frequency they are same. So, for bad microphone the output. if the inputs are same f and p naught are same then what will be the input it will not be a flat thing. So, what it will look like it may look like 0.05, 0.06, 0.08, 0.1, 0.15, 0.18, 0.2 may be something like that.

So, why do we call. So, this one is not flat bad microphone does not have a flat response. Why it is not flat? If I plot on x-axis frequency, and on y-axis I am plotting v naught then for a good microphone. So, this is 0.2 for a good microphone this responses is straight-line flat line. For a bad microphone for not so good microphone, this is not straight line it is doing something like this. So, we certainly so this is case two and this is case one. So, this is what we do not want in a microphone we want a flat response. Now, there is no microphone which will have a perfectly flat response for the whole frequency bandwidth 20 hertz to 20,000 hertz which is our audible range. But we should be looking for a flat response in the frequency of our interest. Suppose my frequency is r from 500 hertz to 5000 hertz then at least in that range the response of the microphone should be flat that is certainly required. So, this is a flat response.

So, what we have discussed till so far are two important attributes of a good microphone linearity and in linearity and the other one is flatness flat response. And lot of times this flat response is also known as flat, and this is more explicit flat frequency response, flat frequency response curve. So, a good microphone has a flat frequency response curve; our bad microphone has a non flat frequency response curve. So, this concludes our discussion for today. Next week which is the seventh week, we will still have this discussion on what makes a good microphone and may be in couple of lectures we cover all we want to know about microphones and then we will start discussing about different mathematical techniques related to noise measurement, so that concludes our discussion.

Thank you very much, have a great week end, and we will meet once again next week. Thank you, bye.