ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

6.2-Résumé des structures analogiques

Structures analogiques

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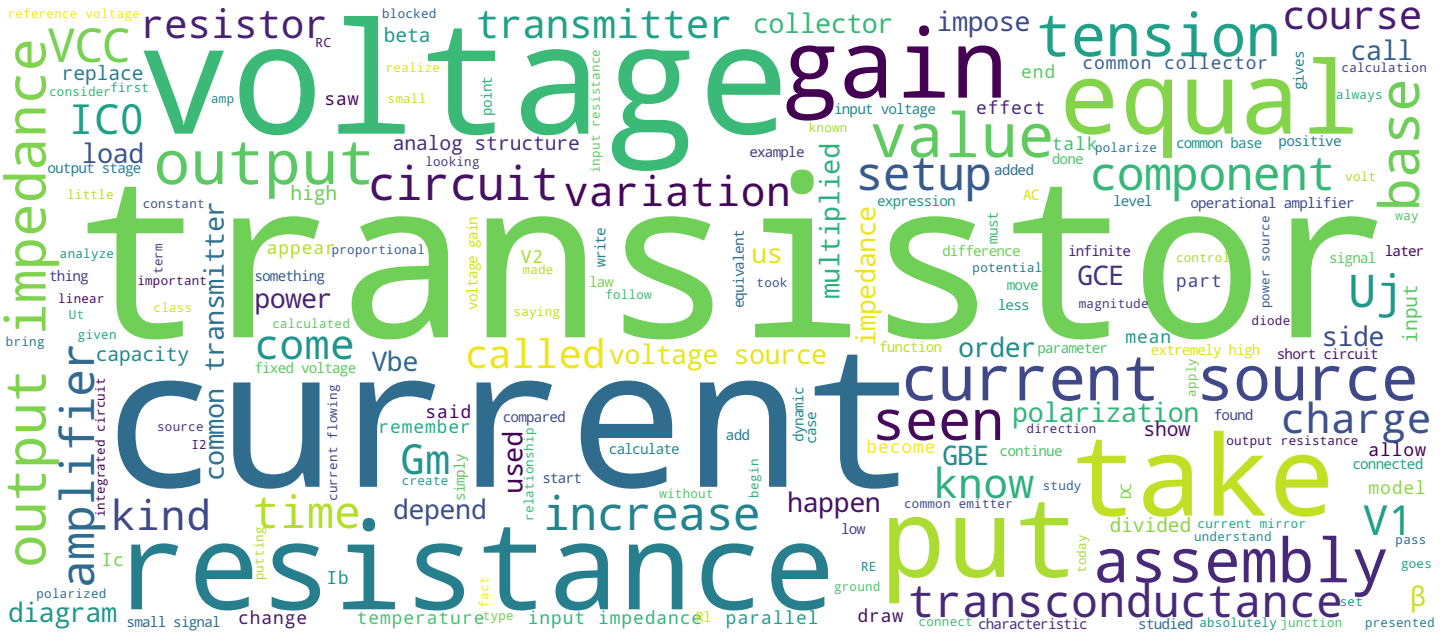


Résumé

- Introduction
- Amplificateurs de tension AC
- Charges actives
- Amplificateurs à transconductance (OTA)
- Amplificateurs opérationnels (Amp. OP)

Electronique II

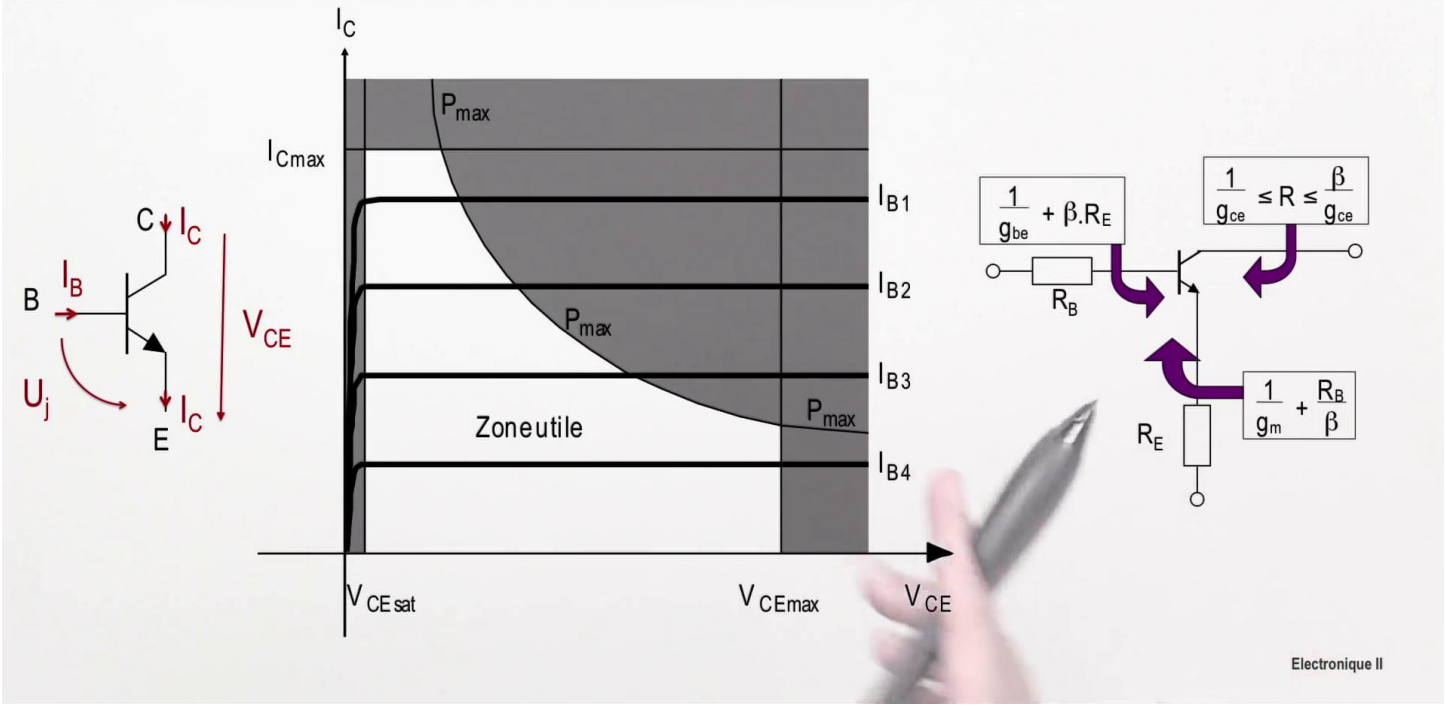
Well, hello! We will continue to study or almost finish the course and revise today what is related to this transistor. So here I will discuss a little introduction. later we will look at the different functions. So until today, we saw the transistors in some setups. I'll try to assign functions using the skills of each of these assemblies that we have seen until today to synthesize and an extremely quick summary.

Notes

Summary

0m 04s

Résumé du transistor

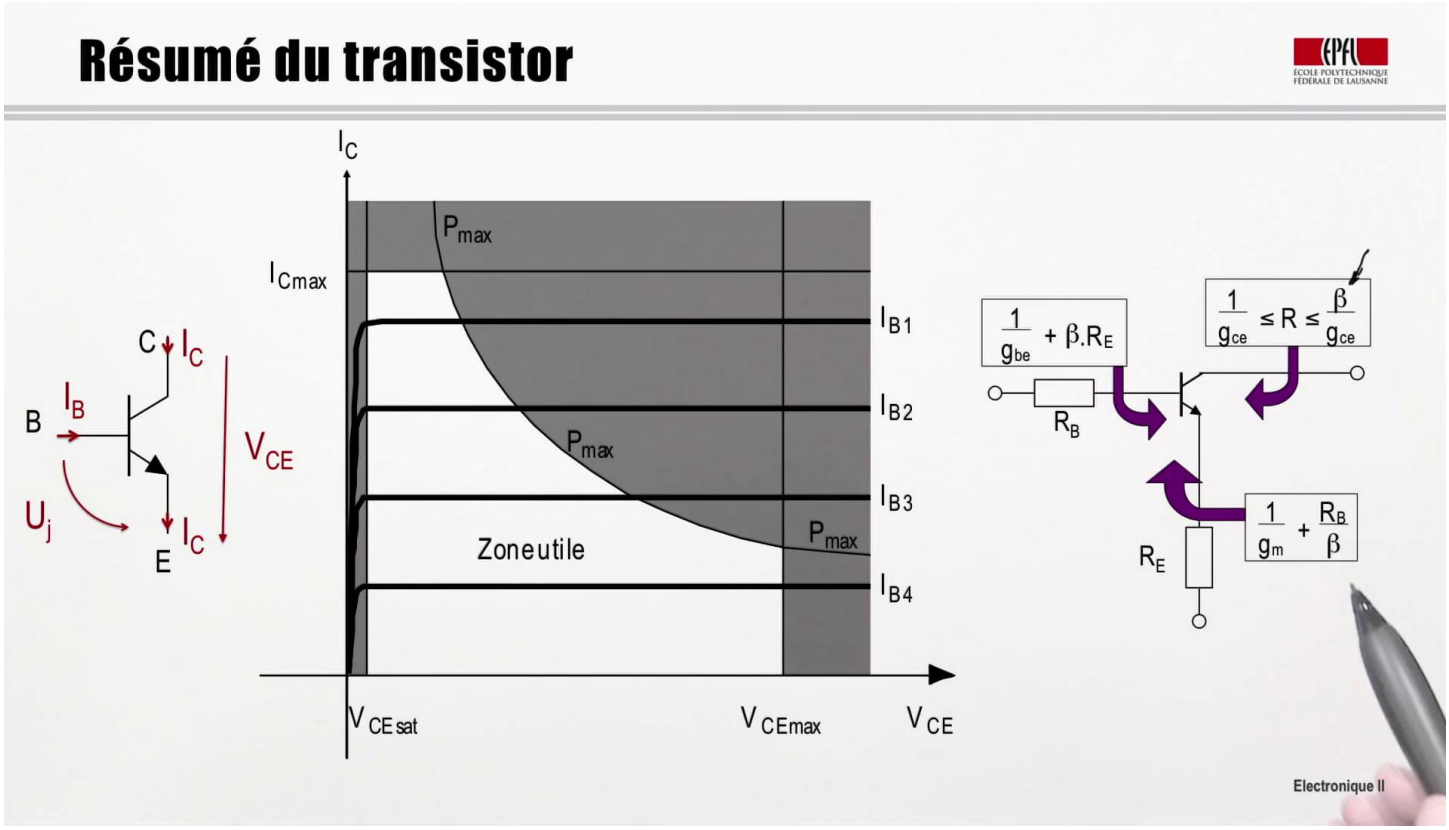


Here is the sum of what we have seen until today. I would really go slowly, bring out interesting ideas and do a simple summary for a few minutes, we would have seen virtually what was presented until today. I take the transistor, which controls a voltage current. this is the output of this transistor. The output currents that we see here clearly show that it is a current source, that this current source collapses when we enter saturation and this saturation voltage is relatively low for the transistor independent of the power limits because it has been shown that the transistor according to the casing, according to the level of characteristics voltage and current at the output. We will still have a limitation that is not all currents that will come out that we will be able to use it. This is in reality the clear area, the useful part of the use of transistor which is related to the power dissipated in the transistor. Then we have a vision pretty enough of the transistor. So enough is to say that our component, it was replaced in the world of small signes. And when you look from the base, we will seen as a resistor whose value 1 on GBE plus the resistance that we could possibly be, It depends on the setup whose transmitter is multiplied by the beta.

Notes

Summary

0m 34s



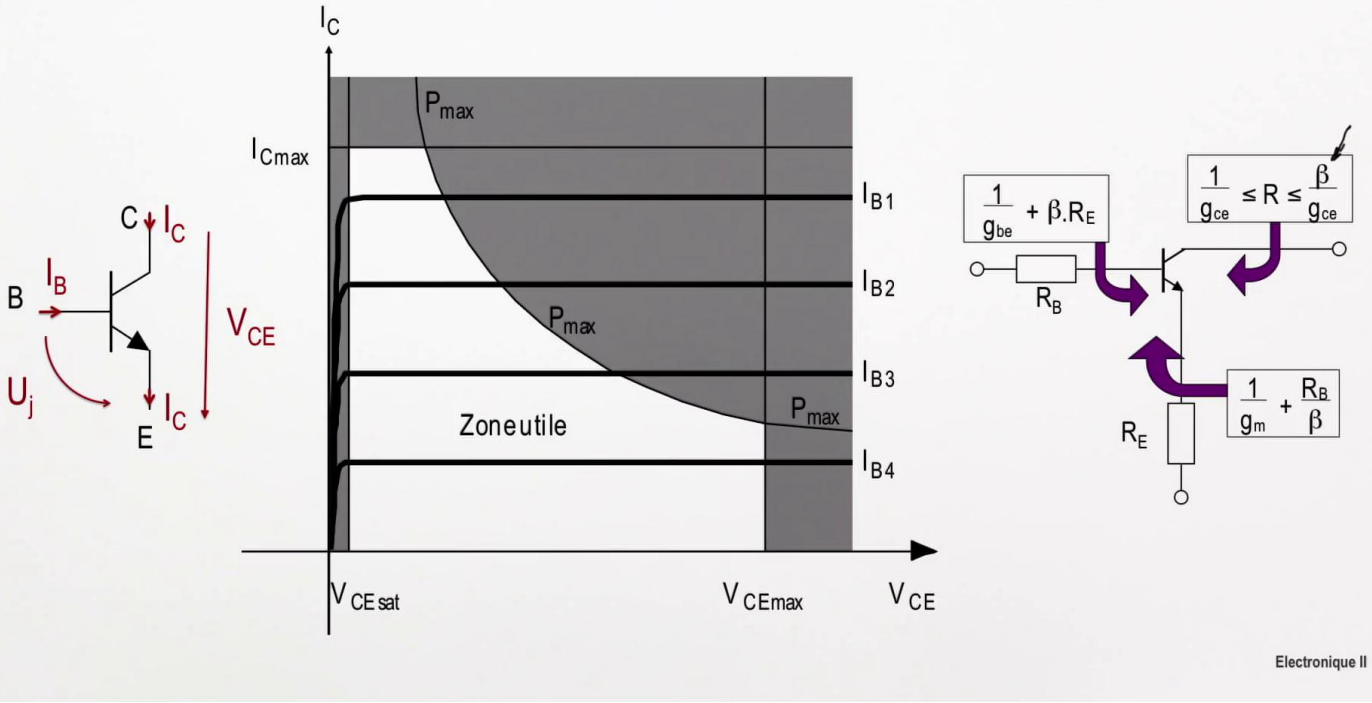
So we see that if this resistance is infinite that means we has a current source here, well, we will find that this value is infinite. If the issuer is directly to the mass, it was enough. Therefore in small signals pattern, there is no resistance the input impedance is limited to 1 GBE. If we look view from the collector, this is where we see the highest resistance. the one whose related to 1 of GCE if the transmitter is grounded. But if by chance, there is a resistance here and if this resistance is high, the resistance seen from there becomes extremely high, it tends to beta divided by the resistance we would have here. And often it is because CGE also has a one transistor and it takes us cascode setup and I return you to the part where we treated this cascode setup. So that's the highest impedance we could get with a transistor when viewed. And as it acts as a current source, so this impedance is in parallel with, corresponds to the highest value confined here. When we looking at the transistor emitter, here we see the effect of a resistance that would have existed on the basis So if this resistance is null, So we are able to take a direct voltage Towards the base which does not suffer from any impediment, and although this component falls.

Notes

Summary

2m 09s

Résumé du transistor

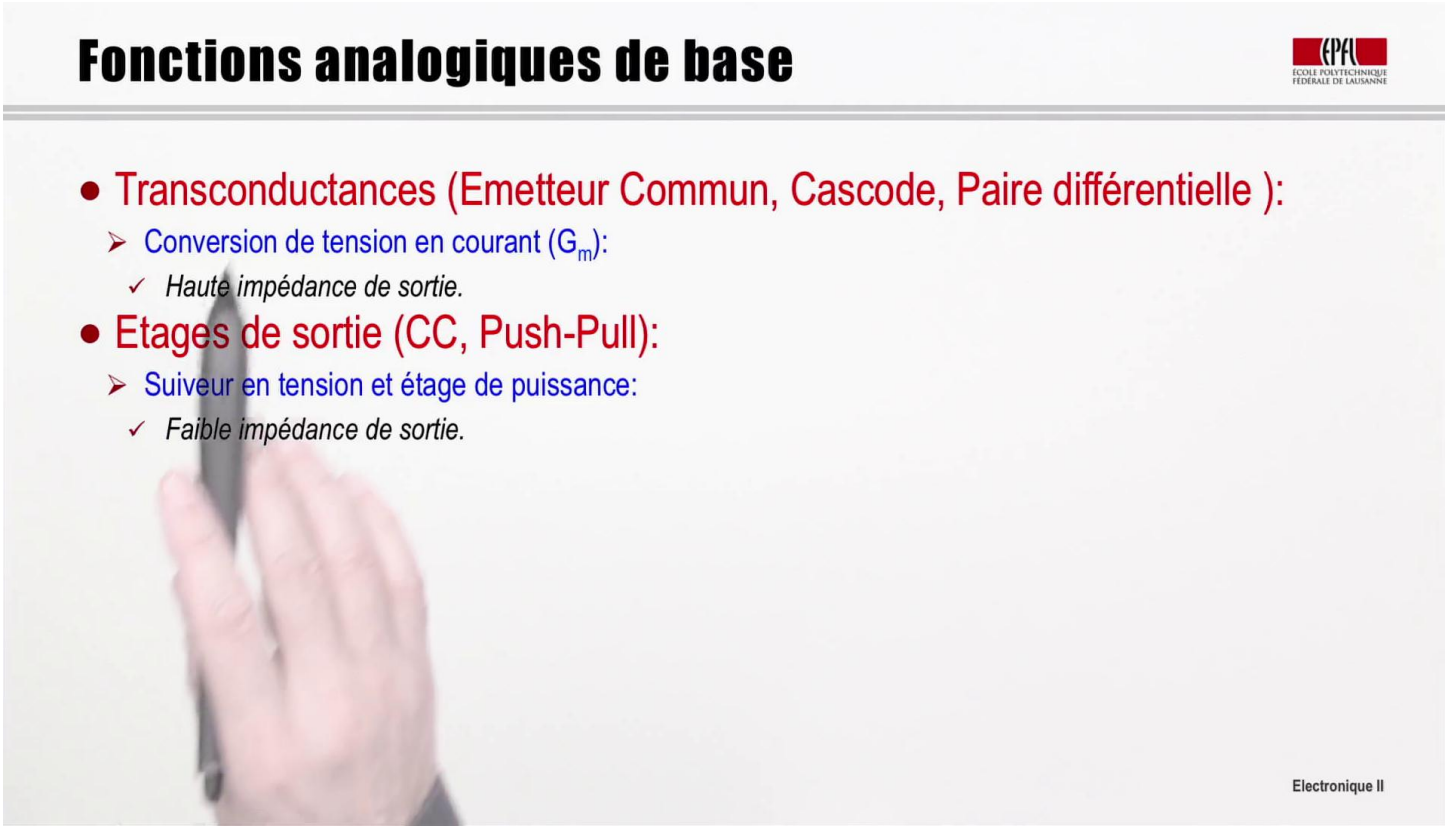


And there we have to do on Gm 1 and this is where the impedance I see from here is the lowest. And anyway, this resistance is seen there, it is divided by the beta of the transistor. The higher the beta is high, the less effect there is of what we would have connected before this floor, So what is appears as input resistance. And now, with that, we would have seen the transistor as the base component, the transistor with its output characteristic, and the small signal patterns that we took on impédences of this transistor.

Notes

Summary

3m 34s

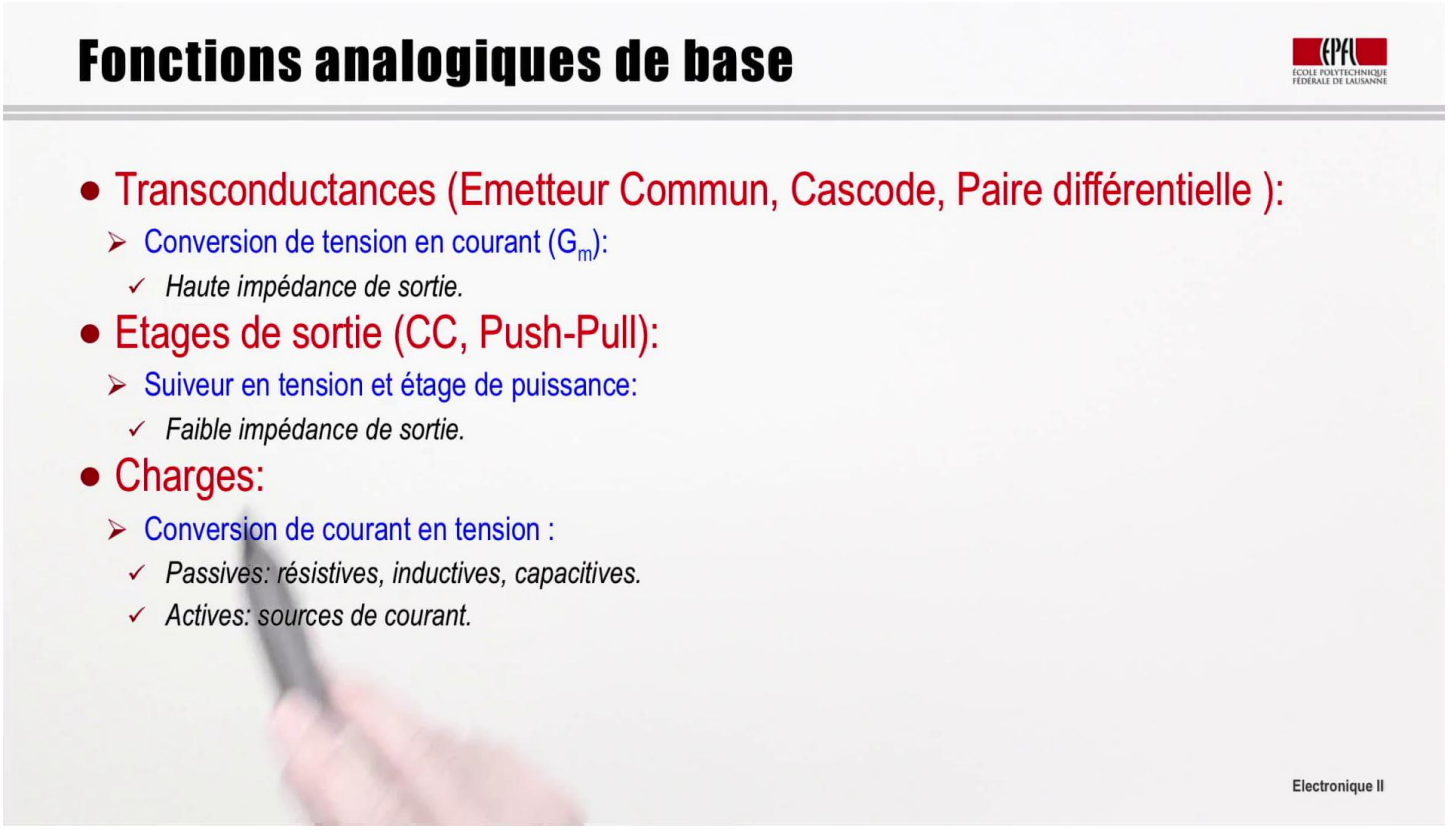


I want to talk aobut the basic analog functions. Until now we mostly talked about how the transistor in a assembly was used We did common transmitters, common collectors, cascode, differential pairs, of Darlington. All that we had seen before, I would like to bring them to functions. While the primary function is the transconductance. A transconductance is the famous feature in which we absolutely wanted to use the transistor in its essential role, converting the input voltage into an output current. And then we try to have a current as output variable, so it has a high impedance at the output and it is the characteristics of these fixtures whose the base is the common emitter. It becomes more sophisticated when it becomes a cascode, it means we puts a common transmitter and is followed by a common base. and has a differential input and optionally a differential output when using twice the same transistor. But these three functions here or there these three setups give us a function of transconductance namely current voltage conversion. If you take this setup here, the output impedance is high.

Notes

Summary

4m 07s

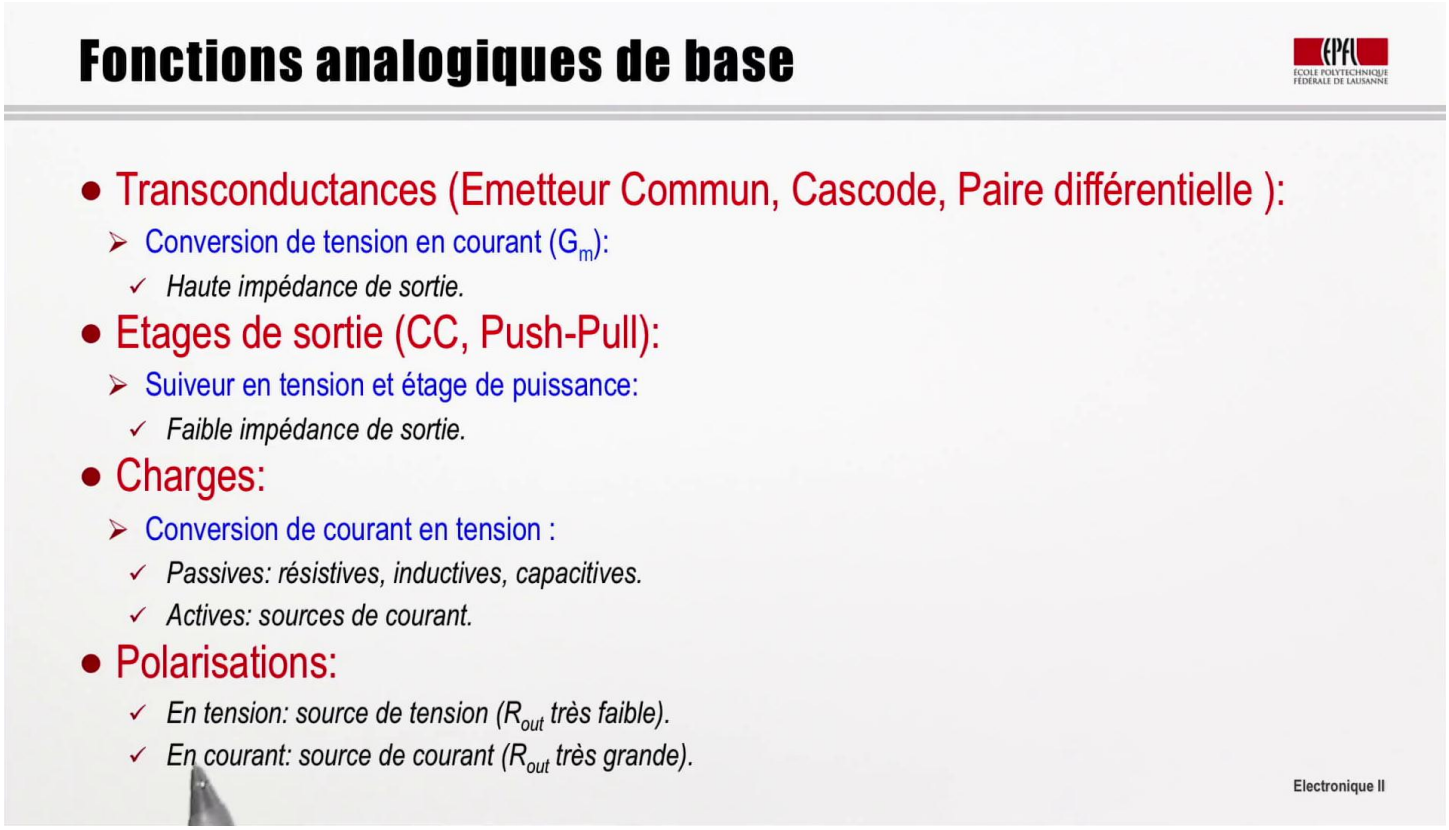


When we try to lower this impedance, is done by cascading or level monitor called the output stage, which engages a transconductance and after ensuring that there is a buffer between the two who performms the output stage, and there, we are not seeking to make the voltage gain. There you can make the gain in tension because the current that might have out by putting it in a high resistance, or even infinite, it gives us an infinite gain. If we put behind an output stage, well this infinite gain realized by a transconductance when looking at the output voltage, we has to follow with an output stage whose gain is unitary often it is a voltage follower, so he makes a gain 1, and it aims to eliminate this high output impedance effect and turn it into low output impedance. So here you have first floor, second floor and you begin to understand if you make a profit with it. Well, to use this gain, you need to put a floor in the high input impedance and the output impedance is large. And what is it ? This assembly there is the common collector or the push-pull, a variation of the common manifold. This assembly then needs a load. And this assembly there needs a load.

Notes

Summary

5m 25s



Therefore when using one or the other, the load can be active or passive. And that, the idea is that if the output of a current, must convert the current to a voltage in a load. If the load is passive, it is a resistance, is an inductance, it is a capacity, this is what you know as passive component. And there, if the assembly needs a transistor which significantly saves space when it was integrated on silicon, and although it is usually a current source and is a current source that realise, called active load. And when it is associated with a transconductance thanks to it obtained an infinite gain. And now, there are 3 levels and the 3 are of AC nature it depends to how we can use them if it is based on the fixtures we had already mentioned before And finally, there is the appearance test is that we would like impolariser our transistors. So we often polarizes either voltage but generally in voltage. So when we impose a fixed current thanks to current sources. When we want to generate fixed voltages that do not move with temperature, is thanks to voltage sources.

Notes

Summary

6m 47s

Fonctions analogiques de base

- Transconductances (Emetteur Commun, Cascode, Paire différentielle):
  - Conversion de tension en courant (G_m):
    - ✓ *Haute impédance de sortie.*
- Etages de sortie (CC, Push-Pull):
  - Suiveur en tension et étage de puissance:
    - ✓ *Faible impédance de sortie.*
- Charges:
  - Conversion de courant en tension :
    - ✓ *Passives: résistives, inductives, capacitives.*
    - ✓ *Actives: sources de courant.*
- Polarisations:
  - ✓ *En tension: source de tension (R_{out} très faible).*
  - ✓ *En courant: source de courant (R_{out} très grande).*

Electronique II

When there is about a voltage source, it ensures that the output is low impedance to not disturb the tension when we draws current and when you have a power source, we would like have an output impedance that is extremely high for us to changes the voltage without the current being affected. so they are the basic functions. I tried to summarize the most important to know: transconductance output level, load and polarization. Now I would like to spend this diagram to what I would call the analog structures.

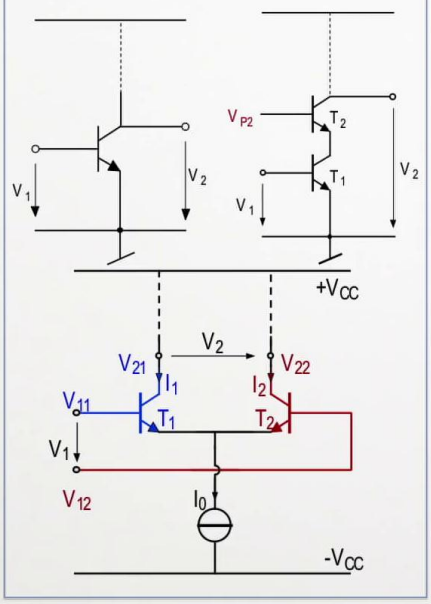
Notes

Summary

8m 04s

Structures analogiques

Transconductances



Paramètres :

- Gain en tension
- Impédances d'entrée et de sortie.
- Dynamique.
- Bande passante.
- Consommation.
- Bruit.

Electronique II

It's about what I said before but I presented here schematically with the transistor. So if I take the transconductance functions I'd say the simplest of transconductance on this kind of installation: common emitter, an input voltage, an output current and it is from this current where we could read voltage if there has been a charge that will be improved thanks to a cascode assembly, because the transistor you see from here to here which is the same, we put it behind a transistor, the base is polarized and then, the output impedance has become extremely high. It's beta time the 1 of the GCE when in this assembly is simply the 1/GCE. So when trying to have an extraordinary current source with the output characteristics ie a very high output impedance, this is used. And we've also studied a transconductance whose input differential voltage and the output is a current that will change between I1 and I2, when one increases, the other decreases. So again, we have a differential output which can be converted into voltage when you throw our current in loads. So when you look at these three fixtures, this is roughly the same. And you'll see if this one and this one can be relatively comparable Why?

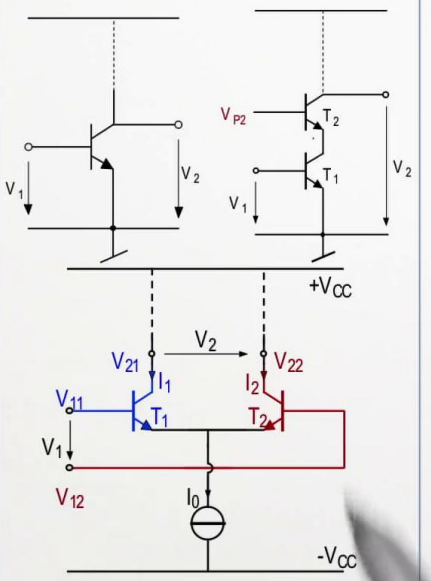
Notes

Summary

8m 38s

Structures analogiques

Transconductances



Paramètres :

- Gain en tension
- Impédances d'entrée et de sortie.
- Dynamique.
- Bande passante.
- Consommation.
- Bruit.

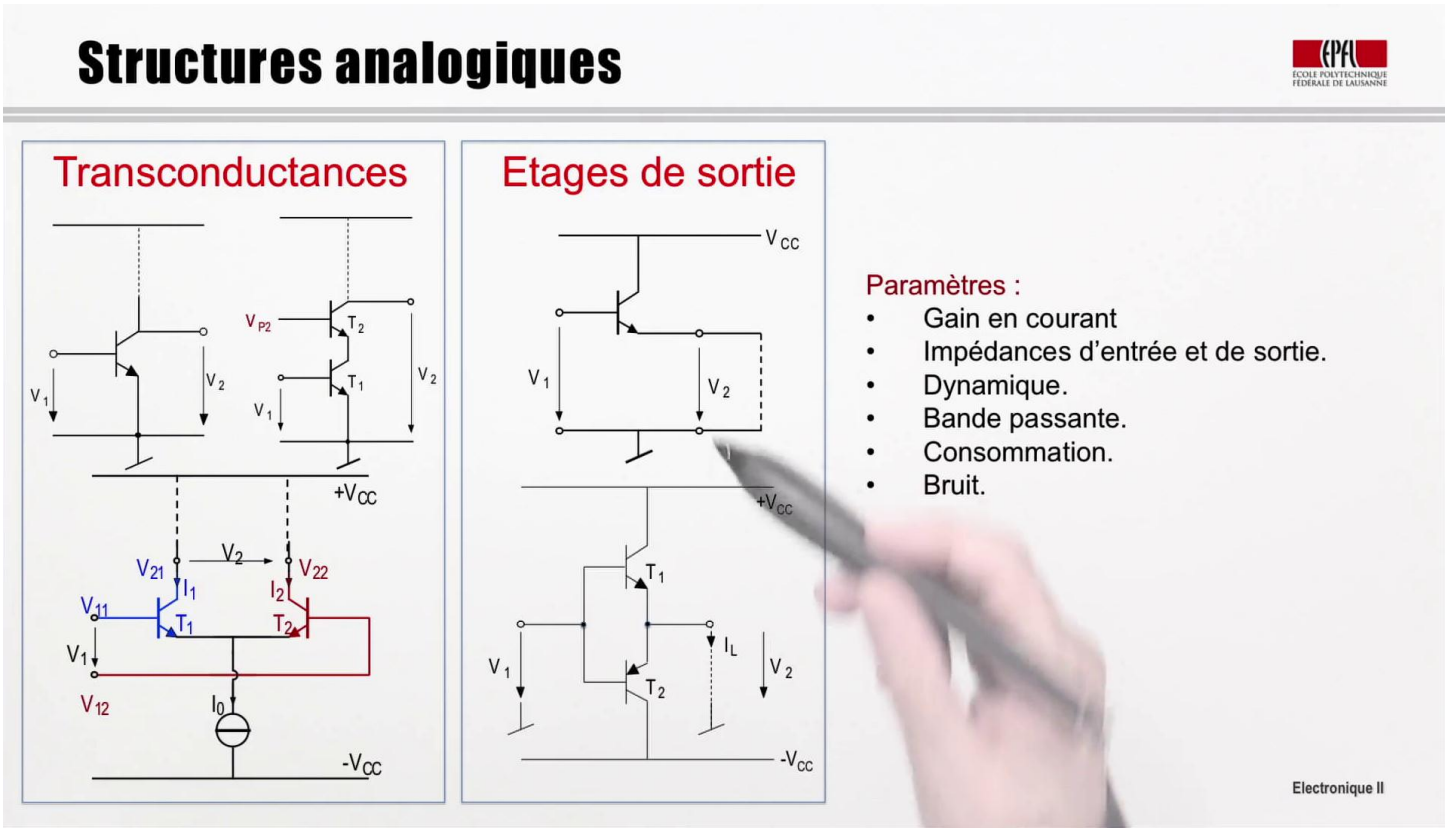
Electronique II

Because we made the voltage gain with this, this and that. So generally the parameters we are looking for, is that when we convert our current in voltage and putting resistance, we get a gain equal to Gm times the value of the output resistance. And it gives us the voltage gain. The input and output impedances we studied them, we known the impedance here and there that are the same. There I have half the impedance because I have 2 transistors. There is the output dynamic. The output dynamic is how this tension will move up and down without the voltage being disturbed, it's mean distorted. So that will give me the dynamics. There it's normal that I lost the dynamics, why? Because I have a transistor that will limit myself here. There I can go down to almost ground. There, I can not go down to the ground, I have to get off until the voltage here allows me to prevent this transistor from saturating. So the dynamic is a parameter, the bandwidth that does not open here. Well, we had seen is the parasitic capacitances such as the Miller effect which has been introduced before, and the same with the capacities used for couplings and decouplings limits us in these 2 assemblies.

Notes

Summary

10m 03s



The consumption, consumption is how much fixed current one had to impose in the assembly to polarize them noise. and something I did not present at all here is the noise. Then if you compare these two assemblies to the one that is below, we realizes that this assembly there has the same parameters. Besides, consumption is very visible because we have here a current source I0 this current is fixed, you can not use no more no less, which multiplied by the supply voltage, I get it with the total power I need to provide such an assembly. And when I look at the one below, you will see compared to those above, It would typically be used when I'll make an operational amplifiers or transconductance amplifiers because I have 2 positive and negative inputs that would allow me to make inputs (INAUDIBLE) as you know it So the first structure or first series of Analog structure to make transconductances are presented here. If you remember of these three fixtures, it will help you much later to build more complex patterns. I continue with analog structures. I called it transconductance, I want to look at it well what I called the floor function, the output floors. So output floors, there I present 2 followers voltage.

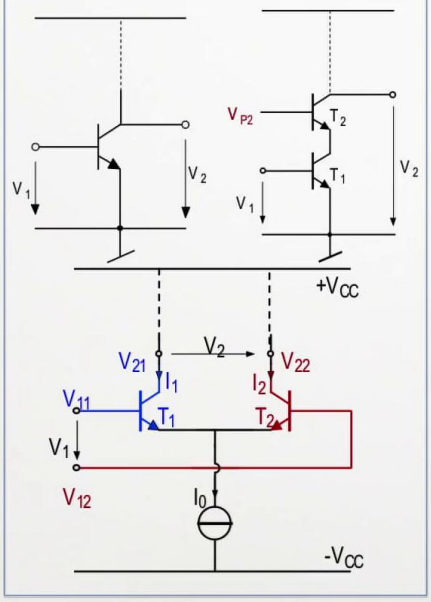
Notes

Summary

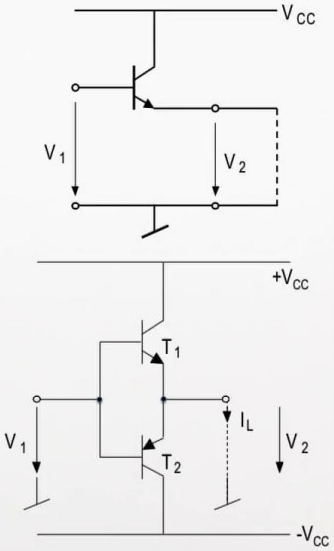
11m 21s

Structures analogiques

Transconductances



Etages de sortie



Paramètres :

- Gain en courant
- Impédances d'entrée et de sortie.
- Dynamique.
- Bande passante.
- Consommation.
- Bruit.

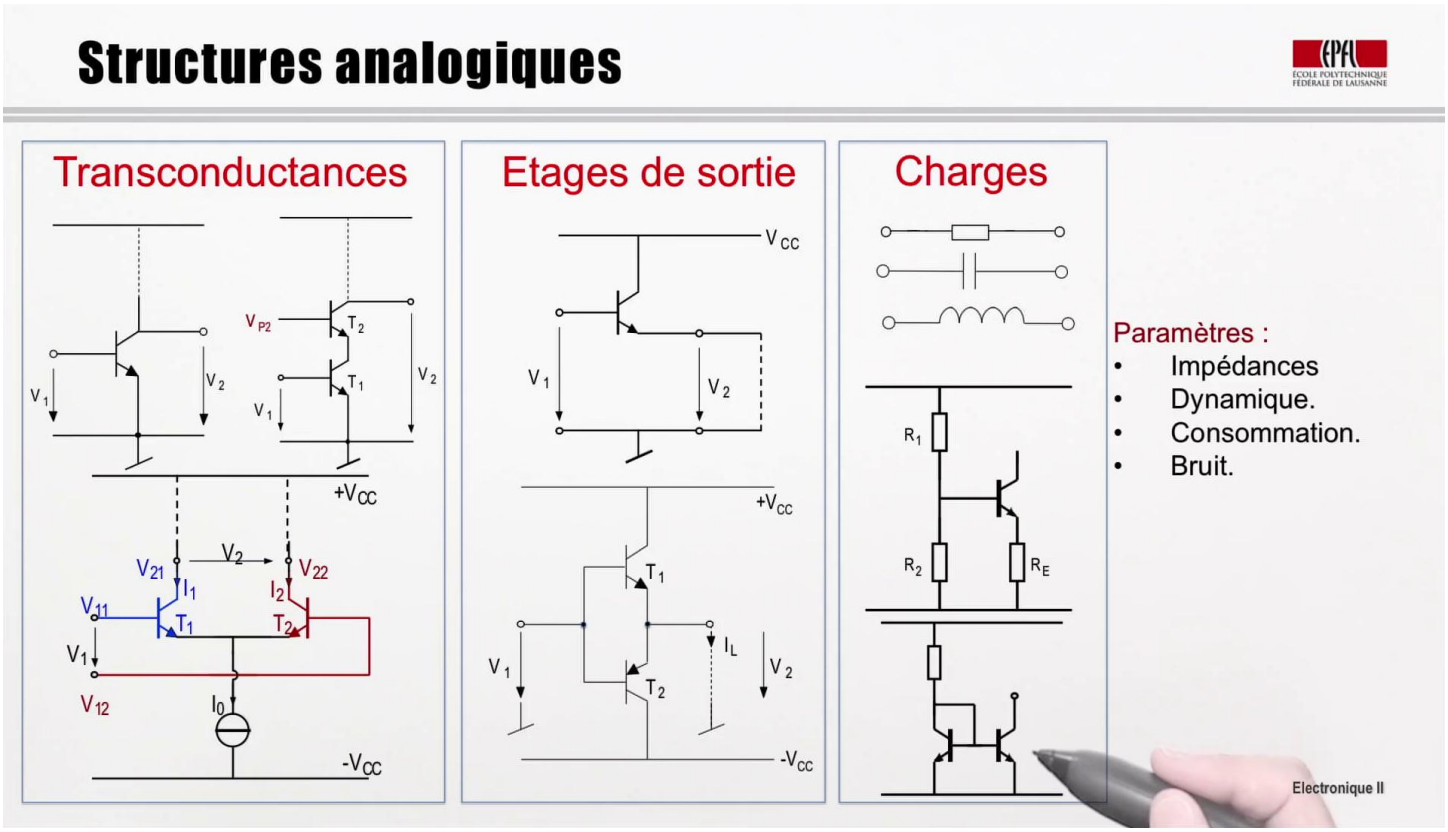
Electronique II

A setup based on a common collector So the tension there and there are the same with a lag a junction voltage. There, I have the same assembly but duplifié. that mean I have a NPN and PNP transistor which would allow me to have a greater dynamic and I block a transistor while using another transistor you will see the use of this kind of setup when I talk about classes of amplifiers and we see that the performance of such an assembly is significantly better than the performance of such an assembly because here I have for alternating half a transistor that works while the other half-wave and the other transistor that works. The parameters, that is exactly what I has shown when I spoke about the transconductance. So, when I speak of transconductance and output stage, the parameters are the same. Now what is it for this kind of thing and that kind of thing? I think you will understand very quickly the day you want to make power gains and not break your voltage gain, you are forced to take what I would call a voltage follower but it will make me a current gain and especially lower impedance. I take the family there and I put it behind the family there. And the 2 make me an amplifier having a large gain due to this kind of assembly and due to low output impedance due to this kind of setup.

Notes

Summary

12m 45s

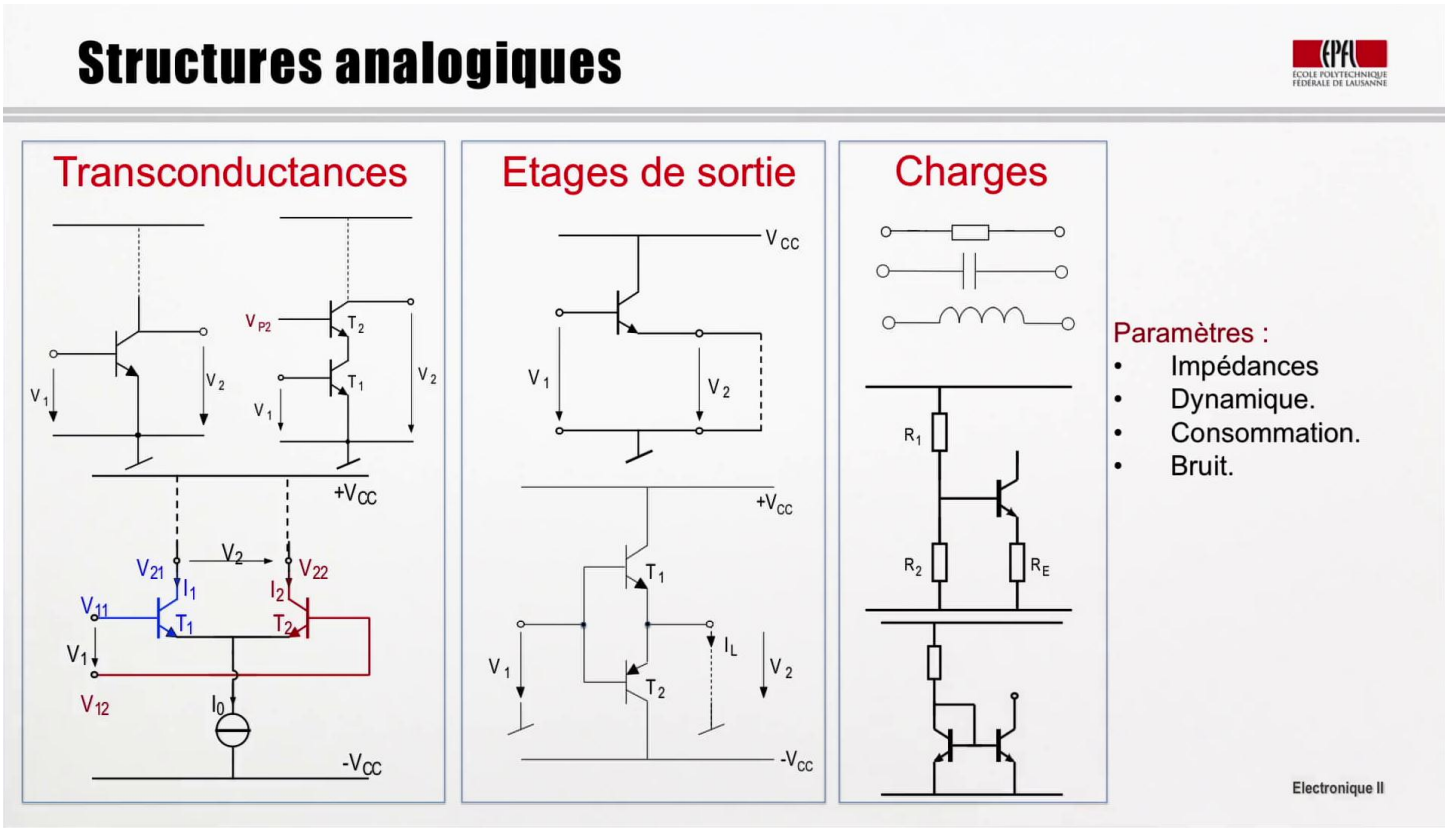


In my analoiques structures I have passive loads, you know: R, L, C. I have not been here the transformer because of course, I could replace an inductor by mutual inductance, what is true, that would allow me to decouple a signal to AC. Which is widely used for lack of space in this diagram and a willingness to be synthetic in the presentation of what I call the charge. I contented myself with decomposing, I would say simply the resistance of an inductance capacity. But we have seen that if you take discrete components, and you want to make a current source. A current source, that is an assembly which has an extremely high output impedance, and that the output impedance increases abruptly when you put a large enough strength there. This resistance, it could be passive or active like we did here, and it would give us an assembly called: the power source is done with discrete components, that is to imposes the current here by placing a fixed voltage on the base. And we had good comment on the difference between this circuit and this assembly. just saying that when one has to make to integrated circuits, we can put two similar transistors and we are not souffered of a thermal runaway of a transistor when he was taken to heat Because of the current flowing through it and the voltage at these terminals.

Notes

Summary

14m 08s

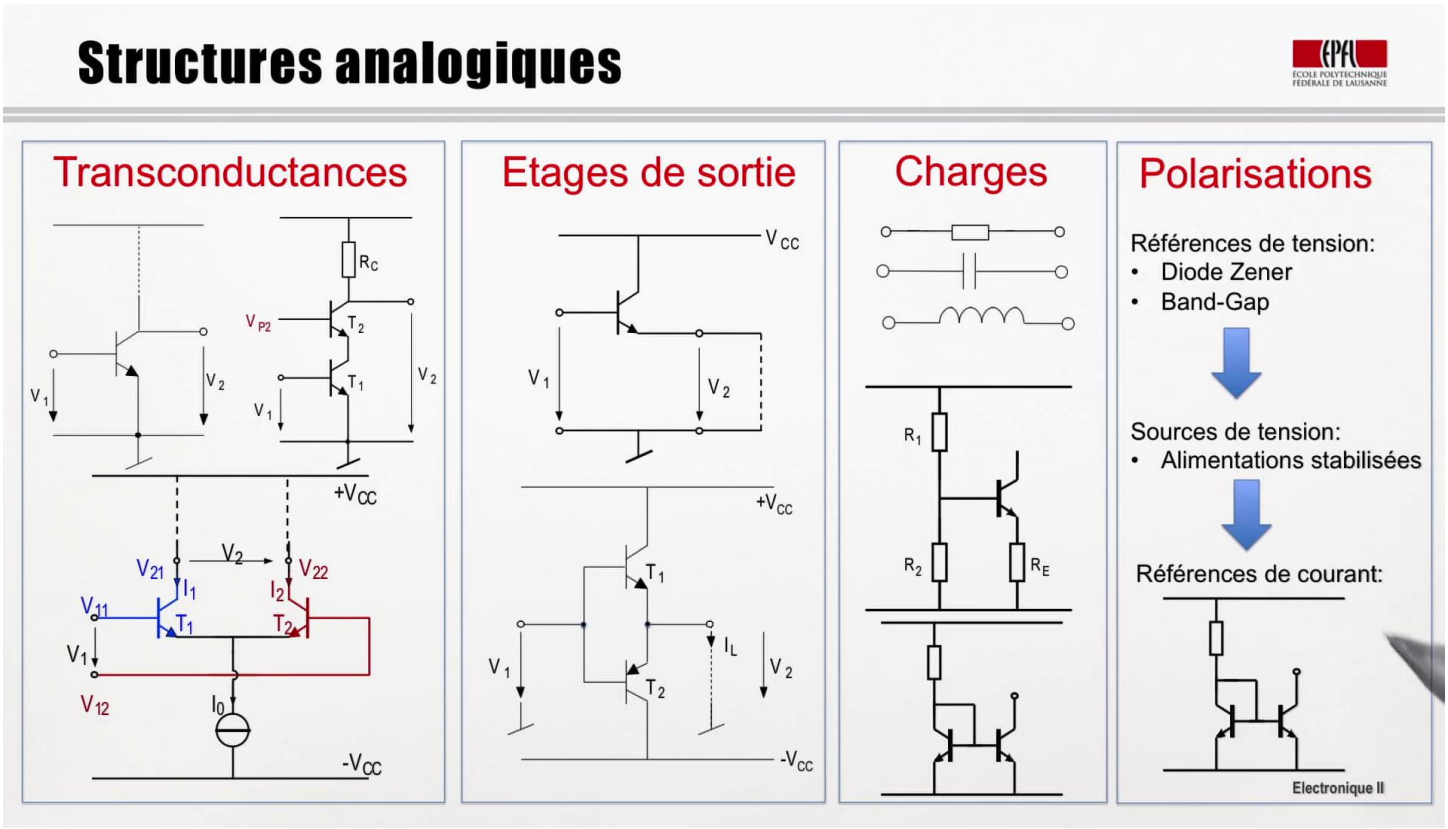


So we can make this current mirror which has a much lower impedance than we see here if it is not cascoded. Otherwise, I can very well take a component that you see there and put a transmitter setup pardon me, a cascode current mirror, and it would allow me to turn this setup into a cascode mirror and was also studied. Still if you take this kind of installation, there you are doing an impedance view from the manifold and the manifold extremely high that you have done with passive components, as seen here. If the resistance is integrated to obtain a high resistance, we must use many surface to achieve a resistance that could do with a reactive component which occupies very little silicon area on therefore in an integrated circuit.

Notes

Summary

15m 39s

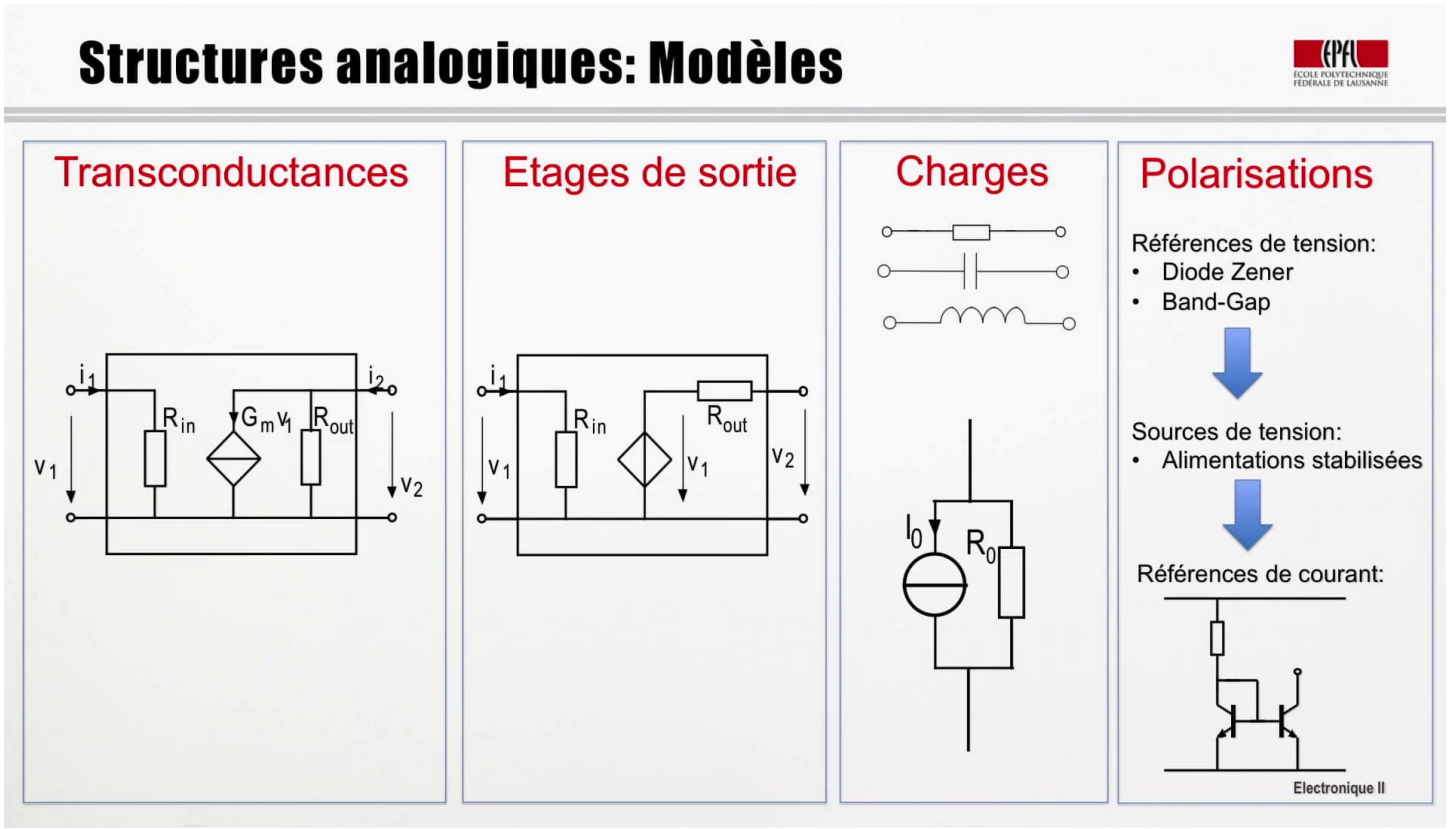


And to finish, I want to talk about everything trial. Make voltage references, there are simple techniques based on components such as the Zener diode. There are physical phenomena that we use are called the Band-Gap, which with a transistor polarization technique, we can have a reference voltage. That is to say a tension which does not depend at all on the temperature or very little of a temperature. And this tension we generate helps to generate references of fixed voltage in integrated circuits. You will have the opportunity to study them in other courses. Therefore, having these 2, we can generate voltage sources because by taking a voltage reference that is a fixed voltage, putting behind an operational amplifier which will create a buffer between a reference voltage and a voltage source and we would do with this thanks to the counter-erection of a stabilized power supply. And like that, we test power alder stabilized which allow us to power a circuit. And if we want to make current references, and if it has a voltage generated from here, used here and give us a fixed voltage, the reference current is derived from a fixed voltage where we impose this kind of mounting and comes across a stream that we can use for example to produce this kind of installation.

Notes

Summary

16m 28s

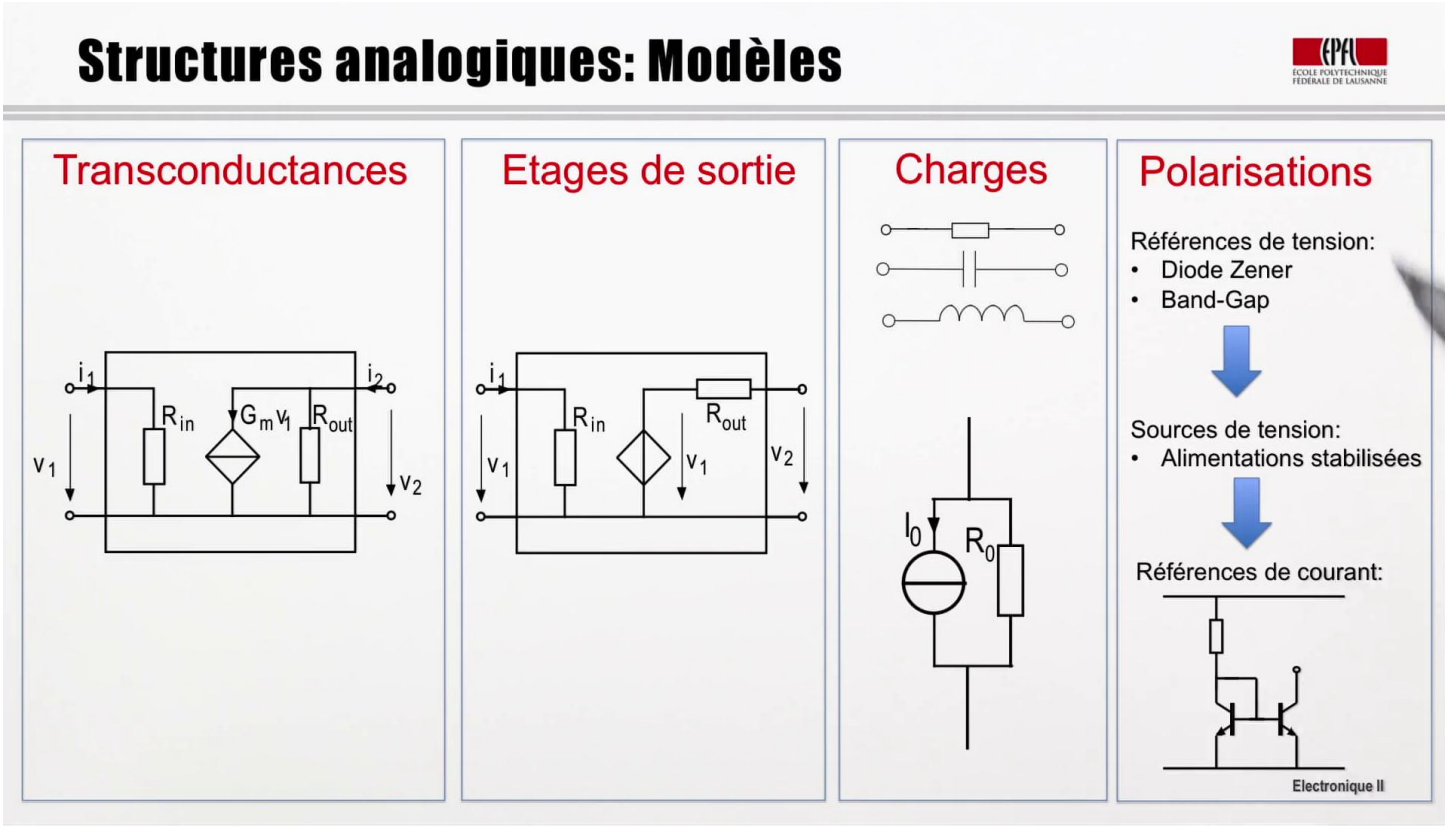


If I want to use a power source here well I just have to take this current mirror and put here by taking a stabilized voltage and by generating a stabilized power supply with that, I can get a stabilized current. I tried in this kind of diagram to show you that we think in analog structure. These analog structures have roles that call functions. And now I'll show you, In this course during all we studied how is what we tried to synthesize these functions. And immediately after, chained by a video that would show you that if I want to do an operational amplifier, I just have to play with these analog structures by putting one behind the other and use all the functions you here to build an operational amplifier. I start from my analog structures, and I will generate models; It was the essential of what we studied this semester. We replaced representations with transistor by highly synthetic representations to tell a transconductance, is when my input variable is a voltage my output variable is a current.

Notes

Summary

17m 56s

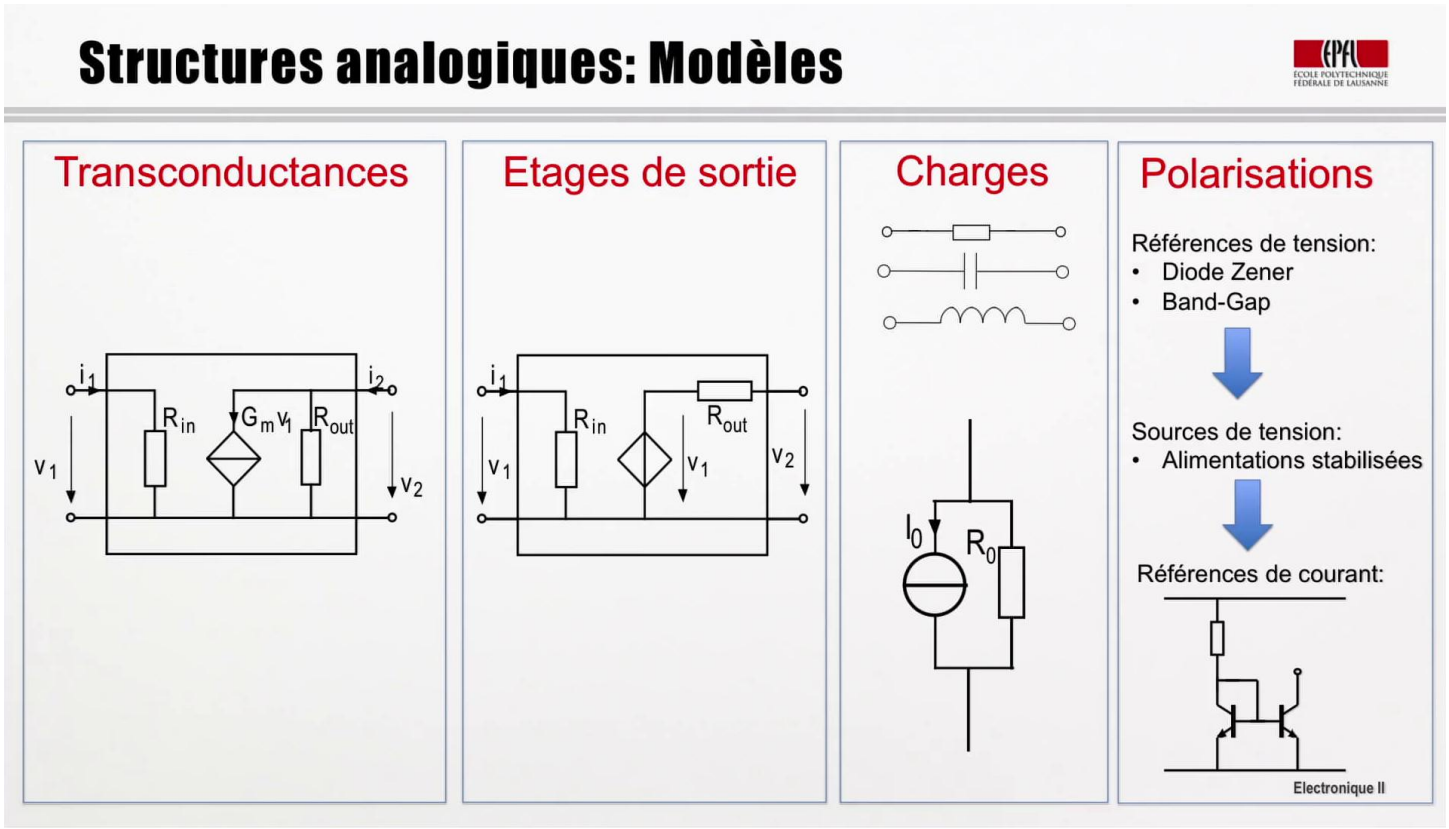


He suffers this controlled current source suffers resistance, it happens, they put it here and you realize with that a function that will take the input voltage, convert and which contains all the necessary components to put it with all floors which will precede it which will become before and after and we could solve it as an exercise of basic circuit theory with Kirchhoff's laws and all that is linear simplification. So now, the output stage can be presented Either like that, or like that. Since V1 and V2 are the same, and generally identifies R Out is a very small, so it appears there V1 here, it seems quite sensible to use the model Thevenin instead of Norton model to present an output stage knowing that the gain here is equal to 1. Here, the model is the one you see here. By against the equivalent of an active load of a transistor as we saw just before be replaced by the current source a test current source with its output impedance. Quite often, this output impedance is calculated in function of the transistor output conductance. And if it is cascode, there is the beta is going to interfere in that calculation. And polarization, there I have not changed compared to what we had seen before.

Notes

Summary

19m 10s



because it is a current source, it's the same as what you see here. And the voltage source is good is the voltage source realized as we had seen in the theory of basic circuit. I would like to end this I just go now. I wanted at all costs to distinguish what I would call function and what I call analog structures. We spent the semester, well we spent all these courses studying analog structures And I wished to make a small summary to show you that these small assemblies that correspond to structures, taking functions. What will make things easier In the video that will follow right now to do a little editing and show you that I just have to make these analog structures when I mastered and assigned a clear function in each of these structures and assemble them to perform the the most advanced electronic functions I'll give you an example how is an operational amplifier thanks to these functions we just saw now.

Notes

Summary

20m 33s