Electrical Measurement And Electronic Instruments
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Lecture - 54
Non- inverting amplifier versus Schmitt Trigger

Welcome again. In the last class we have seen what happens, if we swap the plus minus inputs in an inverting amplifier. We can ask also the same question, what happens if we swap the plus minus inputs in an non-inverting amplifier ok. So, this is the correct non-inverting amplifier.

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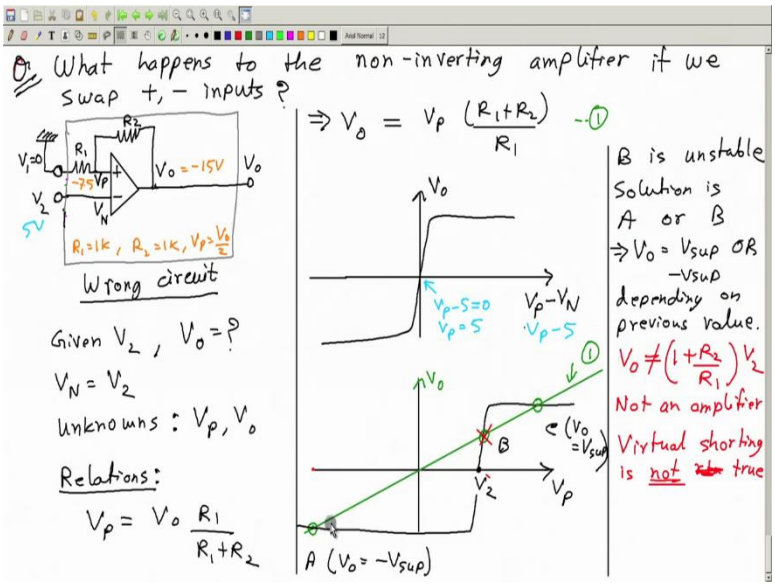

Now, let me draw the wrong circuit; so, where I will make this minus and this plus ok. So, therefore, I should also call this V N and this V P. So, if I connect the op-amp in this way wrongly this is wrong circuit of course, what happens then? Now, the analysis will be very much same and similar to the analysis that we did for the previous case inverting amplifier, I request you do not watch this video; please do not watch this video, but do the problem on your own ok. Although, I will do it again in this video, I request you not to watch this video ok.

So, once again let us first, so, ask the question. So, the question is given V 2 what will be how much will be V o? So, that is the question and now what can we say about V P and V N; V N is of course, equal to V 2 known, but V P is unknown. So, unknowns are V P this

one and V o this 1 output of course, this is what you want to find out. So, there are 2 unknowns so, we need of course, also the two relations, 2 equations. Now, first equation that will come from this part of the circuit ok, which is the series combination of R 2 and R 1 this potential, is 0. So, we can immediately write V P,

$$Vp = Vo \frac{R1}{R1+R2}$$

$$Vo = Vp \frac{R1+R2}{R1}$$

This is true, if I mean this is this relationship is same no matter whether we have this plus minus symbols correct or wrong, this is because this is from the external circuit. And, the other relation which comes from the op-amp that is the static characteristic let us draw that. So, we have V o, this is V P minus V N and the characteristic as always is like this. Now, the unknowns are V P V because V N is known. So, V N is known so, now, V N is equals so, this equal to V 2 some value ok.

Now, if I want to draw this only in terms of V P instead of without have the V N ok, then this curve will shift the origin ok, which way will it shift towards the left or towards the right take an example. So, let us take an example that V 2 or V N is equal to say 5 volt; that means; now this is equal to V P - 5 ok. So, at this point V P, so, at this point therefore, we have V P- 5 is equal to 0 which means V P is equal to 5. So, on in the other curve therefore, when V P is equal to 5 this crossover will take place. So, at the point where V P is 5 see if this is 5 volt ok, if this is 5 volt or then this is where the crossover will take place.

So, in general in case of 5 volt let me put the value V 2 or V N ok, what whichever you like ok that is it so, this is one relationship. Now, let me draw the other relationship, this is y equal to x times constant positive constant. So, it will be a straight line passing through the origin with positive slope. So, that will be a straight line passing through the origin like this ok. So, this is a relation call it one. So, this from relationship one ok so, far so, good this is V o this is V P. Now, what will be the solution the solution will be either this or this or here, let me extend ok? So, I have three possible solutions and once again let me just call them A, B and C, I can justify that B is unstable ok, you do the analysis on your own I request you.

So, like this so, if you start from this point move a bit then you see at this point the op-amp would like to have more output. So, it will go further towards the right, it will try to increase the output and will land here. Similarly, if you go a bit towards the left with a decrease of V o, then at this point op-amp will try to reduce it is output further. So, we will move further down or towards the left and come here ok. So, B point be is unstable. So, we will have the solution A or C; if we are at point A, then the output will be minus V supply. So, at this point we have V o equal to minus V supply here we will have V o equal to plus V supply.

So, it will the output will saturate it will be either negative or positive saturation and it will depend on whether what was the previous value of output. If, I start from the assumption that you can take the same example like we did before ok. So, let us take once again as an example let us take here R 1 = 1 kilo ohm, R 2 = 1 kilo ohm. So, this will imply V P =V o/ 2 1 1 1. So, this is V o/ 2. So, then V P =V o /2 take this example. So, then start with the assumption this is plus 15 volt then this will be 7 and half volt which is greater than V N. So, you will stay at the positive output.

If, you start with V o equal to say minus minus 15 volt then also this will be minus 7.5. So, V P is less than V N output will remain at the negative value no problem ok. So, that is it. So, once again let me write few more points. So, solution is A or B, which means V o is equal to V supply or minus V supply depending on previous value and what else can we say. This will not work definitely as an amplifier ok. So, the relationship for an in this is non-invert originally it was non inverting amplifier. So, the relationship

$$Vo \neq (1+\frac{R2}{R1})\ V2$$

Because, output is going to be constant at the saturation levels is not going to change linearly or proportionally with the input.

So, this is not an amplifier not an amplifier; amplifier is supposed to give output proportional to the input. So, this is not an amplifier, what else can we say can we say something about the virtual sorting. Virtual sorting is not going to work ok. Virtual sorting is not true, why this is not true, why say so, the solution will not be this this is unstable. So, this considered only C or A, if we are at C, then V P will be this much positive ok. V P will be this and what is V N? V N is equal to V 2 is this V N = V 2. So, V N is here, but

V P is here they are not equal. Similarly, if I am here once again V P will be at this point it and it will not be same as V 2 or V N. So, virtual sorting is not going to work.

Now, maybe I will show you one smaller thing interesting thing which is this ok. Suppose, so, the question is what happens say, if I change the input V 2 say if I change it from 5 volt to 1 volt 10 volt whatever what will happen ok. So, will this green line change no, because this green line obeys this equation and it does not depend on V 2? So, what will change, this black line will change. Why? Because, this black line depends on V 2, because this black line is supposed to cross the x axis, at the point of V 2; so, if I change V 2 this black line will move towards the left or right I will show you like this ok.

So, let me copy this black line ok. So, now, if I increase V 2 I am increasing V 2. So, you can also see how the solution will change? Ok. So, if I increase V 2 point C is not changing, neither is point A ok. If, I decrease V 2 the input point C and point A, they are not changing the solution will remain same. But, now if I increase it a lot if I bring it like this here, if I bring it here then you see that now this green line and the black line will intersects only at 1 point. It will only intersect at this point, if I extend this black line here, then this will intersect here. So, then only point A is the only one solution point C does not exist anymore because in this direction they will not intersect.

Similarly, if I bring it down, down, down, a lot, a lot and a lot like this here. Then, also can you see this green line, if I extend it will not intersect with this black line. In this direction it will intersect only in on the right side, if I extend it on the right side, it will intersect here at the point C. So, once again there will be only one solution ok. So, let me bring it back; that means, we can have either 1 or 3 possible solutions ok. Similarly, actually let me just go up bit back to the previous class.

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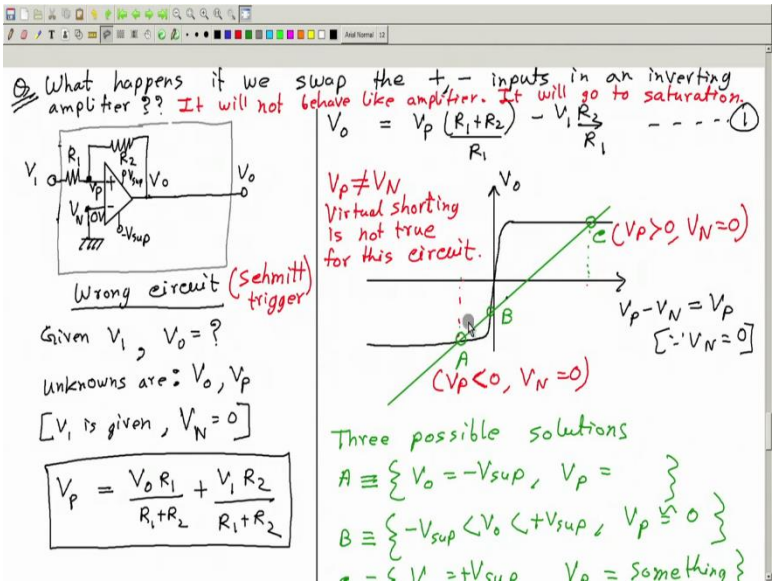

Where we were talking about what happens, if we change plus minus sign for this was what inverting amplifier ok. So now, you can ask once again in this diagram. What will be the solution or how will the solution change, if I change the input V 1. So, what will change here let us see, if I change V 1 then this green curve which is given by this equation is going to change, because it depends on V 1, but this black curve is not going to change ok.

So, if I say increase V 1 what will happen this green curve, this will come down because the y intersect will become further negative. So, it will come down, down and down like this ok, point B, which is the unstable solution is changing, but do not bother about that that is unstable point C is here still at the saturation level.

And, now if I bring it down a lot like this; that means, if I increase V 1 a lot ok, V 1 is really a lot ok, then there will be only one intersection ok. And, similarly if I increase it up once again you will see there is only one possible solution think it yourself it is nice it is a fun.

Thank you.