Analog Circuits
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Module - 02
Lecture – 04

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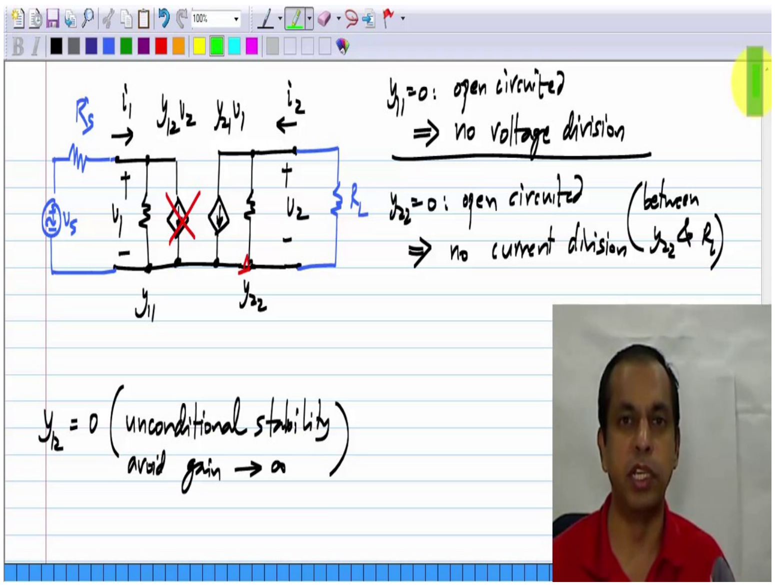

We have evaluated the constraints on small signal y parameters in order to maximize the gain of a two-port amplifier. Now let us get some more intuition behind it. It is quite simple as it turns out. For this, we will use the circuit equivalent of the two-port of the small signal two-port. We know that the circuit equivalent of the small signal two-port consists of a conductance y_{11}, a control source y_{12} v_2, another control source y_{21} v_1 and a conductance y_{22}, where this voltage is v 1, and this voltage is v 2. And these are of course the port currents i1 and i2.This circuit is what corresponds to the y parameter description of a two-port network. And to this, we add a source V_S, and its source resistance is R_S ,so source conductance G_S. And we have a load resistance R_L or a load conductance of G_L.

Now first of all, y_{21} is the forward parameter that is it takes V_1 and drives a current into port two. So y_{21} transfer signals in that direction, and y_{12} in the opposite direction, it takes V_2, and draws current into port one, so that is y_{12} that is the reverse parameter. We already said that we would like the reverse parameter to be zero in order to avoid instability, it turns out it is possible with some combinations of source and load, impendence's and the correct value of feedback parameter, there could be instability, but if you have this reverse to be zero then there is no such possibility that we saw from the expression. So, we want y_{12} equal to zero, for unconditional stability, we have not regressively define the stability here, and we would not do it. But essentially from our expression we do not want the gain going to infinity, which means instability or output without an input.

So, once y_{12} is zero, we can simply remove this control source. So all we are left with is a voltage divider on this side and effectively a current divider on this side. Remember, the two-port, it response to this V_1, and here we see that V_1 is V_S divided by this resistive divider. Now, what does it mean to have y_{11} equal to zero, it means the input is open circuited and this means no voltage division, that is if this resistance is infinite y_{11} by the way is conductance, so if it is zero, this resistance is infinite so all of this V_S appears across port one. Unless the common sense thing to do anyway, because if you have a resistive divider, you will get something less than this source voltage, now you want to get all of the source voltage here. And similarly y_{21} this control source produces some current depending on the value of V_1.

Now that current a part of it goes into y_{22}, and a part of it goes into R_L, so there is current division. So to avoid this current division, to make all of these go into the load, which is what you want right, because you are not interested in what goes into this. You want to maximize the current that goes into this consequently the power that is delivered to R_L. So you want all of these current go into that one, so this should also be an open circuit that is y_{22} must be zero; y_{22} is zero, so again have an open circuit looking into port two, so which means there is no current division. When there is no current division, this is between y_{22} and R_L. So that is all that is there to it, that is what these constraints mean, you want all of the source voltage to appear across the port one, and you want all of the current from the control source y_{21} V_1 to go into the load, so that is the very a simple intuitive explanation of this constraints. And finally we wanted y_{21} to be as large as possible and that's obvious that is in fact the gain that is how much the two-port responds to the voltage on port one. If you go on increasing y_{21}, more and more current will be pumped into R_L and you will maximize the power gain. We wrote the expression for the gain and found the constraints and the constraints are not some mysterious stuff, so there is a very obvious explanation for it and this is it.