Electrical Measurement And Electronic Instruments
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Lecture - 56
Difference amplifier - II

Welcome. So, in this video we are going to give some shortcuts, not very scientific not, very rigorous; but useful for exam purpose, ok.

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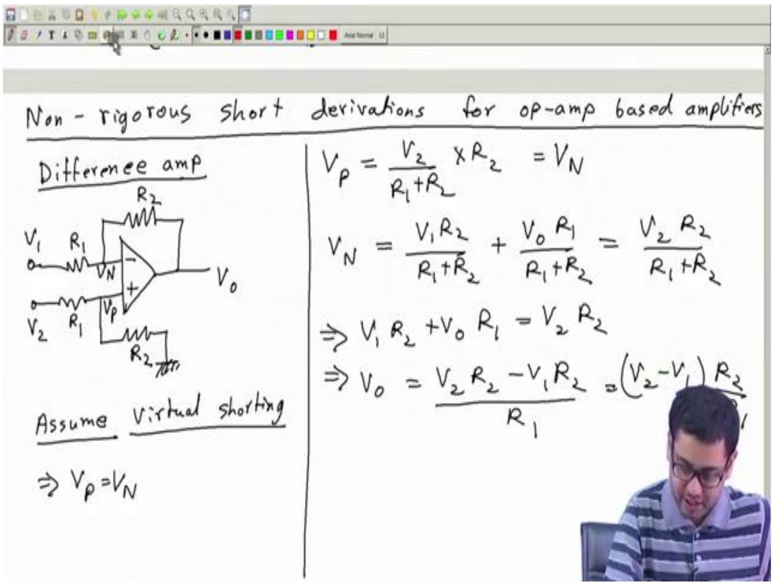

So, let me write, Non-rigorous shortcuts or short derivations for op-amp based amplifiers for; that means, the three amplifiers we have studied so far, inverting, non-inverting, and difference, ok. So, this shortcut is based on the assumption that virtual sorting is true, is happening; the two input terminals are virtually sorted it is based on that assumption ok. So, let us start with the Difference Amplifier.

Let me draw it very quickly. So, draw the op-amp put minus and plus signs then connect the negative to the output in o positive to the ground p g these are the two inputs. So, these are the two inputs and they are at potential V 1 and V 2, this is the output V o; and ideal difference amplifier should have these two resistances same of same value and these two resistances of same value, this is an ideal difference amplifier. Right now, I do not bother whether this is connected in a with a common ground configuration or the differential mode, differential input mode; I am not also drawing the power supply and detail ground connection etcetera. Those are required for real life when you work in lab of course; but this is a shortcut ok, this is an non-rigorous shortcut. So, this point is at an absolute input V 1 V 2, this is V o.

And we assume that these two points are at the same potential V N = V P. Assume virtual sorting; that means, V P = V N, with this assumption we can find the expression of output very quickly. How? Let us see, ok. So, is this is V 2, then this point using potential divider rule I can write directly,

$$Vp = \frac{V2}{R1+R2} \text{ x } R2 = VN$$

Now, V N is how much V N is nothing, but once again a kind of potential divider rule or Millman's theorem if you know; or you can find the current and then multiplied the current with resistance to get this top and then you what you will find is this ok; applying circuit theory in this part, in this part you can find this, that this is nothing but

$$VN = \frac{V1\ R2}{R1+R2} + \frac{V0\ R1}{R1+R2} = \frac{V2}{R1+R2} \text{ x } R2$$

$$V0 = \frac{V2\ R2 - V1\ R2}{R1}$$

So, one key important thing is that you. So, this virtual sorting is I told you it is not true always, it depends on the circuit; it is not a property of the op-amp. So, for example, if you by chance make this plus minus inputs wrong, if you swap them that will not work. So, for example, copy paste ok.

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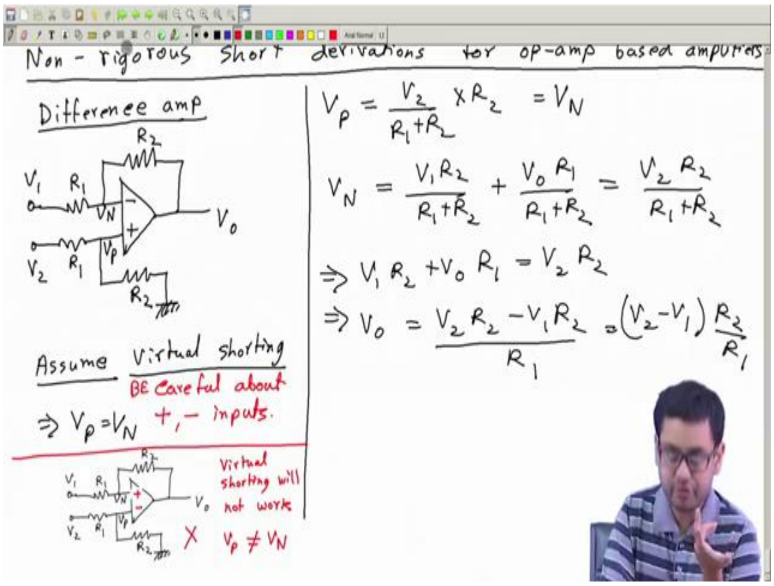

So, for example, here if you swap this plus minus signs like this, you take you make this plus this minus then this is wrong; wrong in what sense, wrong in the sense that virtual sorting is not going to work ok. Virtual sorting will not work; what I mean is that, V P is not going to be equal to with V N.

So, only if you remember this circuit correctly with all plus minus signs proper, then you can then we have previously proved shown with rigorous detailed analysis that virtual sorting is going to work. So, you may just remember that defect ok, virtual sorting is going to work V P is going to V N, then you can do the derivation very quickly ok. So, this is a shortcut. Now let us talk about, so let me also write a comment, be careful about plus minus inputs; if you do it wrong circuit will not work, in exam your answer will be wrong.

Now, let us go to say, inverting and non-inverting amplifiers, quickly.

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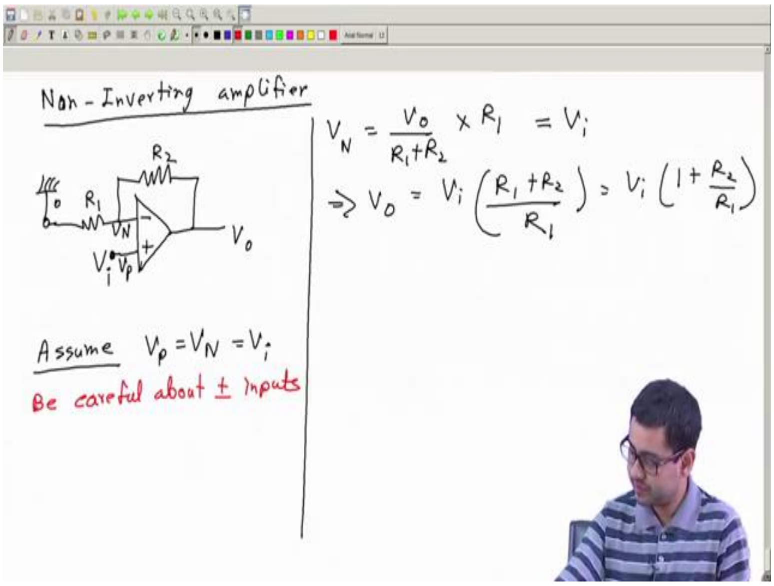

So, first non-inverting or ok, first may be first non-inverting. So, I also have told you how to remember the circuit, you just have to remember this one and then for non-inverting amplifier; that means, this input this will be, this will go to 0. So, you can connect this point to ground and you can give the input here and then we have shown ok, giving the input is same as giving the input directly here because this is only a potential divider. So, therefore, we just erase it and give the input directly, call it V i for input and this terminal is going to be grounded 0.

So, this is the circuit. Now again assume virtual sorting V P = V N; if that is the case, then V P = V i ok. Then what can you say about V N, V N the supply potential divider will here. So, this will be equal to

$$VN = \frac{V0}{R1+R2} \text{ x } R1$$

$$V0 = Vi\,\frac{R1+R2}{R1}$$

So, this is become very easy for exam, you can do it very quickly this derivation but be careful about this plus minus sign ok, be careful about plus minus inputs. If you swap them, if you make this minus and this plus that circuit you know, virtual for that circuit virtual sorting will not happen, that acts as a Schmitt trigger, we told you. So, then this analysis is not true ok. Now last thing, this inverting amplifier ok.

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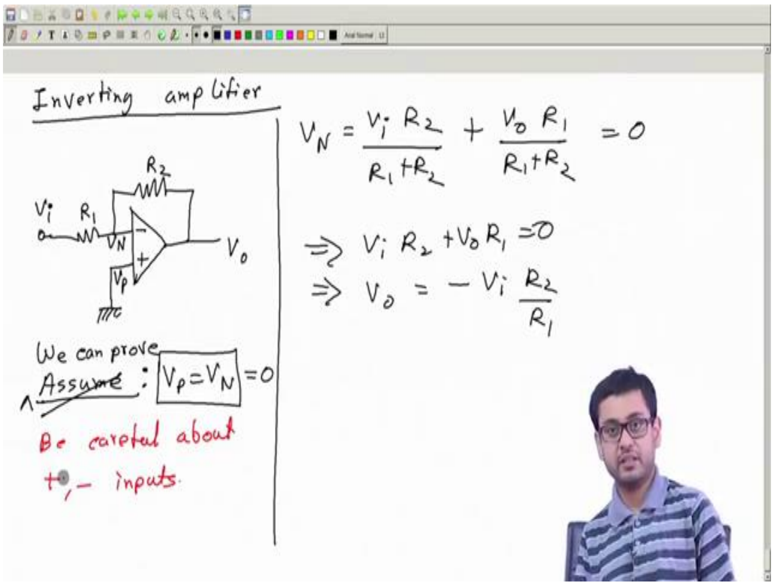

So, last thing is inverting amplifier, quickly I will always start from the circuit of difference amplifier, even if I remember it directly, copy paste; this is R 2.

Now this is inverting amplifier means what? The input will come here at the minus terminal. So, let me call this V i this is input, this is going to be grounded ok. Now if I ground this, it is this is also grounded, this is also grounded, so I can ground this terminal directly, ok. So, therefore, I erase these unnecessary things and connect this directly to the ground, this is inverting amplifier. Now you can make the assumption that, V P = V N this is actually not an assumption; I mean, we know that for this circuit this will be the case.

So, it is better that I write, that we know or we can prove or we have already proved actually ok; it is not an assumption, it is true for this circuit, unless you make this plus minus sign opposite then it will not be true. So, be careful about plus minus inputs, with this proper plus minus inputs this is true V P is equal to V N and then what can we say.

So, V P is 0 ok. V P is 0; so, V N is also 0 and if so, but we can also write V N is nothing but equal to some sort of average of V i and V o with an analysis from this part ok. So,

$$VN = \frac{Vi}{R1+R2} \text{ x } R2 + \frac{V0}{R1+R2} \text{ x } R1 = 0$$

$$Vi\ R2 + V0\ R1 = 0$$

$V0 = - Vi \frac{R2}{R1}$

Now, we know from here that this is equal to 0. So, this is equal to 0. So, from this we can write so; that means, this term is 0, now the denominator is common you can ignore I mean

Thank you.