Analog Circuits
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Module - 01
Lecture – 02

In this lesson, we will discuss amplifiers. As I mentioned in the introduction to the course, this course is about amplifiers. So, what we will do in this lesson is to see the characteristics that an amplifying device must have.

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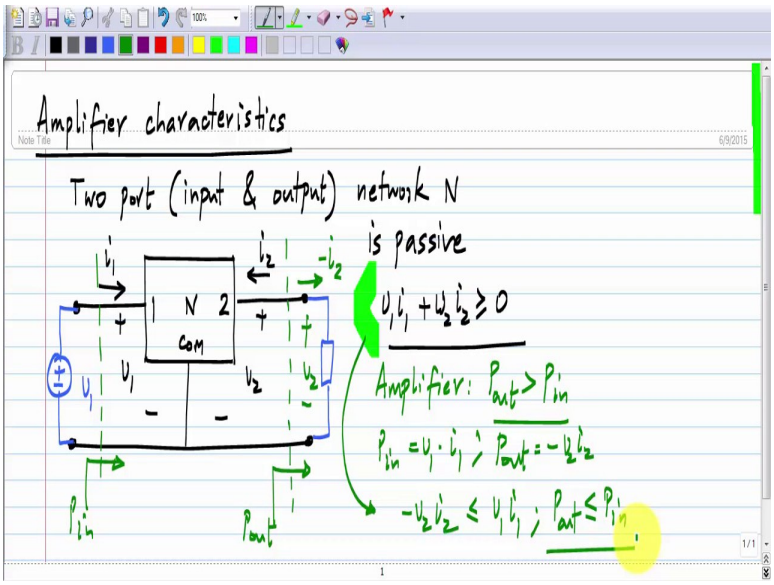

Now in this lesson, we will not be looking at any amplifier device in particular, but only about general characteristic that amplifier devices must have. And amplifier has an input and an output; so we will assume that it is a two port network. So to one of the ports, we will feed the input and from another port, we take the output. And let me consider just for simplicity, a three terminal two port network like this. You would have seen representations of such a two ports in your basic electrical circuit class and this is port 1, port 2 and this is the common terminal. Now let say that, I apply a signal, let say it is call v_1 to port 1, and I will also write down the definition of port voltages and currents v_1 and i_1 ; and v_2 and i_2 in the second port. And let us say that we take the output from the second port; again I have shown a voltage source here, but it does not have to be

like this. It could have a series resistance, it could be a current source and so on, because all the arguments we will make now will be general and in terms of only the port variable. It does not matter what is actually connected to this side or this side.

Now every network that we take is passive that is it does not have a source of energy inside, it can only dissipate power. So what does it mean this two port network N, this is passive. So it means that $v_1 i_1 + v_2 i_2$ is going to be more than zero, or maybe it is equal to zero in which case it is not dissipating any power. So it cannot generate any power; it does not have any source of power inside. Now what does it mean for an amplifier; first of all, we wanted amplification, what it means is that the power that we put into the amplifier P in must become bigger when it comes out that is for an amplifier,we would want P_{out} – the power coming out to be more than power going in. Otherwise there is no amplification at all, so this is what we would want to have.

Now let see if our circuit can amplify power, because just now I said that all our networks are passive so that means that $v_1 i_1 + v_2 i_2$ will be more than zero. So now what is the input power - P_{in}, P_{in} is $v_1 i_1$ so you see that the current flowing out of the positive terminal of v_1 is i_1, so the power supplied by this voltage source which is going into the port one of the network that is $v_1 i_1$. And what is the power delivered into the load that is the voltage across the load which is v_2 times the current flowing into the load according to the passive sign convention which is - i_2. So the output power is - $v_2 i_2$. Remember we choose the signs of v_2 and i_2 according to the passive sign convention. So the power that is coming out of the two port is - $v_2 i_2$.

Now, if you just rearrange this by taking $v_2 i_2$ to the other side, you will easily see that - $v_2 i_2$ is less than or equal $v_1 i_1$. In other words, P_{out} is less than or equal to P_{in}. Now this is not very surprising, this looks in fact like roundabout way of saying that the device is dissipating power, because we already said that the device is passive so that means it is dissipating power and remember there is no other source of power here. The input v_1 is the only source of power, so whatever is coming out of the two port is less than or equal to at most equal to the power delivered by the source v_1.Now the reason I even showed this calculations is, we will elaborate on this later, we have to make a some of other arrangements to amplify a power, so to get use to that I have shown you these calculations, but the calculations basically show what common sense would have told you there is only one source of power here which is v_1 and it is a passive

network. So it can only dissipate power, so what can come out can only be less than what is going in through a single source of power.