ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Amplificateur opérationnel

3.2 Montage non-inverseur indépendant de la fréquence

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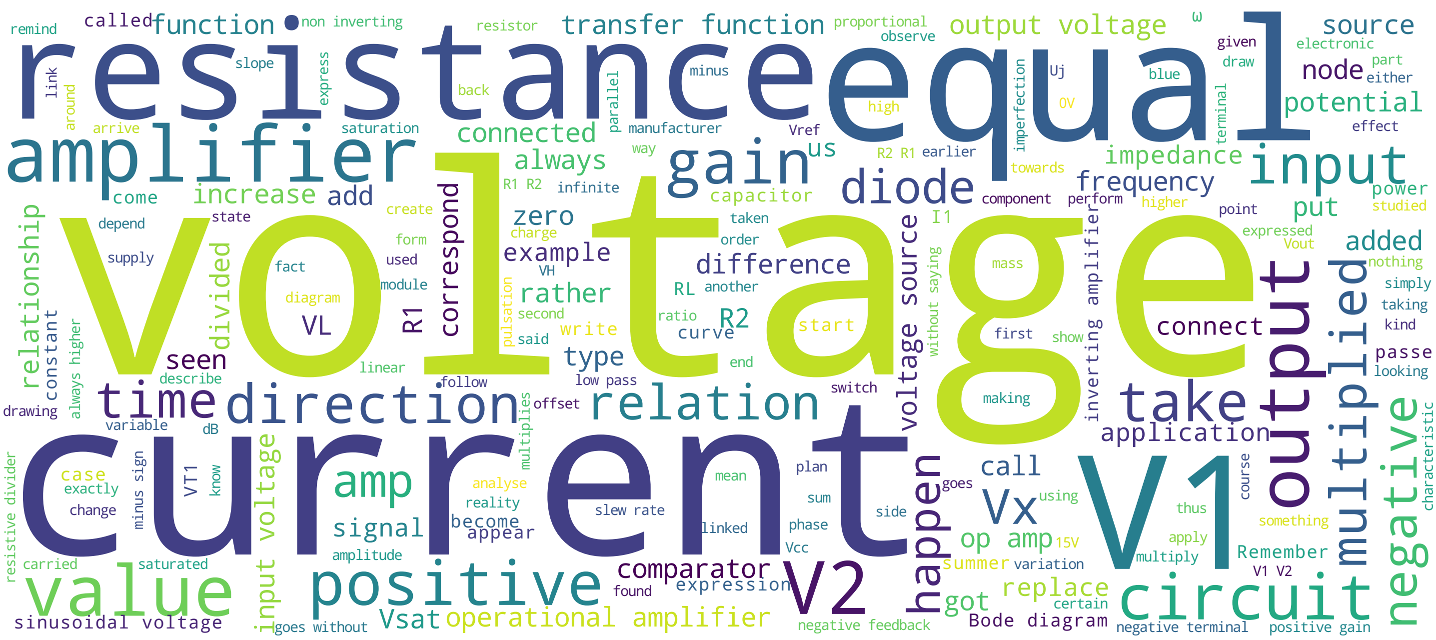
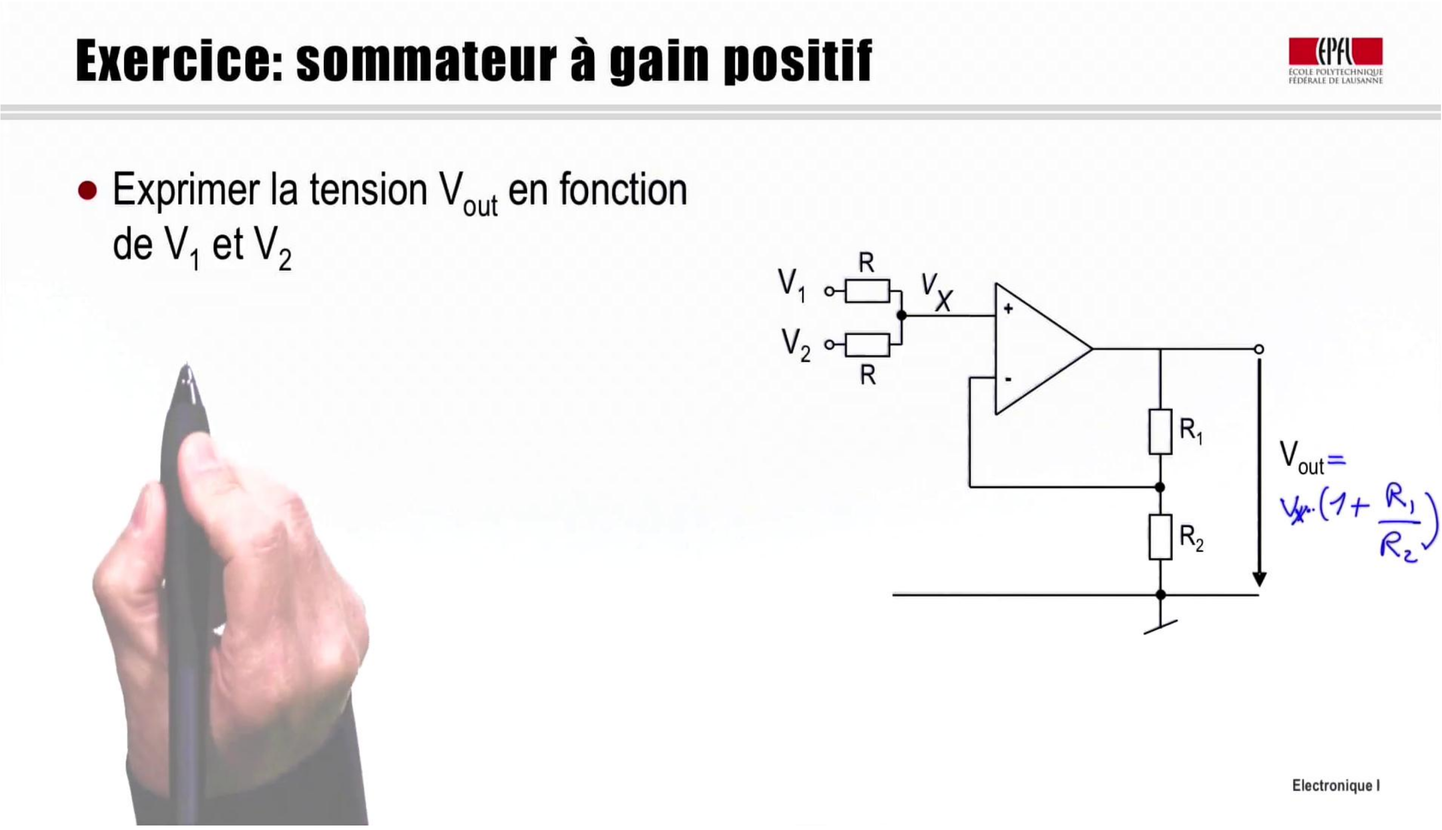


EPFL



You've learnt that with circuits based on the operational amplifier, we can make linear circuits which will link the input and output by functions. We succeeded in making a summer with the inverting amplifier. Now, we will learn how to make a summer with a non-inverting amplifier. We will add up two voltages, *V1* and *V2* and we will see that we can just add two resistances on the positive terminal and that we will find a relation where the summing function, contrary to the inverting amplifier, will not dephase the voltage between the two input voltages and the output voltage. Here is the drawing of a summer with a positive gain. So we can see what is happening here. There, you have your amplifier as we studied it. So you have a *V(out)* voltage which will be equal to the *Vx* voltage multiplied by *(1 + R1/R2)*. So it's a positive gain superior to *R1* on *R2* because there is a 1, and which multiplies the *Vx* voltage. In this case, *Vx* ends up with this circuit that we added. So we have taken two voltage sources. A *V1* voltage source, a *V2* voltage source. And we added a resistive divider, or rather two resistances connected like that.

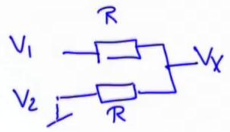
Notes

Summary

0m 04s

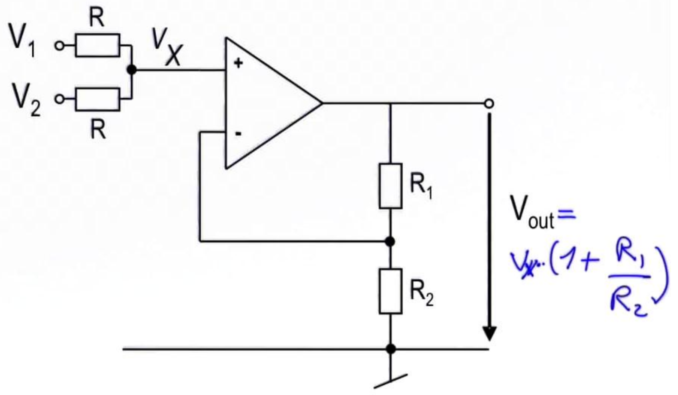
Exercice: sommateur à gain positif

- Exprimer la tension V_{out} en fonction de V_1 et V_2



$$\begin{cases} V'_X\big|_{V_2=0} = V_1 \cdot \frac{1}{2} \\ V''_X\big|_{V_1=0} = V_2 \cdot \frac{1}{2} \end{cases}$$

$$V_X = (V_1 + V_2) \cdot \frac{1}{2}.$$



Electronique I

And we connected a *V1* voltage source here, a *V2* voltage source here, and we are interested in the *Vx* voltage that appears there. And the *Vx* voltage, we learnt that the superposition principle allows us to express *Vx* when the *V2 voltage = 0*. So we cancel one of these two sources. So I put that to the mass and that will give me a resistive divider which performs with two similar resistances, *R* and *R*. So this will give me a *Vx* voltage when *V2 = 0*, which is nothing more than the *V1* voltage multiplied by *R* divided by *R + R*, so it's 1/2. Similarly, the *V'x* and *V''x* voltage when *V1 = 0*, it will give me a voltage equal to *V2* multiplied by 1/2. So the *Vx* voltage, is proportional to *V1 + V2* multiplied by 1/2. I only have to use this and replace *Vx* by its value compared with *V(out)* and observe what we will get.

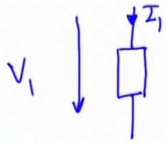
Notes

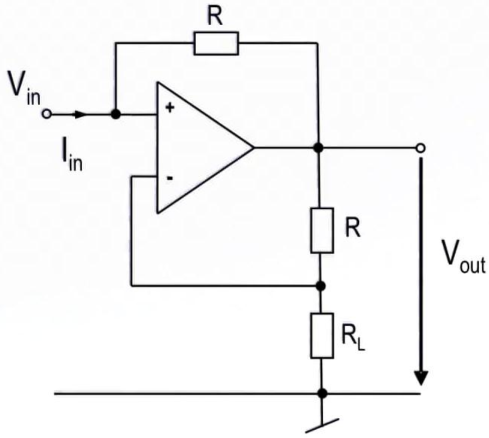
Summary

1m 41s

Exercice: résistance négative

- Donner l'expression de la résistance d'entrée $R_{in}=V_{in}/I_{in}$





Electronique I

So I'll take the same relations. That it's the amplifier compared with *Vx*. That it's the *Vx* voltage expressed in relation to *V1* and *V2*. And when I replace *Vx* by its value here, we get that, which is an expression of a summer. The two voltages are added at the output, it is *V1* + *V2* multiplied by the gain of the amplifier and multiplied by a factor of 1/2. So again it's a gain with the sum of two voltages which enables us to mix or add the two voltages carried out by two independent sources. I am going to look at another application of amplifiers. It's quite funny to see that a resistance can, when it becomes active, so carried out with an active circuit with an OP amplifier, can be carried out in the form of a negative resistance. I will just remind you what a resistance means. I think that everyone knows it very well. That is a resistance. When you take a voltage, and you connect a *V1* voltage to the terminals of a resistance, you will have a current. It goes without saying that this current, is a *I1* current. And this current is positive in this direction.

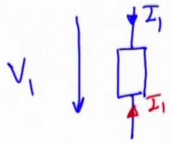
Notes

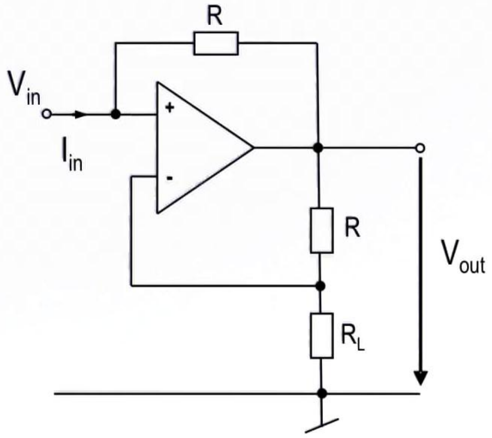
Summary

3m 10s

Exercice: résistance négative

- Donner l'expression de la résistance d'entrée $R_{in}=V_{in}/I_{in}$





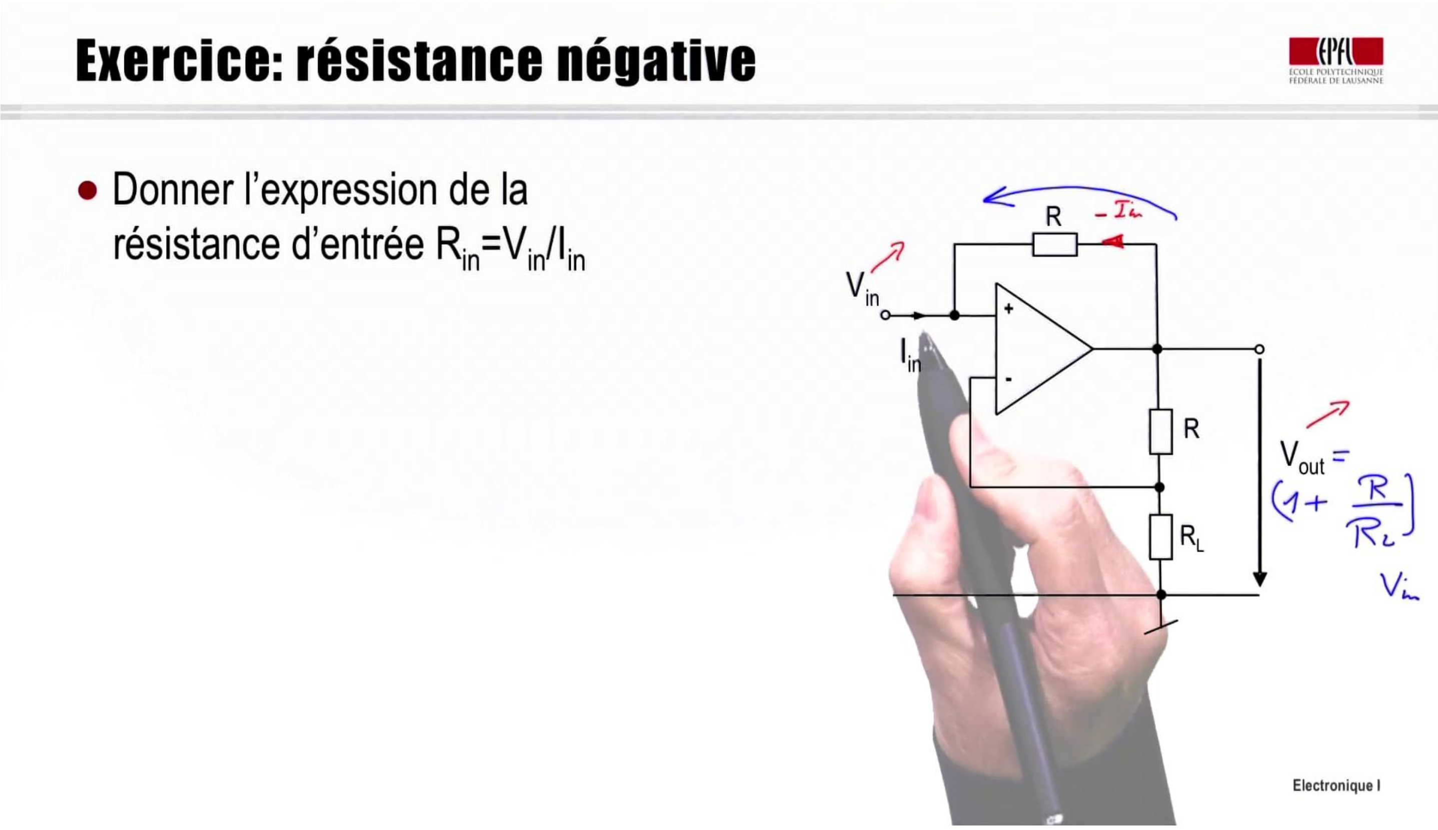
Electronique I

A negative resistance, it's a resistance which will not perform in a dissipative form because there, the voltage and the current have the same vectorial direction, it's the opposite direction so it's as if when you apply a *V1* voltage, you will have a current which will rather go in this direction. So if you will provide a *I1* current in your source. Every time *V1* increases, you will absorb more current so it's a generator. That will give you power which comes off in that direction, instead of having an absorbed power in your resistance. And that's done with a circuit like this one.

Notes

Summary

4m 29s



Here is the amplifier and its behaviour when it's connected to a gain which is equal, which can be expressed as *V(out)* is equal to *1 + R/RL*. And it goes without saying that this *V(out)* with a gain equal to that, which multiplies the *V(in)* voltage, is always higher than *V(in)*. This voltage is always higher than this one because you have *V(out)* equal to *V(in)* multiplied by something which is higher than 1, so this voltage is always higher than this one. So the voltage is positive in that direction. When you increase the *V(in)* voltage, you will increase the *V(out)* voltage at the same time. And the difference between these two voltages will always go in the direction that the output current will go in this direction. That's the current that will be the lE current -*I(in)* in reality. If the current is actually considered *I(in)* positive in this direction, each time you look at the current, that you increase *V(in)*, you will notice that there is a *I(in)* current which would rather go out in that direction. So in reality, this *I(in)* current is positive in this direction and that will happen with this kind of circuit.

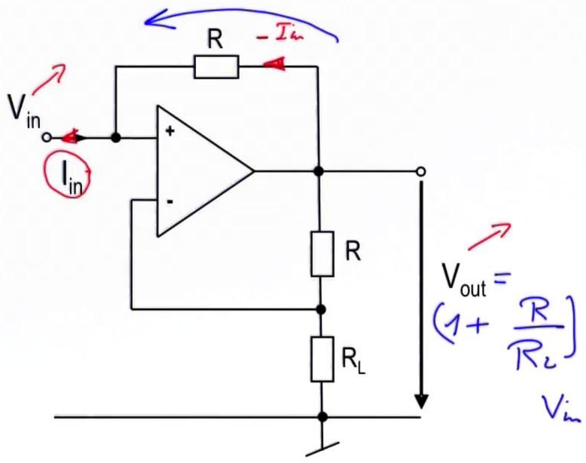
Notes

Summary

5m 14s

Exercice: résistance négative

- Donner l'expression de la résistance d'entrée $R_{in}=V_{in}/I_{in}$



Electronique I

And you can now express the relation between *V(in)* and *I(in)* and replace that in the expression of *V(out)*, and we will find that the input resistance, this *R(in)* resistance, which is expressed as the relation between the *V(in)* voltage and *I(in)*,, and you will see that when *V(in)* increases, or rather for a *V(in)* positive voltage, you will see a positive current in this direction.

Notes

Summary

6m 46s

Exercice: résistance négative

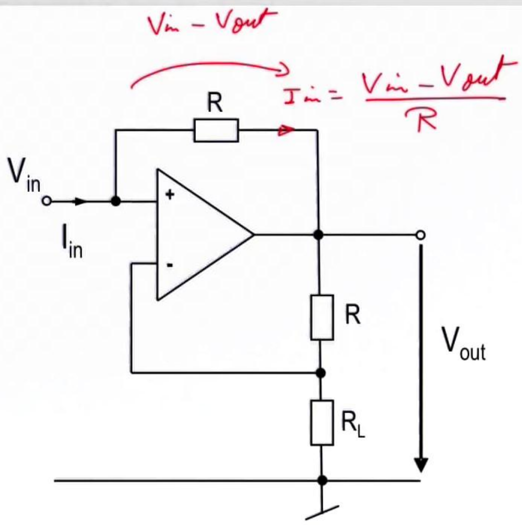
Electronique I

- Donner l'expression de la résistance d'entrée $R_{in}=V_{in}/I_{in}$

$$V_{out}=V_{in}\left(1+\frac{R}{R_L}\right)$$

$$I_{in}=\frac{V_{in}-V_{out}}{R}=-\frac{V_{in}}{R_L}$$

$$R_{in}=-R_L$$



Here is the drawing and the calculation of what we have just seen. So simply, by taking the same relation which describes *V(out)* in relation to *V(in)*, with the gain of the amplifier, and by expressing *I(in)* as the difference between the *V(in)*-*V(out)* voltage divided by *R* because really, the voltage that you see there, is a voltage that is *V(in)* - *V(out)* and will become a current *I(in)* = *V(in)* - *V(out)* divided by this *R* resistance that we added here. And as *R* and *R* are the same, I invite you to calculate and check that by replacing *V(out)* by its value here, you will end up with a *R(in)* resistance which is equal to -*RL*. So in this type of circuit, by connecting a *RL* resistance, you are making it negative. Any resistance connected between this node here and that node there, makes it look like it's minus its value. So it's *V(in)* which will be equal to -*RL* and the current will be absorbed by the source which is located on this side here, it will depend on the value of *RL* but with a minus sign.

Notes

Summary

7m 12s