Basic Electrical Circuits
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Lecture - 85

Now, we looked at y parameters, where the voltages are taken as independent variables and current as dependent variables and z parameters, where the currents for independent variables and the voltages where the result of those currents. And there is no need to take voltages on both sides to be independent variables or currents on both sides, we can make some much.

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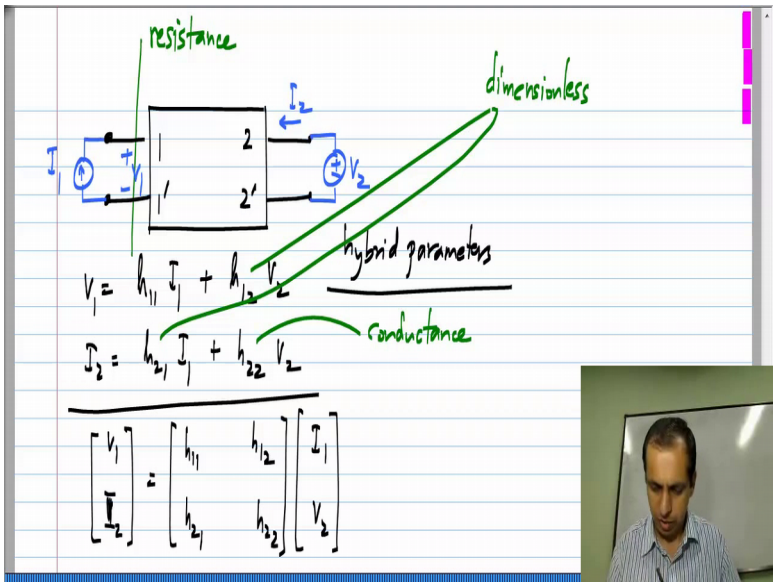

Now, let us say we have a two port and we think of applying a current to port 1 and a voltage to port 2. Now, the voltage here V 1 and the current over there I 2 will also be linear combinations of independent sources that are applied. And in this particular case, when we take I 1 that is current on port 1 and the voltage on port 2, the set of parameters we get are called h parameters. So, we have V 1 to be h 1 1 I 1 plus h 1 2 V 2 and we have I 2 to be h 2 1 I 1 plus h 2 2 V 2.

In other words, this vector V 1 I 2 equals h 1 1, h 1 2, h 2 1, h 2 2 times the vector I 1 V 2. Now, this is denoted by the letter h to denote that they are hybrid. So, these are known as hybrid parameters and they are hybrid parameters, because this voltage equals h 1 1 times a current. So, h 1 1 has dimensions of resistance, this voltage equals h 1 2 times V

2, so h 1 2 is dimensionless. So, this has dimensions of resistance that is dimensionless this is; obviously, for dimensional consistency.

Similarly, in the second expression I 2 equals h 2 1 times I 1, so this has to be dimensionless h 2 1. So, this is also dimensionless and finally, this is a current equaling something times a voltage, so h 2 2 has dimensions of conductance. So, the four parameters do not have the same dimensions, so they are called hybrid parameters. Now, evaluation of this is exactly in the same as earlier, you set one of the independent variables to 0 and evaluate them. As before you can take four different sets of the independent variables and evaluate everything, but the most convenient thing is to set one of them to be 0.

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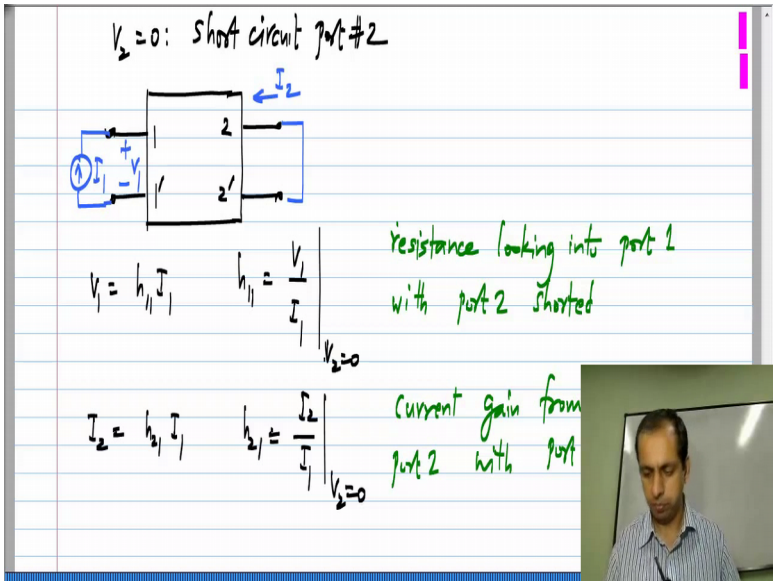

So, in the first case we set V 2 to 0; which means, your short circuit port number 2 and you apply I 1 to this side and you measure V 1 and I 2. So, what do we get with V 2 set to 0? We have V 1 to be h 1 1 I 1, in other words h 1 1 is simply V 1 by I 1 or the resistance looking into port 1 with port 2 short circuited. And similarly, we have from the second equation I 2 is h 2 1 times I 1 or h 2 1 is simply I 2 by I 1, that is the current gain from port 1 to port 2 with port 2 short circuited.

So, this is resistance looking into port 1 with port 2 short circuited and h 2 1 is the current gain from port 1 to port 2 with port 2 shorted. The general principle is always the

same, you set one of the independent variables to 0 and applies stimulate on the other side and evaluate two of the parameters.

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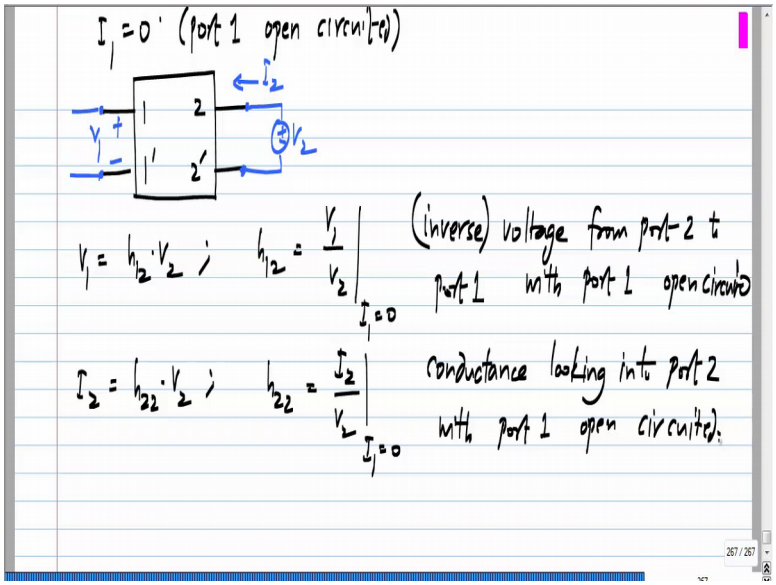

Similarly, we set I 1 to 0; which means, we are open circuiting port 1. If I set I 1 to 0, it means that port 1 is open circuited and then, you apply V 2 and you measure both I 2 and V 1. So, V 1 would be just h 1 2 times V 2, because I 1 is 0 and from this we get h 1 2 to be V 1 by V 2 with port 1 open circuited and this is nothing but, this is called the inverse voltage gain, that is the voltage gain from port 2 to port 1 with port 1 open circuited and we get I 2 to be h 2 2 times V 2, in other words h 2 2 is I 2 by V 2 with I 1 set to 0 or port 1 open circuited and I 2 is nothing but, conductance looking into port 2 with port 1 with open circuited, so these are the hybrid parameters.

Now, it turns out that this hybrid parameters for useful for describing a particular type of transistor, like I said you could use any parameter set for any element. Sometimes, some of them will have infinite values and not useful and even when all of them do exist, some or more convenient than others. Now, previously there was a particular type of transistor known as the bipolar junction transistor to describe the small signal model of the bipolar junction transistor, this h parameter was widely used, but actually the current style is to use y parameters, the admittance parameters for both the bipolar transistor and the MOS transistor. So, you will see those things when you take a course on active circuits that is, amplifiers using bipolar transistors and MOS transistors.