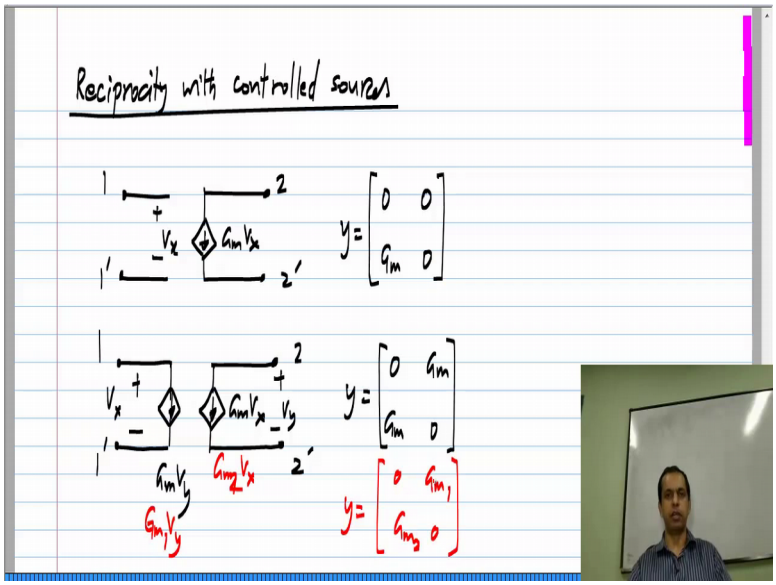
Basic Electrical Circuits
Dr Nagendra Krishnapura
Department of Electrical Engineering
Indian Institute of Technology Madras

Lecture - 98
Reciprocity in Circuits Containing Controlled Sources

(Refer Slide Time: 00:08)



In this lesson, we will look at the issue of the reciprocity, when we have control sources in the circuit. Now we have proven reciprocity for resistive networks, what this means is that if you have a purely resistive network, it is definitely reciprocal. So, you take any two ports in a resistive network, between those two ports, there will be reciprocity. And we have define reciprocity and you can define it in terms of this two port parameters z 1 2 will be z 2 1, y 1 2 will be y 2 1, h 1 2 will be minus h 2 1, or g 1 2 will be minus g 2 1. Now if you have control sources, it is not that there will be necessarily non reciprocal.

So, now first let me take a very simple example. Let say I take only a voltage controlled current source, this is V x and this is G m V x. If I define this to be my two port; I know that first of all the correct parameters set for describing this is the y parameter set, and the y parameters are these; clearly, it is non reciprocal. So, a control source by itself is non reciprocal, but what I want to point out is, it is possible to realize reciprocal network using control sources. So, while purely resistive networks and necessarily reciprocal; it is not that when you have control sources it will be non reciprocal, we have to evaluate the two port parameters to find out. This particular to port this is non reciprocal, but let us

say we takes something else, for instance, we connect two controlled sources together and let us say this is V x and this is G m V x; and if this is V y that will be G m V y. Now we can evaluate the y parameters of these two ports and I am not going to do that, but you can do that very easily. So, y would be 0 G m G m and zero.

So, clearly y 1 2 equals y 2 1; and this is a reciprocal network that consist of control sources; and you can also have resistors and on. So, you can always arrange a circuit with control sources to be reciprocal. The most trivial cases when every resistor in your resistive network is implemented using control sources; even if you do not do that even if you do not use control sources to realize equivalent resistors, you can make them reciprocal. And this particular case, let say instead of G m V y, we had G m 1 V y, and here I had G m 2 V x, so then the y parameters set would be 0; G m 1 G m 2 and 0 and in that case, we do not have reciprocity. So, if that two control sources have equal coefficients this particular network is a reciprocal; otherwise it is not. So, you cannot make a general statement in case of circuits having control sources.