Noise Management & Its Control
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Lecture – 34
Classification of Microphones – I

Hello, welcome to Noise Control and its Management. Today is the fourth day of this particular week and what we planned to do today is continue our discussion on classification of microphones. Yesterday we just started discussing different types of microphones and what we planned to do today is discuss capacitive microphones and inductive and piezoelectric ones as well so that you become familiar. So, we discuss the resistive microphone yesterday, today we will discuss capacitive microphone for starters.

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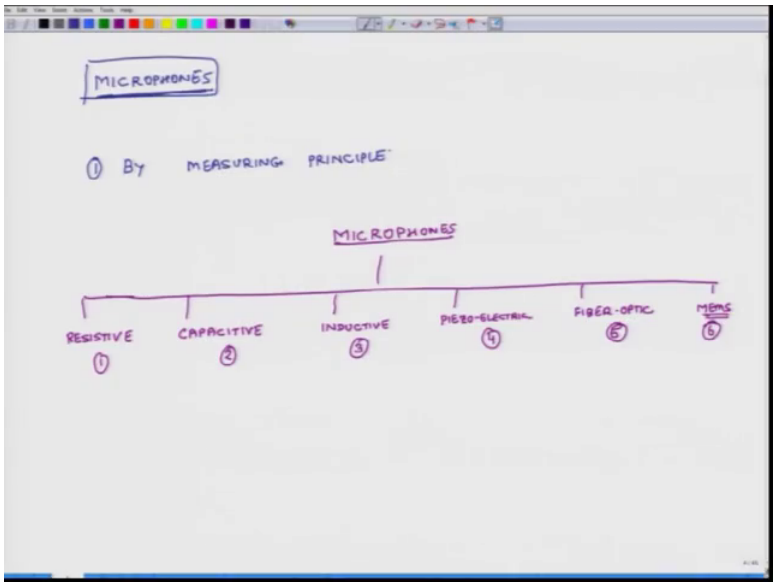

Capacitive microphones operate on the principle of capacitance. So, you have essentially in a capacitive microphones you have two plates separated by some distance and one plate is more or less fixed, the other plate is vibrating based on changes in sound pressure level and as it vibrates the distance between these two capacitive plates goes up or down and as that distance changes the capacitance between these two plates changes and what we do is we measure the change in that capacitance and from that we try to figure out

what is the sound pressure level.

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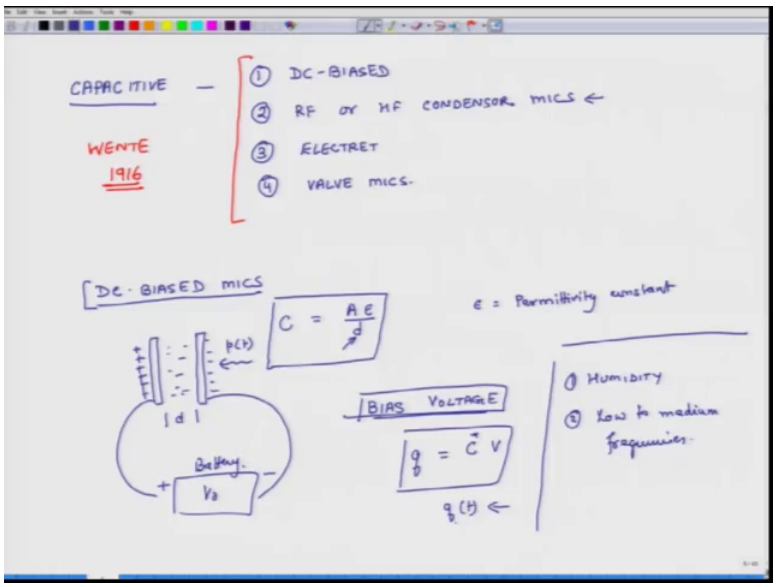

So, there are three types or three broad categories of capacitive microphones. So, the first one is DC biased microphones, the second one is RF by RF I imply radio frequency or H F high frequency microphones condenser mics.

So, these capacitive microphones are also known as condenser microphones because a condenser is a capacitor right. So, these you can also call them condenser microphones and the third one is electret microphones. There is a fourth category also we will not talk, but at least you should just know the name valve microphones. So, first let us understand how a DC biased microphone works. By the way the first microphone of this capacitive nature was invented by a person by the name Wente w e n t e in 1916, he was working in a company known as Bell labs which was started by Alexander Graham Bell and this is where he invented this microphone.

So, we will talk about DC biased mics and what you have here as I explained the basic principle I will explain, you have a fixed plate and a vibrating diaphragm of course, there would be some you can have either a here or some dielectric material between these two plates. Now the distance is d and let us so, then what is the capacitance of between these

two plates, capacitance C as measured in farads will be the cross sectional area of the plates times epsilon. So, epsilon is permittivity constant and it which varies whether its air or there is some dielectric material inside it then it is a different value. So, a times epsilon divided by d this is the capacitance. Now the way this microphone works is that in a DC biased microphone what they do is, they connect this to some battery. So, this may be the positive end and this may be the negative term and the battery voltage could be as high as 150 or 300 or 400 volts.

So, it is a good amount of voltage, this voltage let us call this v naught is called biased voltage biased voltage and because of this biased voltage now there is this capacitance and for a capacitor you have charge equals capacitance times voltage right. So, some charge accumulates on the two electrodes on the two plates. So, if there is no sound pressure level there is charge does not change for a fixed voltage and once this thing gets excited by oscillating pressure, because the capacitance is changes capacitance changes q starts changing. So, q becomes a function of time.

So, then using charge amplifiers electronic devises known as charge amplifiers we try to measure, what is the change happening in these in the charge and that is how we and if we know how q as a function of time, then I can calculate changes in c and if I know change in c what it will help me calculate is change in d right and I know and then based on some calibration methods, I know that if I apply 1 Pascal of pressure d changes by so many millimetres. So, from that I can calculate how much pressure is changing as a function of time. So, the way to these microphones work is you figure out changes in q from that you figure out change in capacitance, from that you figure out change in d from that you figure out change in pressure.

And, but you need a biased volt voltage because there is no bias then there would not be any charge. So, then you would not be able to sense anything. So, you need some bias voltage. So, this is important now the problem with these mics is. So, these are fairly popular, but the problem is that these are very sensitive to humidity, because what happens there is moisture then this charge can flow and charge can become less or high based on because these plates are very close and if there is moisture then you can have some conduction also happening. So, they are sensitive to moisture and the other thing is

that they work reasonably well for low to medium frequencies.

So, these are DC biased microphones and then known as DC biased microphones because we put a biased voltage on that to DC biased voltage to make the system in to excite the system. So, that its starts functioning. Now then there are there is this other category RF or high frequency condenser mics. So, these are used for extremely high frequency. So, at least in context of noise measurement we will not talk much about it, but in general these are less sensitive to moisture, but I will talk about this electric mic.

So, what happens? So, we will discuss electret mics, now these electret mics when they were invented they were not of very great quality and so, they were not used for measuring noise for noise for scientific measurement of noise they were not used a lot, but they were used for a lot of general applications that for instance in your laptops or in your mobile phones, the microphone which is there is an electret mic and they are very popular they are available all over the place and they are now very inexpensive also, but initially when they were invented they were not of high quality. So, for lab required the measurement of noise for scientific measurement of noise they were not used that much.

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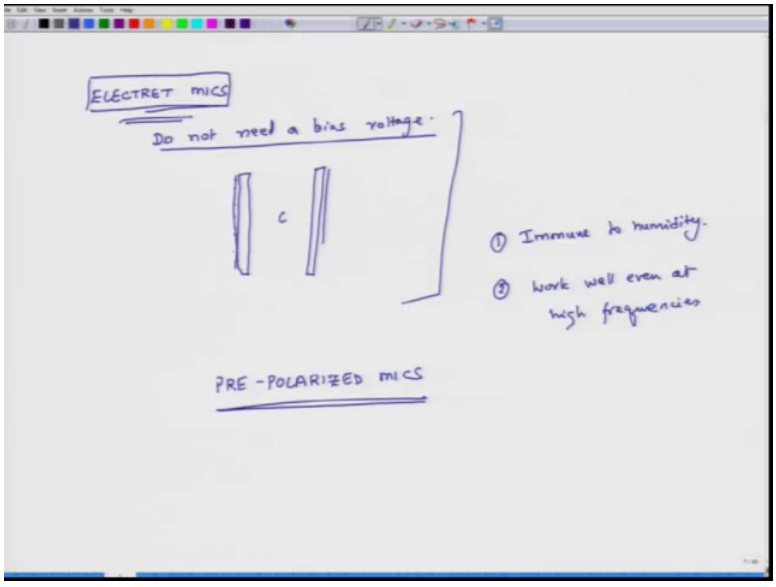

Now a special thing about these electret mics is that you do not need a bias, how do they

work?

They still have two plates, but in this in case of DC biased you have to apply an external voltage to generate this basic charge. Here when you purchase a microphone from the shop, the charge is actually deposited on top of it because of a manufacturing process. So, what happens is that they are some materials, for instance some special types of plastics if you pull them or if you heat them and in heated state if you exert some external potential difference across them, if you subject them to some put them in a strong electric field. So, for instance you have a plastic sheet some special type of plastic sheets, then on one side you may have positive charges accumulate right you may. So, it is a property of the system based on it is electronic nature.

So, you take a plastic sheet particular type of plastic sheet heat it so that to say it in simple words. So, that electrons become mobile and then when electrons are in somewhat mobile then and heated state you put it in an electric field. So, suppose this side is positive this side is negative and you have a heated piece of plastic there. So, electrons will tend to go towards the positive side of the field. So, on the surface they will collect and then in that state itself while you have an external electric field applied, you make the temperature of the plastic you bring it to room temperature. So, now, what happens is electrons are frozen, they cannot move because at high temperature they could move, but now they cannot move anymore. So, they are kind of like deposited on the surface. So, here you have charge deposited on the surface right the charge is already deposited on the surface and you have capacitance. So, you do not need a bias ok.

So, in this case, that is the basic concept and now people have I have become much more smarter and the quality of these microphones has also become very good. So, lot of scientific measurements are also being done using these electric mic electret mics. These microphones are also known as prepolarized mics they are pre why do they call pre why do you call them prepolarized? Because the polarization see in DC biased you apply charge there is DC bias to polarize them, here you do not need them they already come in a polarized state. So, these are prepolarized mics and because of this you do not need the external bias voltage. So, you can start using them directly and of course, you have to amplify signals and so on and so forth, but an advantage of these types of microphones is

that they are immune to humidity, because these electrons they have nowhere to go they immune to humidity.

Second thing is they work very well even at high frequencies. So, our earlier type of microphones DC biased they were working, well enough only for low and low frequencies and mid frequencies, but these also work well at high frequencies. So, this is all about electro electret mics.

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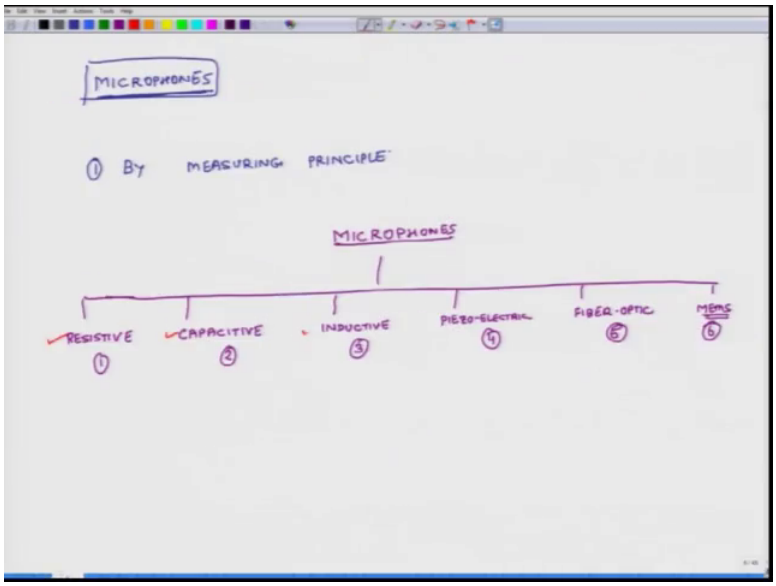

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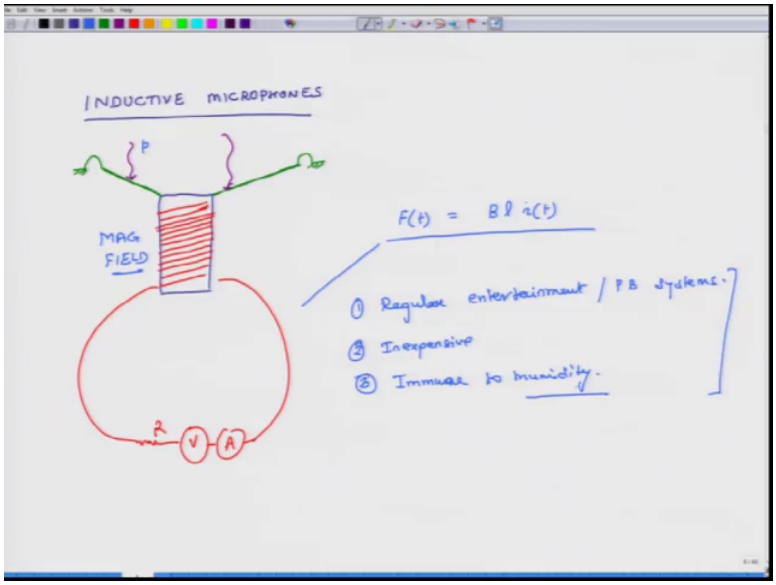

So, we have discussed all these three and then of course, they were valve mics, but in context of this course I think this these are the two microphones we should worry about and now what we will discuss is the next category of microphones, which is inductive mics.

So, we will discuss inductive microphones. So, we have three important elements in electricity resistance capacitance and inductance. In resistive mics we use principle of resistance, in capacitive mics we use principle of capacitance here we use the principle of inductance. So, what happens in these microphones is that. So, you have a coil. So, let us say this is very thin cylinder hollow cylinder very thin and on top of it you have very fine copper wire bound. So, it is a winding and now think about it suppose I connect this winding or this coil to a diaphragm which can vibrate. So, if sound falls here sound pressure comes here the pressure is going to change because of this diaphragm will tend to vibrate and when it vibrates the coil is also going to vibrate. So, now, we have and what is a coil it is a move its a conductor, it is a conductor which is moving and then of course, the ends of the coil you can have a resistor and then of course, you can put a voltmeter here or an voltmeter and or you can also put an ammeter to measure current.

So, you can measure current as well as volt across the ends of this thing. So, when the coil vibrates right now nothing will happen, if you take a piece of wire and you move it

up and down nothing will happen. But if you take the same piece of wire and you connect its ends and you move and up and down nothing happens, but if this contraction is put in a magnetic field and the magnetic field is such that it cuts these conductors its normal to the conductors. So, there is a magnetic field outside not outside in this whole thing, then what happens that when you have a conductor vibrating in a magnetic field it will generate current right. So, this is from principles of electromagnetism.

So, a current is induced in these wires that is why it is an inductive microphone. So, what is the value of this current? So, suppose I put a force. So, here I have pressure and pressure times area is force. So, if I am a applying some force. So, force is a function of time that equals B, B is what? Magnetic field times i, i is current and l is length of the conductor and this B l and i is the function of time also. So, what we do is through some electronic system we measure changes in current and from that change in current we can figure out what is the sound pressure level. So, this is the inductive principle where do we use these microphones? We use them in a lot of you know regular applications in when we have big public or gatherings, those types of microphones in auditoriums in halls in radio stations. So, these are used for a lot of regular applications, regular entertainment and public broadcast systems.

They are inexpensive. So, they are inexpensive and what else they are also immune to humidity do not get influenced by a lot of humidity. So, these are the things, but they accuracy is not all that great for regular applications its fine, but for scientific measurements if you are trying to measure noise pressure levels for engine ring purposes and all that for labs, we do not tend to use these types of microphones.

So, these are inductive microphones, now we are left with two more categories one is piezo and then we will also do fibre optic, we will not discuss too much about mems based microphones. So, what we will do is we will discuss these two microphones piezos and fibre optics in the next class and then till then have a great day bye.