Basic Electrical Circuits
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Lecture – 104

Let me now take an example.

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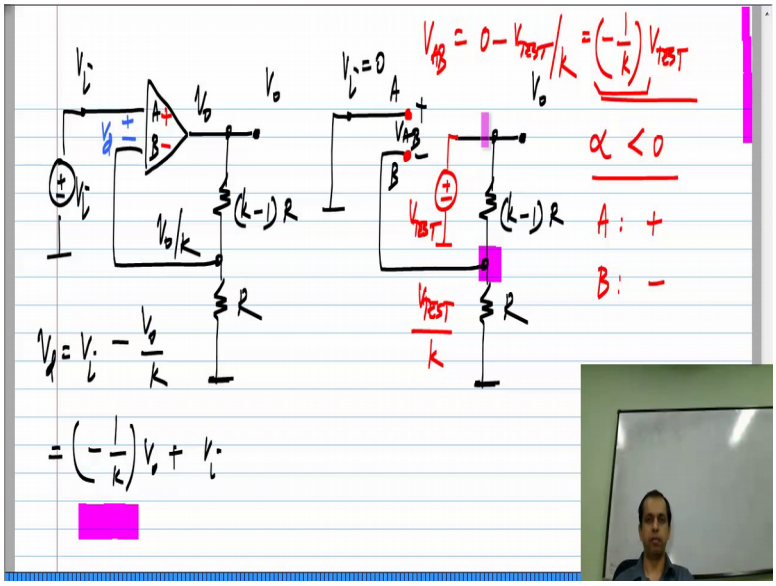

Let us pretend that we were given this circuit without the signs assigned to the op amp. This is a circuit we already know we have derived it, I already told you which were the signs must be for the op amp to be negative feedback, but we will now verify whether that is really the case. So, we will not assuming anything about the signs, I will label them A and B I need to find out whether A should be the positive terminal of the op amp or the negative terminal of the op amp.

So, what is the first step? First step is I remove the op amp and wherever the output of the op amp was, I stimulate that I derive it with V test. By the way this is A and this is B, I also set the independent inputs to the circuit to 0, in this case I shown it as V i, this really means that a voltage source V i is connected that way and I said that to 0. So, if I set V i to 0, I just short circuit this to ground and then, I find the difference V A B, now this is an extremely trivial circuit.

So, if I have V test driving this point, at this point I will have a fraction of V test, which is V test divided by K. This V A B is the difference between the voltages at node A and B

and V A, the voltage at node A is 0, the voltage at node B is V test by K. So, V A B is 0 minus V test by K, which is minus 1 by K times V test. So, clearly the proportionality constant alpha here is less than 0 and by what I described to you earlier, this means that terminal A has to the positive terminal and terminal B has to be the negative terminal of the op amp.

In other words, I would assign the signs like that and earlier I use those signs, we know they are correct, but this is how you know they are correct by doing this analysis. Because, as you can see, this V A B the input to the op amp is minus 1 by K times V test, in other words this is V d according to the assumed signs and if I evaluated V d in terms of V naught, which is the output voltage of the op amp and V i what will I get, this voltage is V naught by K and this voltage is V i. So, V d is V i minus V naught by K or basically minus 1 by K times V naught plus V i.

Now, part of the V i that comes to V d is not relevant for analyzing whether the op amp is in negative feedback. This part is, we can see that the difference input of the op amp receives a negative multiple of it is own output. So, this means that the op amp is in negative feedback. So, this shows that our algorithm works properly. Now, in general it is easier to remove the op amp, apply the source and analyze the rest of the circuit, in this case the rest of the circuit was trivial, but in some cases it can be quite complicated.

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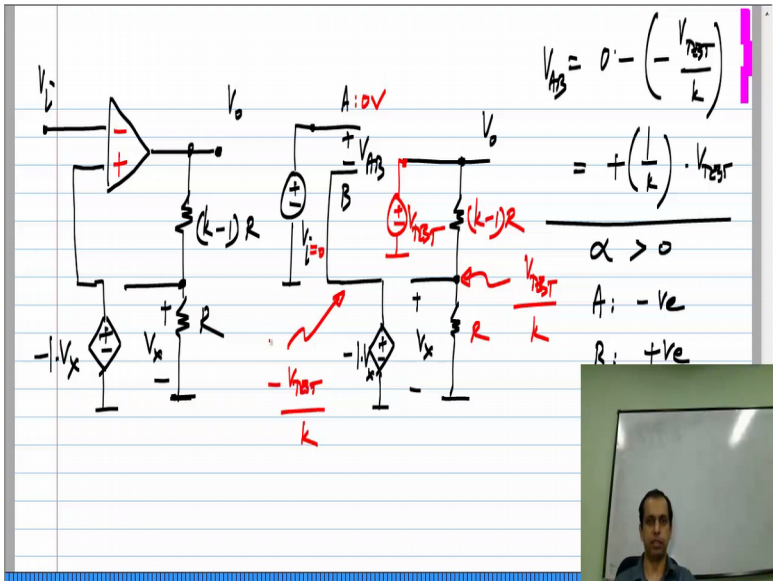

There is one other thing I want to point out, sometimes it is said that, hey look the output is here and the feedback is taken to the terminal B, we want negative feedback. So,

terminal B must be negative, because something is return in to terminal B, if B is negative there is negative feedback. But, such a reasoning is seriously flop, I will shown you one example soon, now one of the things is that there may be circuits in which both of the inputs of the op amp or in some manner connected to the output.

So, in this case terminal A is not connected to the output of the op amp, but all only terminal B is through this network, but there could be circuits where both of them are connected. This is what I showed by, both terminals of the op amp could be receiving feedback from the output of the op amp. So, in that case you certainly cannot use this logic and even when only one of the terminal is receiving it, you cannot say that whichever terminal the wire is coming back to is the negative terminal. A very, very trivial example of that I am going to show now.

So, let me modify the circuits slightly and let me insert a voltage control voltage source of gain minus 1 and feedback. I will call this V x and this is minus 1 times V x, this is my circuit and I apply my input voltage V i over here and I take the output there. Now, let us analyze the circuit for obtaining the right signs for the op amp, so that it is in negative feedback. So, as usual these are A and B and this is V A B and the first step is to apply V test over here and also set V i to 0.

So, the voltage at node A is 0 volts, the voltage at node B let see what it is, if I apply V test here we have a resistive divider and the same resistors as before K minus 1 R and R. So, at this point we get V test divided by K. Now, I have this control source with the gain of minus 1, so; that means, that at this point I have remember this V x is V test by K, so at this point I have minus V test divided by K.

So, the voltage V A B is nothing but, 0 which is the voltage at node A minus no voltage at node B which is negative of V test by K. So, this is plus 1 by K times V test, so it is the same magnitude of the voltage as before, but the sign is reversed. Now, according to the algorithm I described clearly, this alpha is greater than 0 and you have to assign A to the negative terminal and B to the positive terminal.

So, if I have a controlled source with a gain of minus 1 in feedback, where this is V x then you certainly cannot argue that, hey look the feedback is coming to this terminal of the op amp it is negative. In fact, B must be positive, the correct signs for this circuit are minus and plus. So, do not use that vague reasoning, that whichever terminal the wire is returning to is the negative terminal, it could be either positive or negative for the op amp

to be in negative feedback.

So, the method is very easy, you can analyze it systematically as I described earlier and I also showed it with an example. So, for any circuit for which you want to determine the signs of the op amp, please use this method.