Electronic Systems for Cancer Diagnosis
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Lecture - 30
Basic building blocks of Electronics System: Amplifiers (contd.)

Welcome to this module, and here today we will see what exactly as a differential amplifier. So, we have seen the op-amp as an inverting, we have seen op-amp as an non inverting and we have seen op-amp as a summing amplifier. Now let us see how the operation amplifier can be used as a Differential Amplifier alright.

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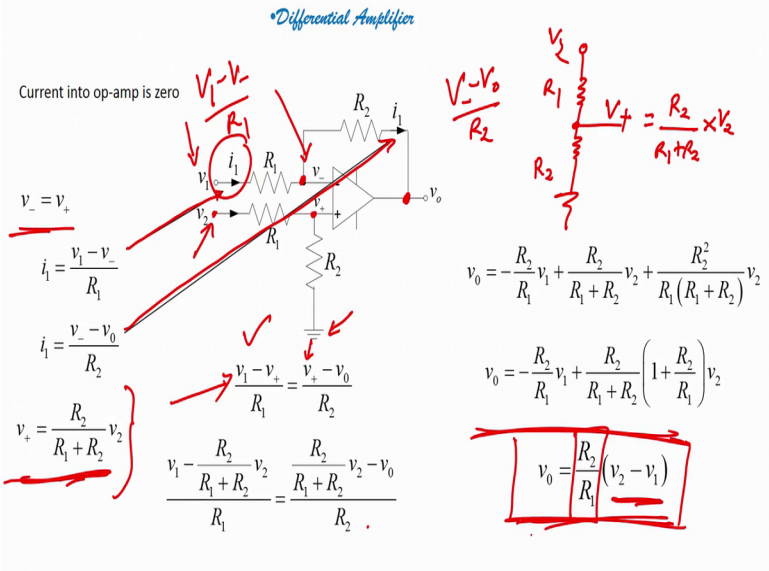

So, if you come back to the screen. So, if I have a op-amp in the following configuration in the following schematic or following circuits then what I see is, I am applying input to the inverting as well as non inverting amplifier, correct. Applying input to the inverting and well as non inverting terminal of the amplifier. Inverting is a non inverting terminal of the amplifier. I have values R 1, R 2right. In this particular configuration, how can I find my output voltage v o? First case is how first I had to find the output voltage v o; the relation between the R 2 R 1 v 1 v 2 with respect to v o ok.

So, you see this points, one is v minus another one is v plus. One is v minus another one is v plus. Now what can I see? v minus equals to v plus, how? Because current into the op-amp is zero or because of the virtual ground concept right v 1 equal to v 2 or v minus

equals to v minus v plus. So, I would be so, this one first we are considering this value which is i 1, then we will consider the value which is right over here i 1..

Now this value is nothing but, what will be v 1 minus v minus v 1 minus v minus divide by R 1 correct. And if I consider this value, then it will be nothing but v minus right because here you can see here then you have to see here. So, it will be v minus minus v o by R 2 minus v o by R 2. So, what is my v plus? My v plus here; now if I want to measure this value, v plus right what is v plus; v plus will be, so you see here v plus you have to consider this ground you have voltage here. So, this is like a potential divider.

So, v plus will be R 2 divided by R 1 plus R 2 into v 2 correct. Because you see here v 2 is v and here is a ground. So, it looks like we are measuring we have v 2 we have R 1 we have R 2 and we are measuring the v plus correct. So, v plus would be nothing, but R 2 by R 1 plus R 2; v plus would be nothing but R 2 divided by R 1 plus R 2 into v 2 into v 2. Right. Now I know that v plus right because v minus equals to v plus. So, I also put my value i 1 equals to this both values. So, v 1 minus v minus by R 1 equals to v plus minus v o by R 2 correct, this is the value.

Now if I substitute the value of v plus, if I substitute the value of v plus in this equation, in this equation right, what will I write? v v 1 minus this value divided by R 1 equals to R 2 divided by this whole value again we are substituting here, in this place right. So, if I solve further, what will I have? When I solve the complete equation, I will find that my v o equals to minus R 2 by R 1 v 1 plus R 2 by R 1 plus R 2 into 1 plus R 2 by R 1 into v 2. Or further I solve it, then my voltage output voltage will be nothing, but R 2 by R 1 into v 2 minus v 1 correct.

When you solve it further you will again nothing, but R 2 by R 1 into v 2 minus v 1. So, what is it doing? It is the Differential Amplifier. It is amplifying it is amplifying the difference of voltage at the output right. What is the amplification factor? Amplification is done by values of R 1 and R 2. Amplification is done by substituting the values of or selecting the values of R 1 and R 2. What are R 1 and R 2? R 1, R 2 are my feedback resistors R 1 and R 2 are nothing but my feedback resistors. You got it?

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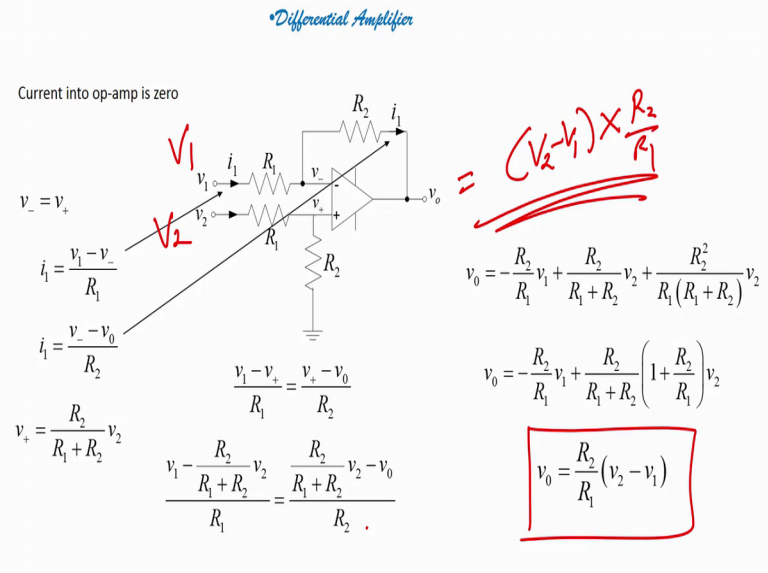

So, this is how my differential amplifier would work, that whenever I apply a voltage at both the terminals voltage v 1 and here v 2 it the another terminal my output voltage will be nothing but difference of the voltage right; difference of the voltage into R 2 by R 1. This is the formula that I have to remember. And this is will be this would be my differential amplifier this will be my differential amplifier ok.

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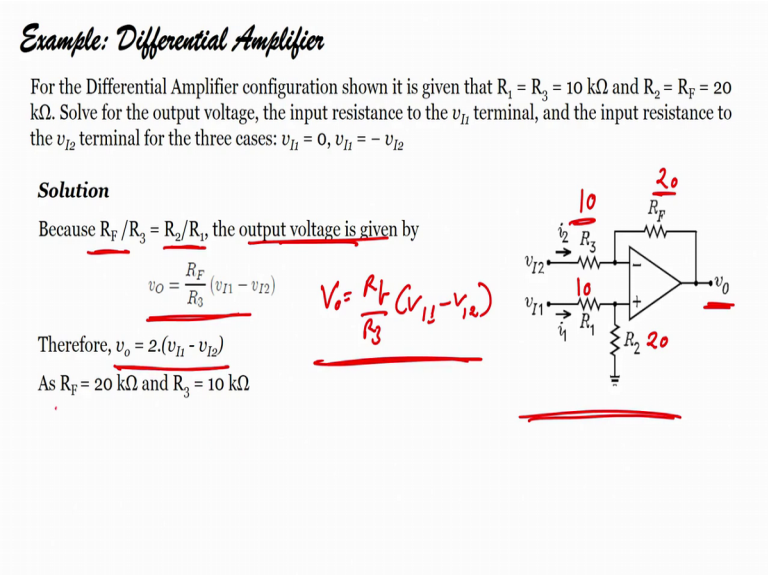

So, let us solve an example, let us solve an example. So, for the differential amplifier configuration shown here, it is given that R 1 equals to R 3 equals to 10 kilo ohm. So,

this is 10, this is 10. R 2 equals to R F equals to 20. This is 20, this is 20. So, all for the output voltage you have to find v o right the input voltage v 1 terminal and input resistance to v 1 terminal for three cases v 1 equals to 0 and v 1 equals to minus v I 2 right.

So, let us see, let us see one by one. Now because R f by R 3 equals to R 2 by R 1 the output voltage is given by, the output voltage is given by it is very easy right v o equals to R f by R 3 into this one v I 1 minus v I 2 right. If I substitute the value 20 divided by 10 equals to 2;so, 2 times v I 1 minus v I 2. So, as R f equals to 20 kilo ohm and R 3 equals to 10 kilo ohm.

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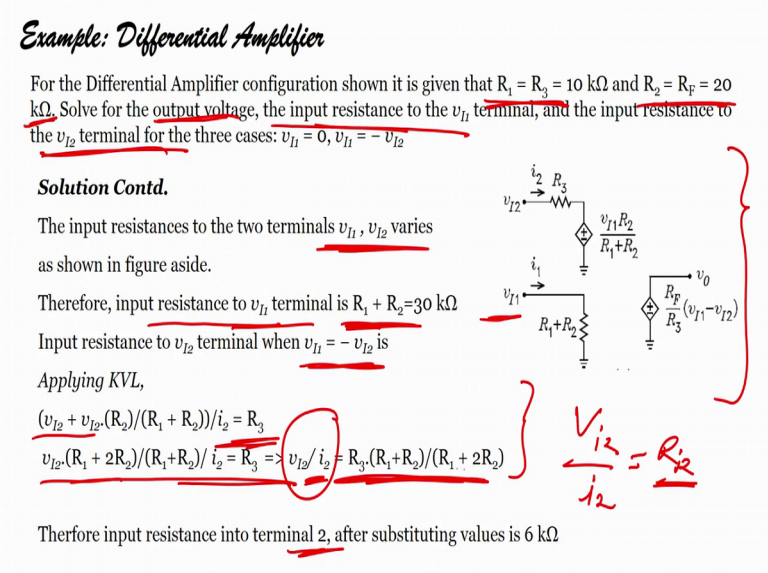

Input resistant two terminals v I 1 and v I 2 varies as shown here you can so, see here right. So, what will happen? Therefore, input resistance to v I terminal 1 is nothing, but R 1 plus R 2 right. If you see this circuit what we will find that the input resistance to terminal v I 1 will be nothing but R 1 plus R 2 right. What is R 1? R 1 is 10, R 2 is 20. So, it is 30 kilo ohm input resistance of v I 2, when v I 1 equals to minus v I 2 will be if we apply the Kirchoff's voltage law, then you will find that v I 1, v I 2 plus v I 2 into R 2 divide by R 1 plus R 2 divide by R 2 equals to R 3 right.

If you see this circuit, you have to see this circuit you will find this how we are solving. Also v I 2 so, when you further solve it what do you get v I 2 by i 2 equals to this particular value. So, therefore, the input resistance to terminal 2 after substituting the

value, say if I this is nothing, but my input resistance of the terminal 2 right v i 2 by i 2 is nothing but input resistance to the terminal 2 right whatever the input resistance is.

So, substitute if we substitute the values what will I have 6 kilo ohm. I have value of 6 kilo ohm right. This is how we can solve the this is how we can solve the problem for the Differential Amplifier. And solve few more examples by yourself all right. Till then you take care, I will see in the next module bye.