ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

8.1- Amplificateurs de puissances

Principes

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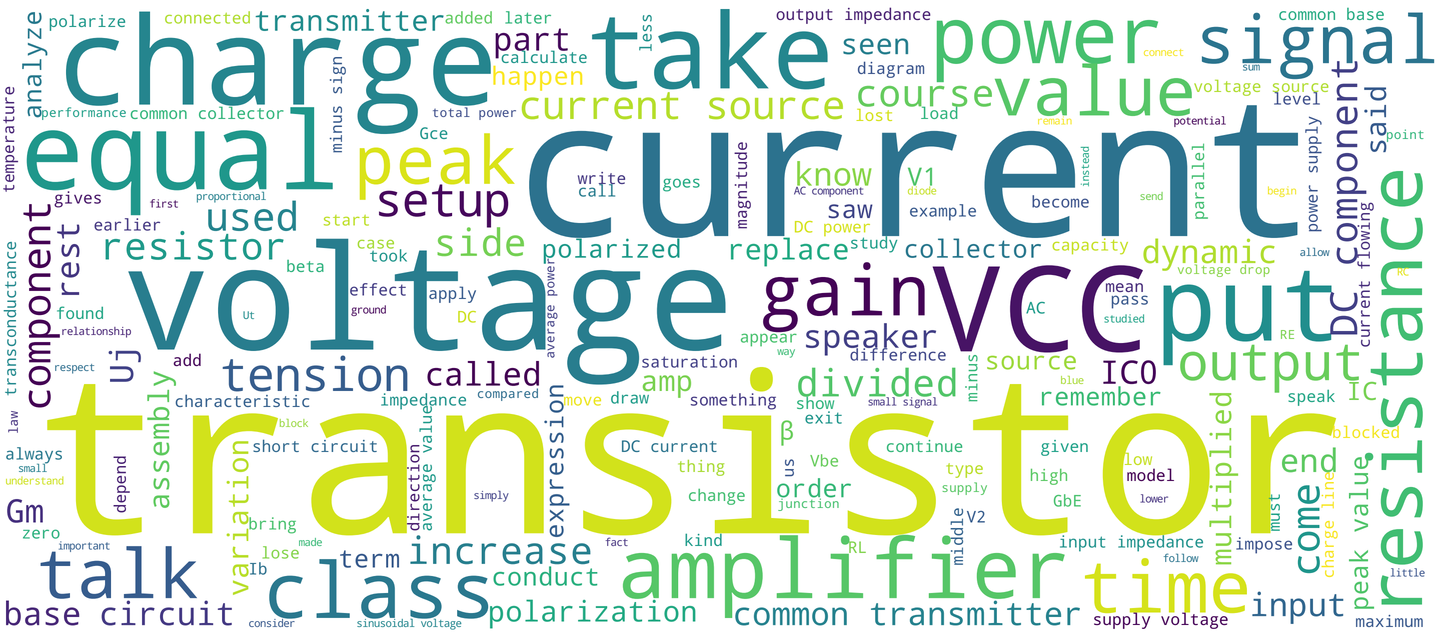
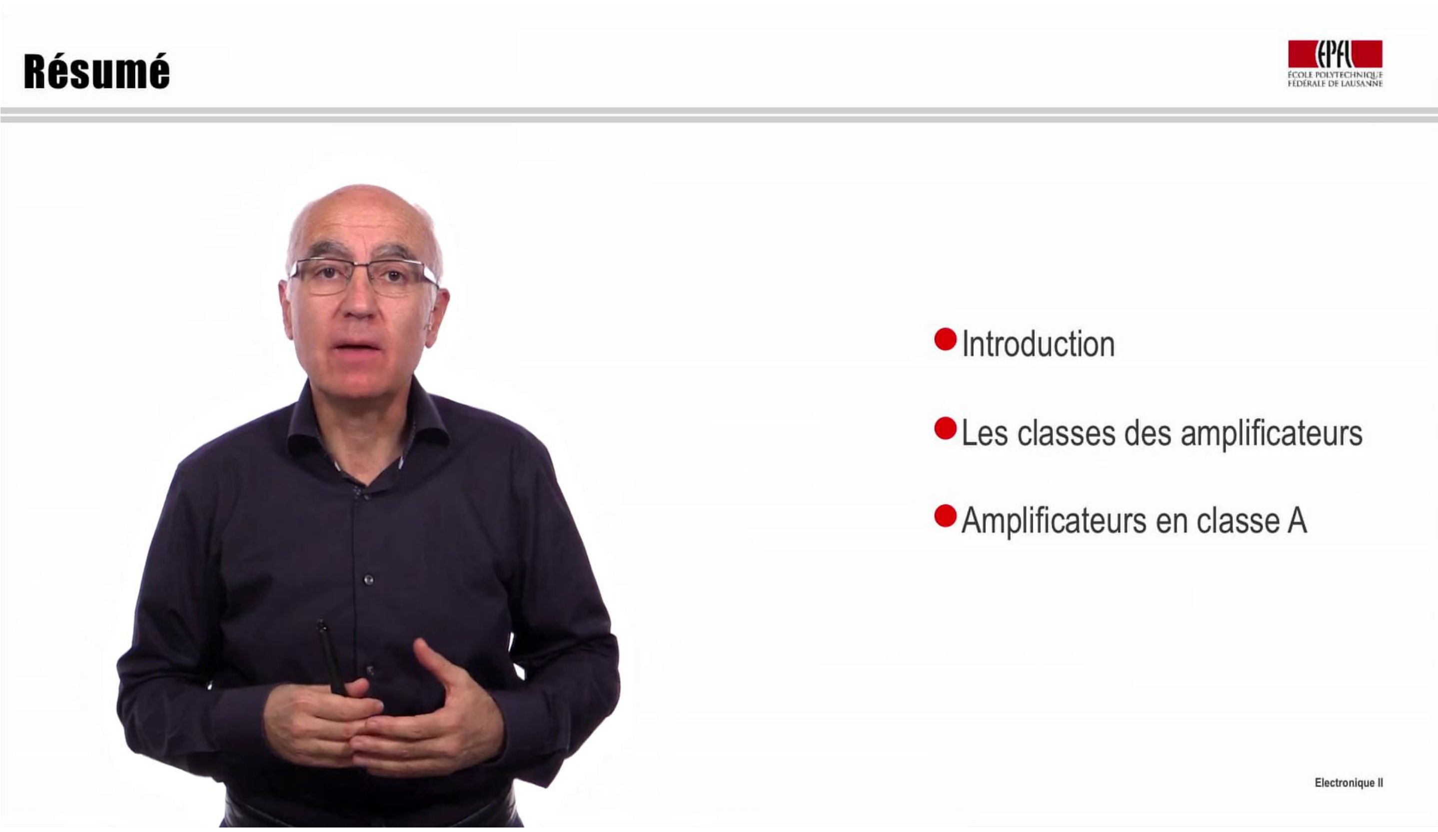


Video

EPFL

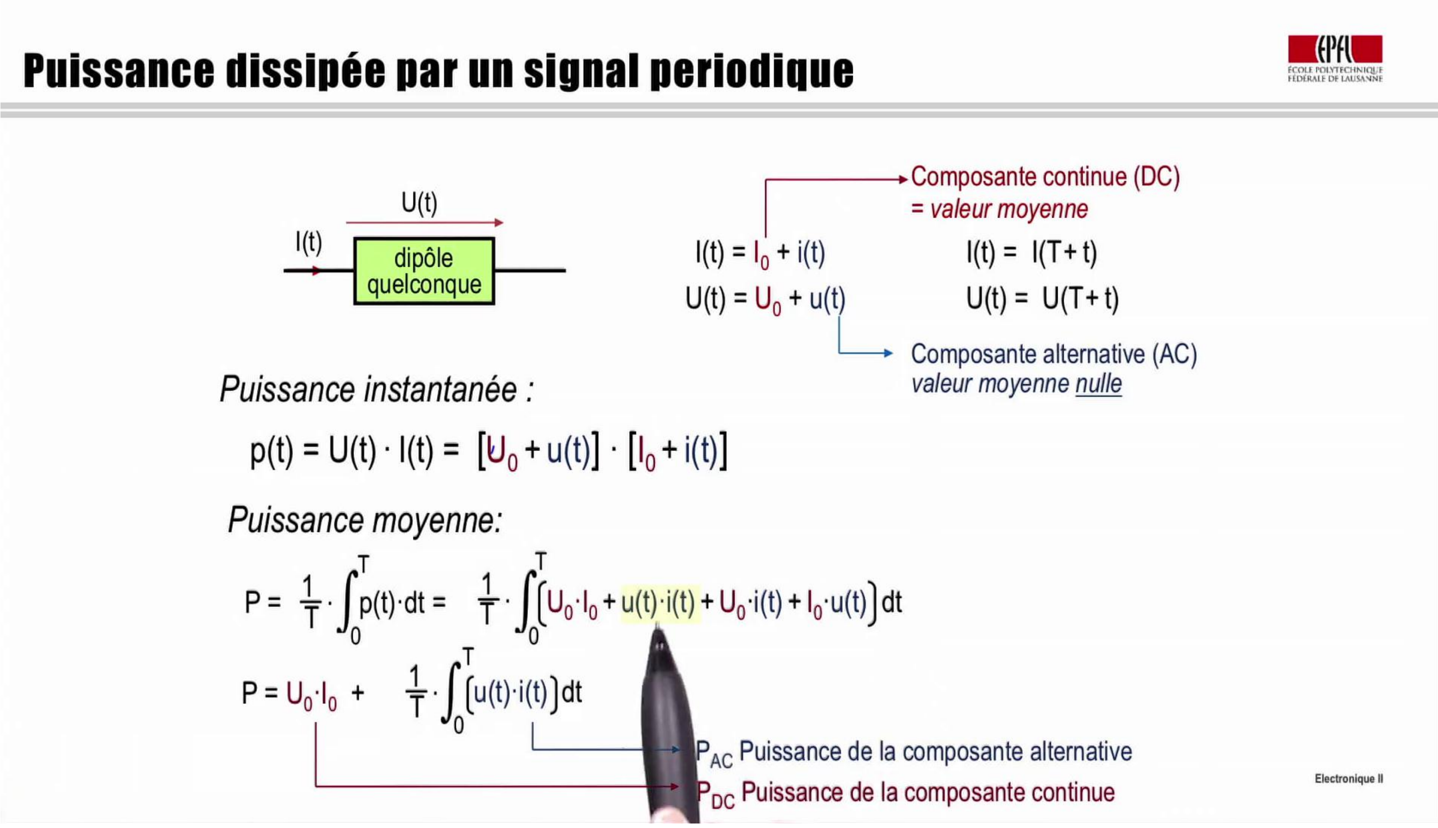


Hello, today we'll discuss amplifiers and especially talk about the notion of power in the amplifiers. I'll start first with an introduction followed by a classification of amplifiers types Class A, Class AB, Class C, Class D. We'll see what that means and then I'll end this video by telling what is a class A amplifier and analyzing the topology of a class A type of amplifier.

Notes

Summary

0m 05s

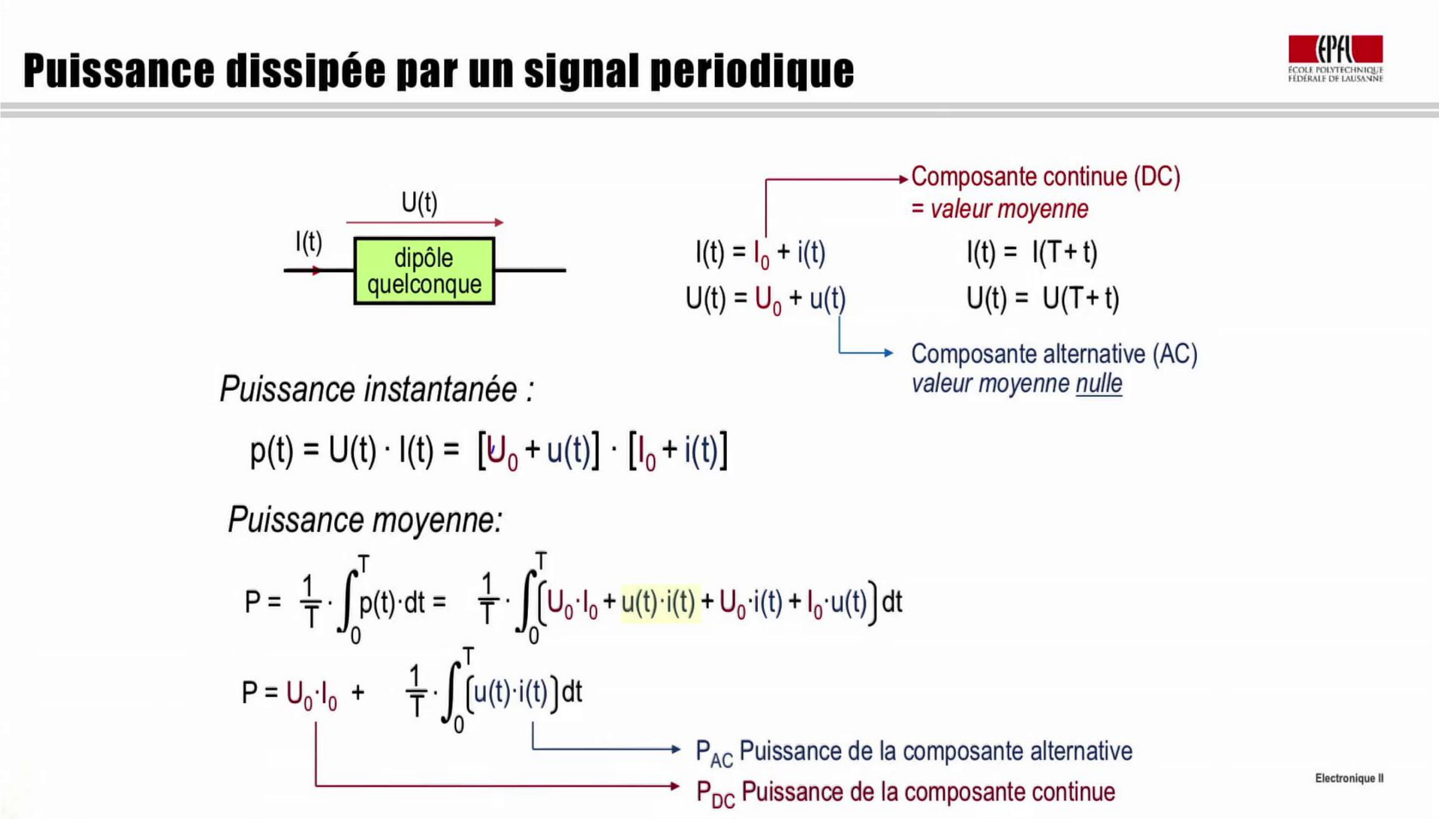


We will start by analyzing the power dissipated by a periodic signal. You take a charge this charge could be a speaker if we speak of an audio amplifier or it could be something else. It is a resistive, inductive, or capacitive charge and if you look at the voltage and current that goes through and you analyze the expression of current and voltage given that in the amplifiers we'll polarize certain types of amp therefore there will be a DC component whose average value is zero. There will be also an AC component whose average value is zero. So I used the color red to identify what is in DC and I used the color blue to talk about AC components. The expression for the instantaneous power is the product of U(t) x U(t). I'll multiply this by this and here is the multiplication result. We can talk about the average power of a signal which is composed of a voltage and a current containing a DC portion, AC portion and here the expression of the average power, is the integral between 0 and T over a period of the instant term multiplied by 1 / T. So you develop this multiplication and you will end up with these terms. I put in yellow what I want, it is the useful power in my charge.

Notes

Summary

0m 35s

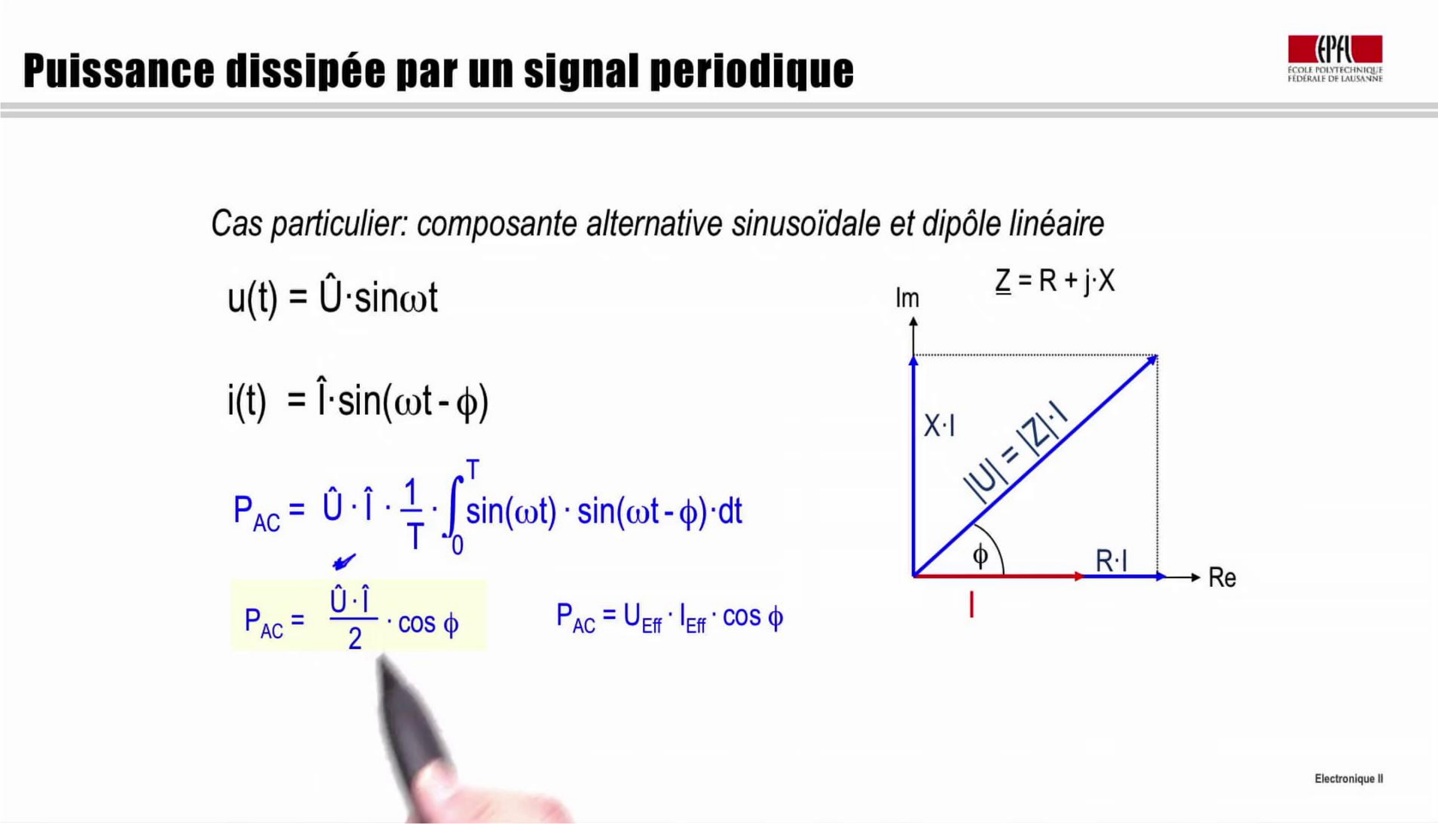


So it is that which corresponds to the AC portion. you will find a component U0 I0 which is the product of two DC parts. The current continues in the charge, DC voltage at the edge of the charge which will be called the DC power in the DC nature charge and we will find the useful component, that I mentioned just now, so it is this U (t) × I (t). Of course this is zero, that is zero because the component, the integral over one period of a component whose average value is zero is zero. So we will end up with an average power and this average power is the one that we'll use and it is composed of a DC portion and an AC portion.

Notes

Summary

2m 13s



Just to remind the expression of an average power dissipated in a charge when it is an excitation voltage of a sinusoidal nature So you remember very well what is called the phasers. So we'll present this component U (t) I (t) in a charge which might be such inductive, capacitive nature, or which contains the two components or resistive. So it has an imaginary part, a real part and the AC power into a charge like this we saw it is the average value of a sinusoidal component so it's peak u, peak i multiplied by 1 / T and ∫ 0 to T of sin(ωt), sin (ωt-Φ). I asked for a sinusoidal voltage having a phi phase the power A to C which is the peak u, peak i of 2 and I marked it in yellow. Of course we can write the same thing as Ueff, Ieff, cosΦ but we will see all the time the peak u, peak i appearring for a simple reason that it is an amplifier, just now when we will achieve it, with components based on transistors. We are interested in the peak value, we will especially talk of the peak value because that is the value that will show when the signal saturates or blocks. When it is a sinusoidal voltage we will see that the sinusoidal voltage will be capped. So we talk quite often in these...

Notes

Summary

3m 01s

Puissance dissipée par un signal periodique

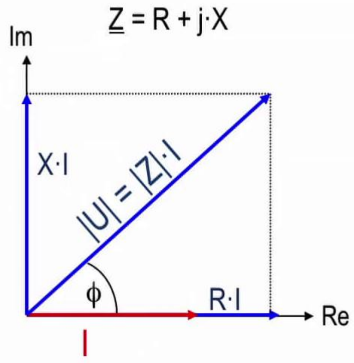
Cas particulier: composante alternative sinusoïdale et dipôle linéaire

$$u(t) = \hat{U} \cdot \sin\omega t$$

$$i(t) = \hat{I} \cdot \sin(\omega t - \phi)$$

$$P_{AC} = \hat{U} \cdot \hat{I} \cdot \frac{1}{T} \cdot \int_0^T \sin(\omega t) \cdot \sin(\omega t - \phi) \cdot dt$$

$$P_{AC} = \frac{\hat{U} \cdot \hat{I}}{2} \cdot \cos\phi \qquad P_{AC} = U_{Eff} \cdot I_{Eff} \cdot \cos\phi$$



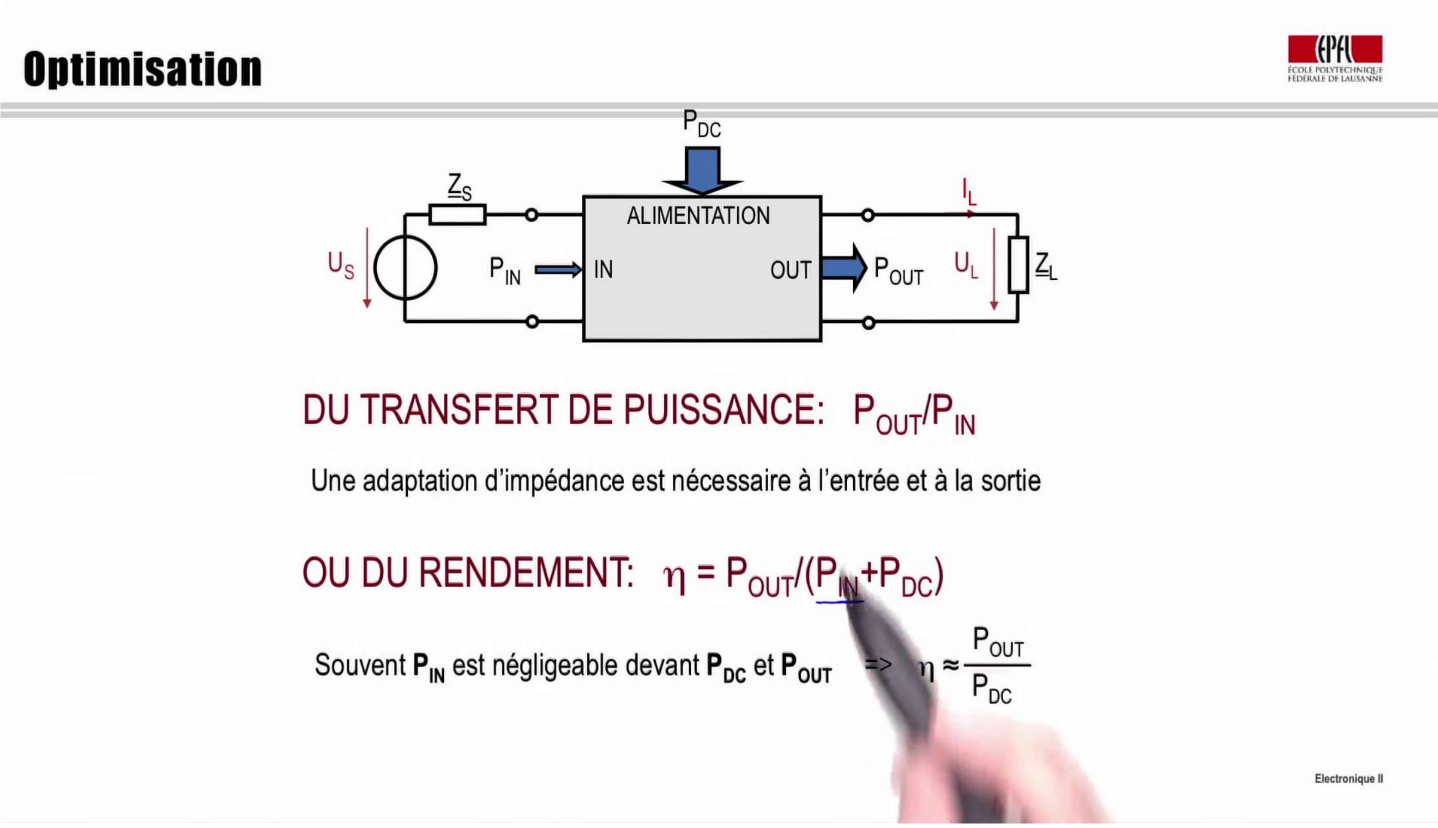
Electronique II

cases of amplifiers of the peak value than the efficient values for understanding reasons of signal dynamics at the exit. But we will understand it better later when I talk of a transistor patterns.

Notes

Summary

4m 35s



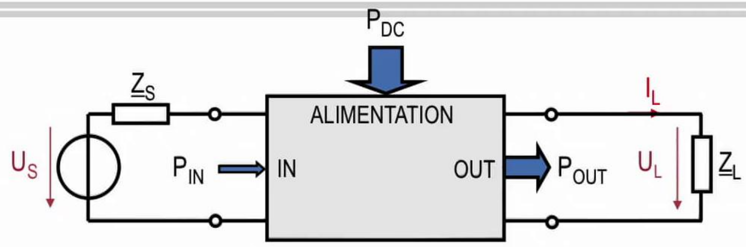
When analyzing an amplifier always talk about this concept of optimization. will optimize what? Well we will optimize the power that we will draw compared to the power that we will lose You know very well if you take a quadrupole and you say "I have an amplifier inside" you will it power it by a DC voltage coming from a supply. You will bring a signal and send back this and if you speak of a charge on this side. the power that will go to the charge is a component which must be very accurate with respect to the input signal but amplified in power whose power comes from the DC. We will talk all the time about yield. What is it that we had to give in there and what had we to remove out and what was lost? So the yield is expressed as the output power divided by the input power plus the DC power that the power supply gave. Quite often DC power, it pardons the input power with respect to the DC power this is supposed to be 3 times nothing because usually the power is amplified hence the title power amplifier. So, the component here is the greatest of the two which is the smallest relative to the two and generally, if you take a signal here whose power is very low we can neglect it with respect to this power which is supposed to provide us the component that must exceed these two things and there is power that we will lose that will come from the DC power.

Notes

Summary

4m 49s

Optimisation



DU TRANSFERT DE PUISSANCE: P_{OUT}/P_{IN}

Une adaptation d'impédance est nécessaire à l'entrée et à la sortie

OU DU RENDEMENT: $\eta = P_{OUT}/(P_{IN}+P_{DC})$

Souvent $\mathbf{P_{IN}}$ est négligeable devant $\mathbf{P_{DC}}$ et $\mathbf{P_{OUT}}$ => $\eta \approx \frac{P_{OUT}}{P_{DC}}$

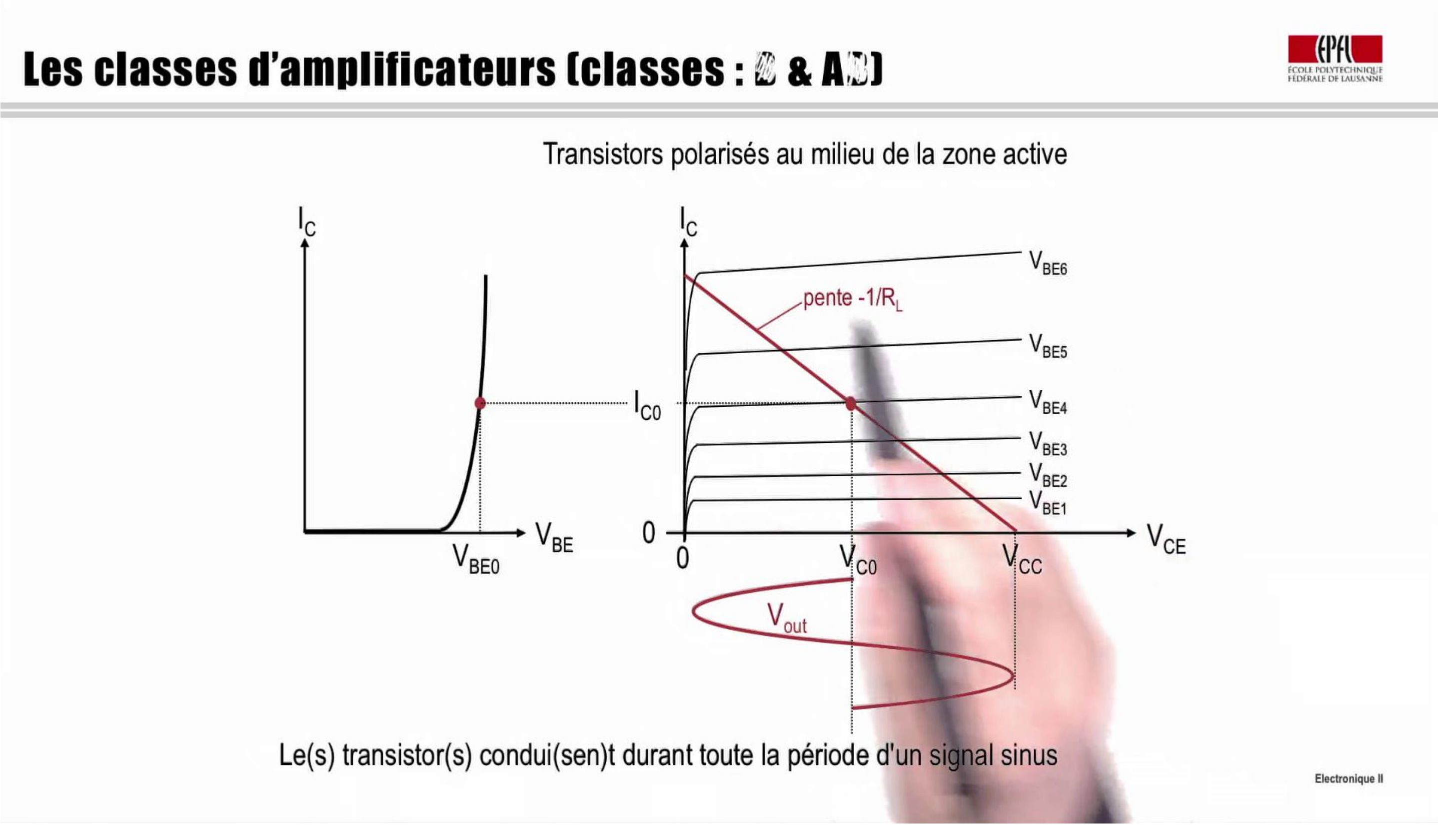
Electronique II

So in return this is what came out as power compared to what was given in the supply. So this, we will come back to it everytime and comment on it for these different types of amp that we'll see.

Notes

Summary

6m 27s

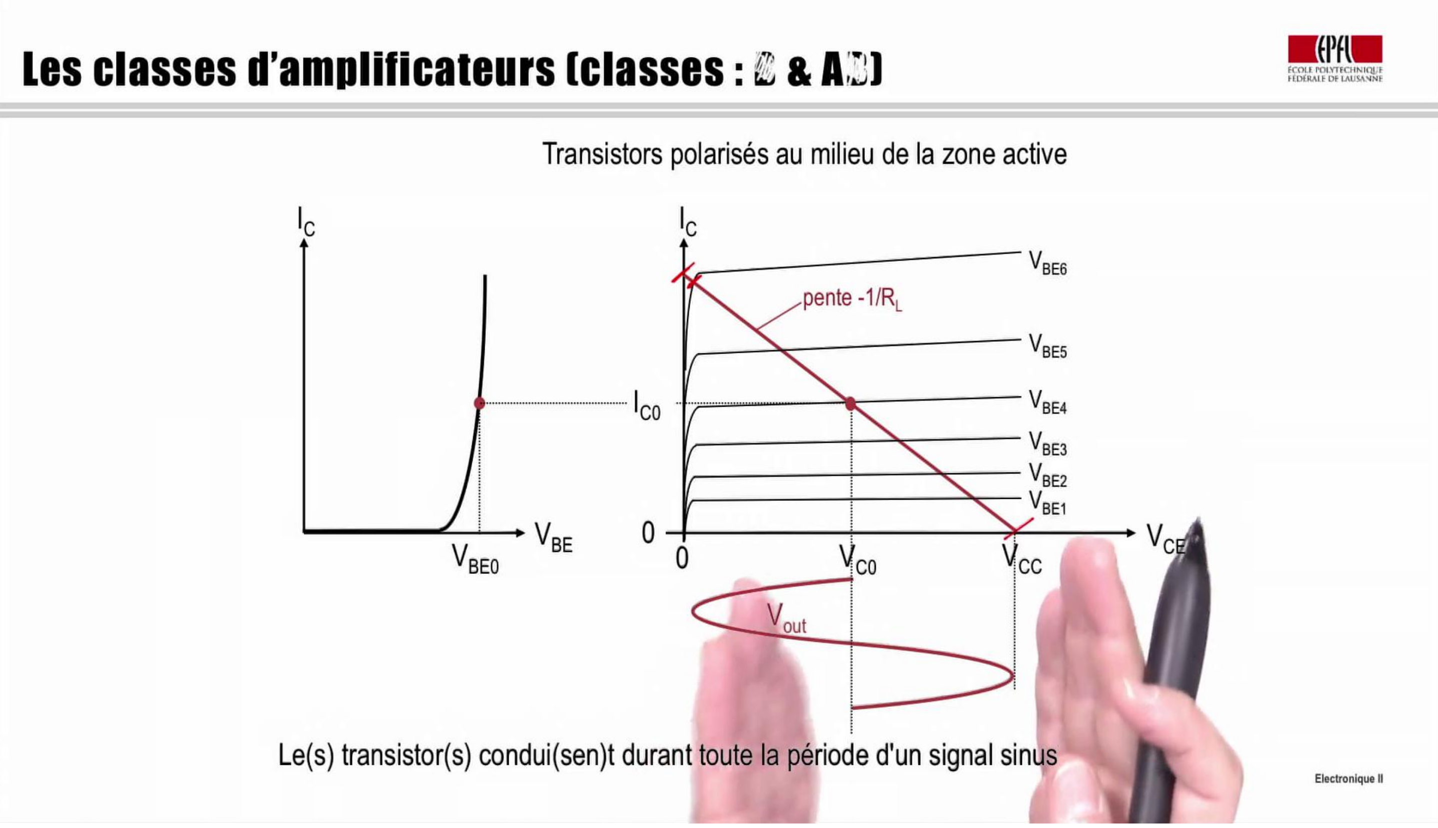


We will define what is called the amplifier class. And I will talk of classes A to start. In the title there is an error. So we will not speak of class B, we will rather speak of class so I erase this. We are talking of classes A and immediately afterwards we will talk of class B and AB classes. The definition of a class A amplifier this is an amplifier when you take the non-linear component a transistor it can be any type of transistor Bipolar, MOS, or otherwise. We have an output current and a control voltage. If your transistor conducts throughout the period of a signal you can speak of a class A amplifier That is, your transistor, you need to polarize it. You must apply a DC component. And then when you make a change in the control voltage of this transistor you will see that your transistor will never or saturate or block, so it will stay all the time in this conversion characteristic voltage - current. And it will never come into blockage. So it is called the conduct transistor throughout the signal period. And if you look at it at the exit you look at the current that you can put in your charge, that's the charge line, which has a slope 1 / RL with a negative sign in front and you see these different characteristics which are controlled by the UBE.

Notes

Summary

6m 38s



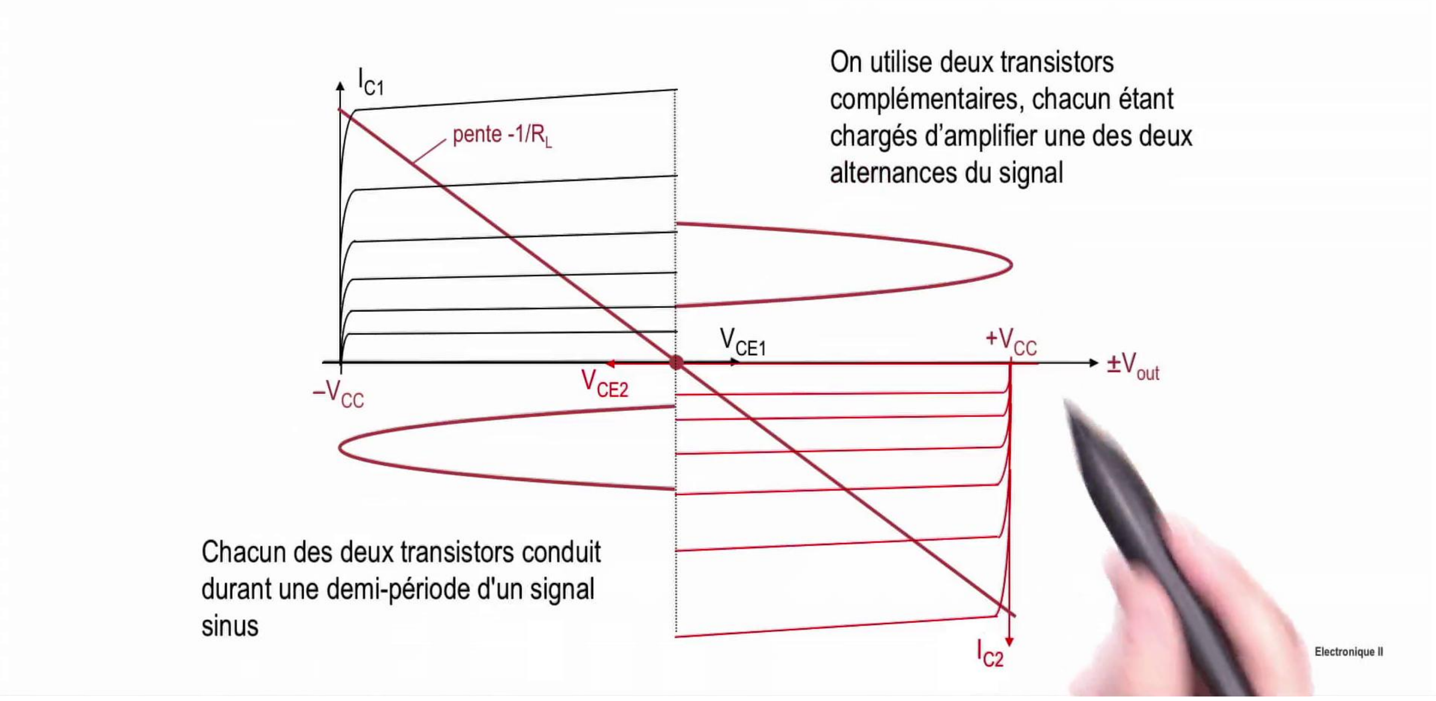
So you have the UBE which varies here and you will see that this UBE which varies and here we will see a current which is sent to the charge and that linearity is expressed. This is when the transistor blocks. And here is when the transistor saturates. So if we neglect saturation one can very well speak of a dynamic which is equal to the supply voltage so we will be able to say that a signal if we polarized the transistor well that is to say, we placed our DC component on the DC output voltage In the middle of the charge graph as follows we will have a positive alternation exactly equal to this alternation of the other side. And all this without ever blocking the transistor or saturating it. This is the blocking here of your transistor and saturation if this is the blockage this, will be almost here, we will consider it here so we will talk about saturation here and we will talk about a dynamic that is equal to VCC of 0 to VCC. And we'll talk about half of the dynamic if we really polarized in the middle of the charge graph When we speak of a class B amplifier here, the data is another transistor or just going to be especially transistors that will conduct or conduct during a half period of a sinus signal.

Notes

Summary

8m 07s

Les classes d'amplificateurs (classes : B & AB)



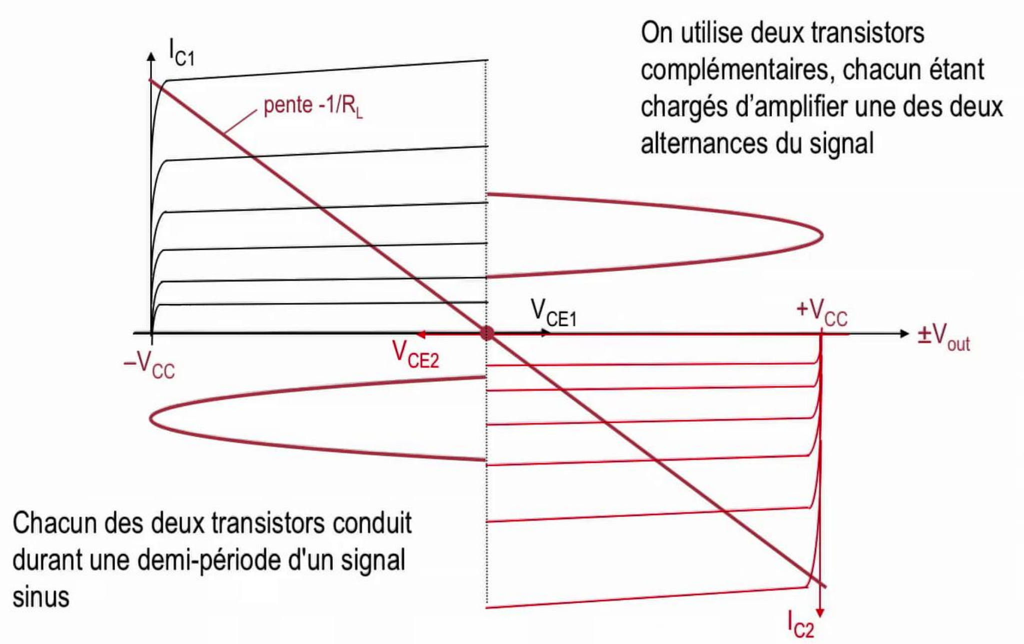
What we will do is that we will place the transistor when the transistor is off and each time there is a positive half one we'll conduct and we need another transistor to make it conduct for the negative alternation. So we stand around zero here we will say that the transistor will conduct only in a period and again we will have a problem of the transistor blocking between here and there before starting to conduct then we will have a distortion of the signal and that's why we talk of a Class B amplifier whose expression is really one that is written there: the transistors conduct during a half period of a signal and they are blocked for for a better part of their characteristic and they will conduct after and then we will need another transistor which conducts for the other alternately and here we will talk about two complementary types of transistors and we'll see right away that it is a push-pull setup. So here is the characteristic of a class B amplifier We will see that when we talk about AB is that we added inside a little bit of component A that is to say we polarized the transistor slightly for this transistor to block correctly.

Notes

Summary

9m 38s

Les classes d'amplificateurs (classes : B & AB)

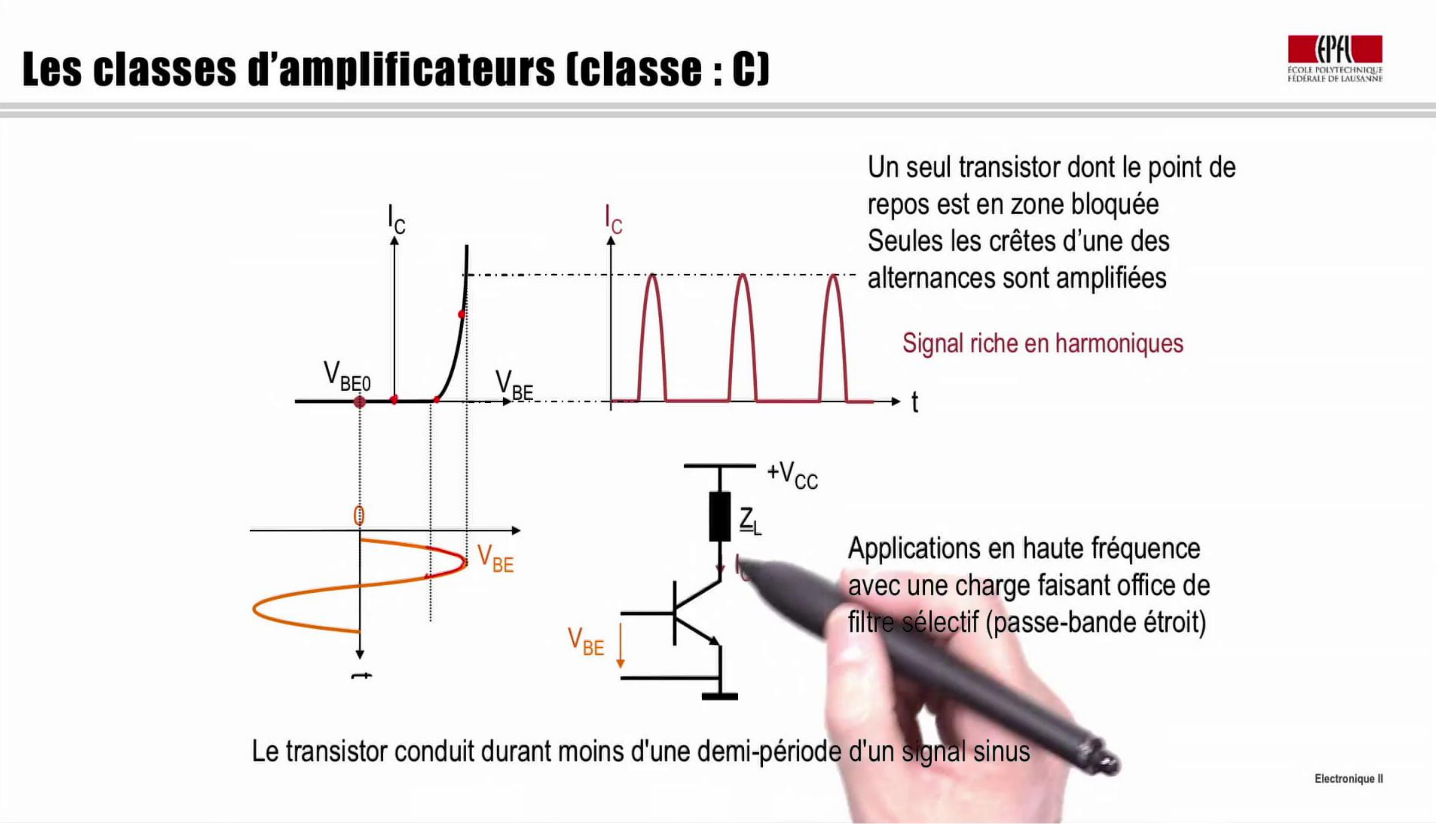


But it is close to blocking and very little polarized, absolutely not like the class A amplifier where we made the transistor conduct throughout. So here we see the two characteristics of a transistor and another transistor where one will conduct in alternation in this direction and the other for the other alternation and we see that there are two transistors and it will be our famous push-pull setup.

Notes

Summary

11m 00s



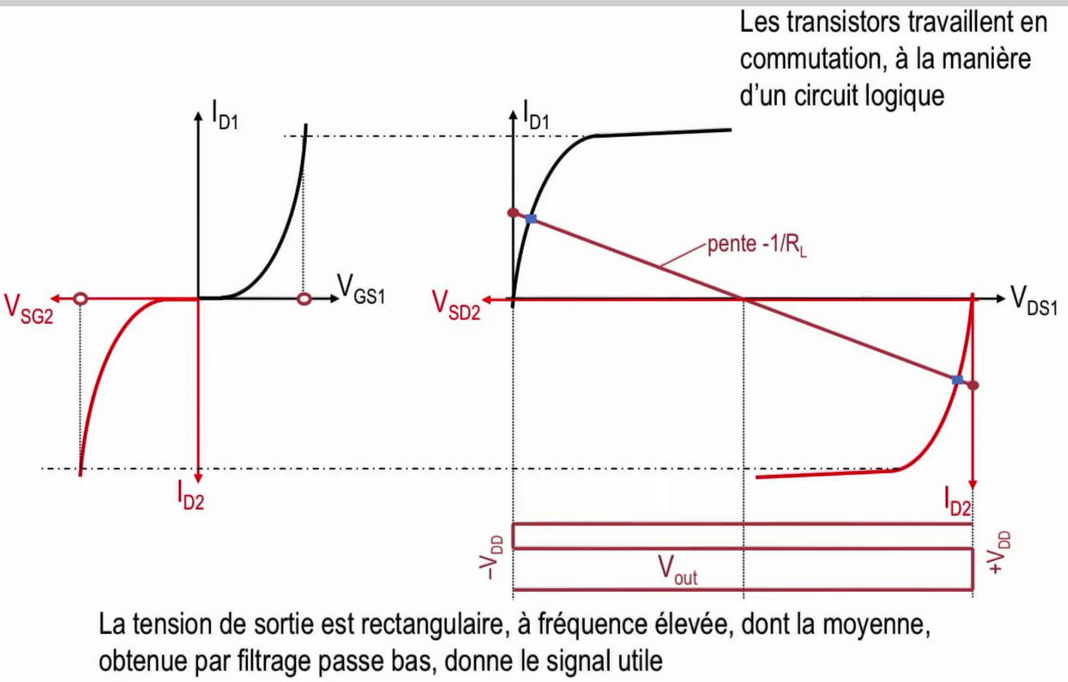
Look at what is a class C amplifier So typically the amp A and Class A and class B could have been used to make the audio. Here we are talking about a rather special amplifier. I will read the expression: the transistor conducts for less than a half period of a signal. So if the class A amp was polarized here, if the Class B amp was polarized here, the class A amp, it was polarized here the Class C amplifier is polarized when the transistor is really blocked is seriously blocked and it will simply conduct, look when it will conduct just for the small spikes if I talk of a sinusoidal voltage. Your transistor is blocked all along and whenever there is a small alternation going from here to there your transistor will send a current to the output. So we will find current peaks that will happen just during what we call an opening angle of our transistor that is to say it is a tiny bit but it is adjusted with your generated signal. If it is a periodic signal we will filter the signal. So if you put a selective filter, if your charge is an LC type resonant circuit you'll have your filter thanks to this impedance which is a narrow band pass filter or resonant circuit.

Notes

Summary

11m 25s

Les classes d'amplificateurs (classe : D)



You'll just have a voltage corresponding to a voltage which is synchronous with the fundamental frequency of your signal. So that brings us to certain types of amplifiers typically used in RF amplifiers or high frequency with a quite specific charge of LC filter type. So these amplifiers will not be considered as part of what we'll do in this video and in the following video. But this is typical of the amplifiers used in high frequency circuits. The class D amplifier we will read this sentence below: the voltage out is rectangular at high frequency whose average obtained by low-pass filtering in the useful signal. That means, it's not a linear amplifier, so we will not take Y = AX because we will first pick the transistor or two transistors and we will each be in the part where the transistor does not behave as a current source. So we will each time push the transistor to saturation. It will no longer function as a switch. So we block it and saturate it, we block and saturate it. And when we do this with a transistor it will give us a square signal according to what we control with. So the output voltage is a signal like the one you see here it is rectangular. and we will use this kind of installation to do the signal modulation. I will give an example right away.

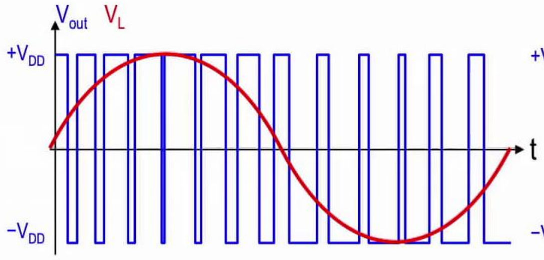
Notes

Summary

12m 54s

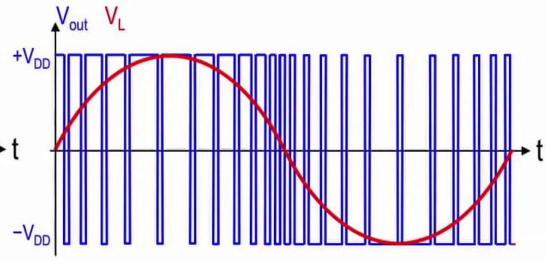
Les classes d'amplificateurs (classe : D)

Les transistors travaillent en commutation, à la manière d'un circuit logique.
La tension de sortie est rectangulaire, à fréquence élevée, dont la moyenne, obtenue par filtrage passe bas, donne le signal utile



PWM

Fréquence fixe, rapport cyclique proportionnel à V_{in}



Δ-Σ

Impulsions de durée fixe, densité temporelle proportionnelle à V_{in}

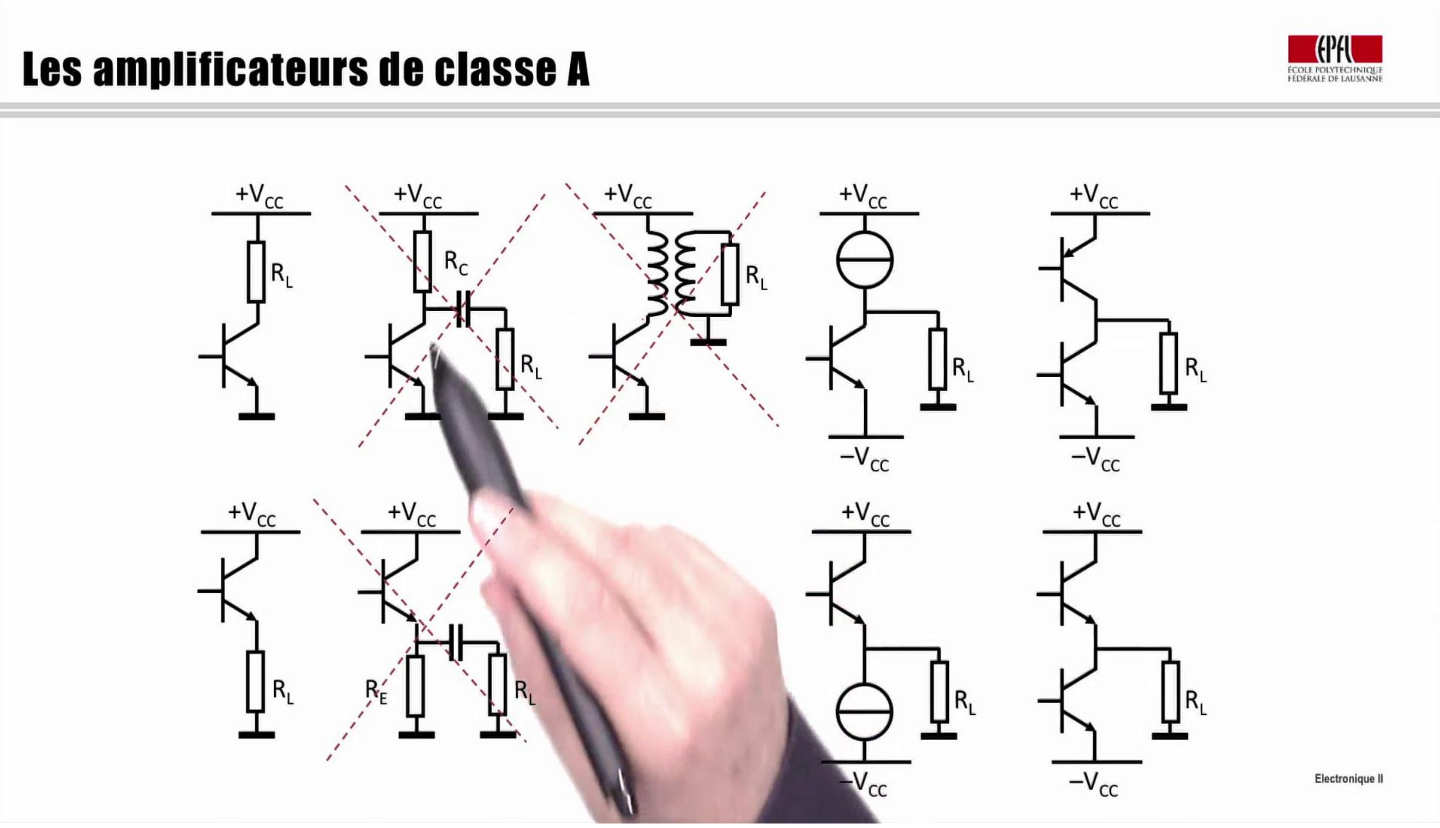
Electronique II

Here is an example. I took a signal modulated by the PWM that is to say it is a pulse width modulation. If you take a square sign, you modulate in PWM, you pass it through a filter, which is in blue which is a signal of rectangular type, if you filter by low-pass you will see what is in red. And that will give you your desired signal. If this is an audio signal and the signal that appears with the blue is a modulated signal PWM and you filter you get your audio signal. The efficiency of such a setup is extremely high compared to the returns that we know. Unfortunately our blue signal is a signal which is rectangular in nature and that risks keeping still some harmonies and which requires a fairly specific filter and the higher the power the more it is a passive filter of a dimensional nature to have a useful signal in red unique to what was in the carrier that we put in the PWM. You can of course use a ΣΔ where the width of the pulses are fixed duration. This is the temporal density therefore we see here by the zero crossing more pulse is seen that when the signal passes through the maximum. It is a type of modulation you will study in other types of courses. Nevertheless this amp either we will not study it under this course, we will focus on class A amplifiers, Class AB amplifiers, and B.

Notes

Summary

14m 26s

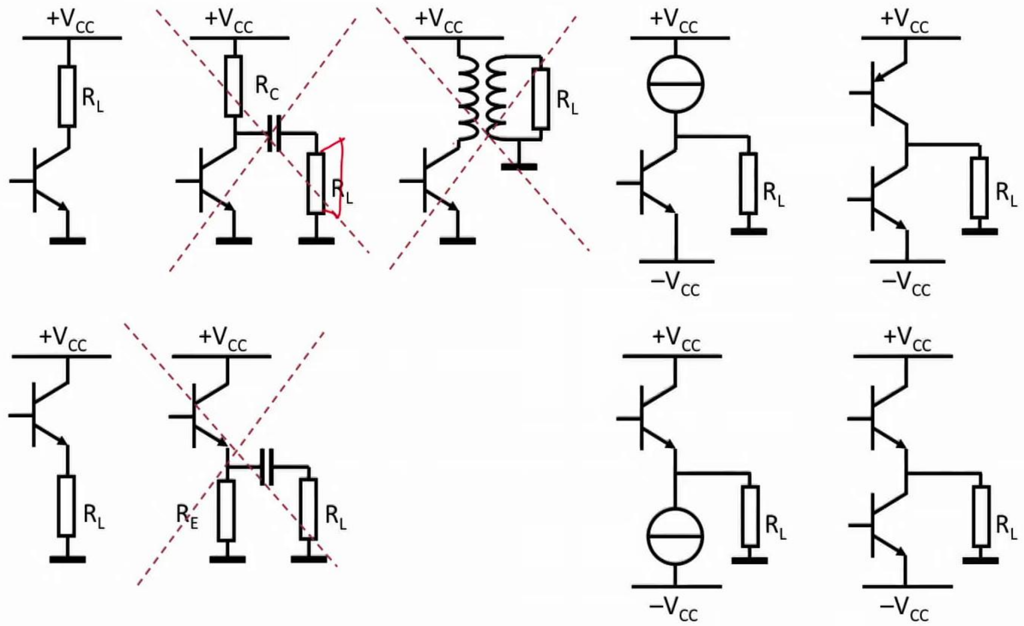


I'll start with the class A amplifiers A class A amplifier is what we studied for the whole series of this courses that is to say we took a transistor and we polarized it. If I take the common transmitter We used the common transmitter with a resistive charge in the collector but the common collector, resistive charge in the transmitter or a charge of no other nature than resistive. We used the same assembl for decoupling the DC component. We put a coupling capacitor and we put the charge on the other side so that there is no direct current flowing through it. Similar: common transmitter, common collector. We did not study the inductive charge where a transformer is placed where in terms of DC, the connector of this transistor is connected directly here in terms of AC it is the current change in that will inductively couple in the other self or the other part of the transformer a variable signal that will be on the resistance. So I will not talk about this because we will try to focus primarily on audio amplifiers. It's very bad in terms of audio amplifiers because if you put a speaker here, instead of this it's true that you have decoupled the component continue but remember that your charge from the AC perspective is in parallel with this resistor.

Notes

Summary

16m 05s

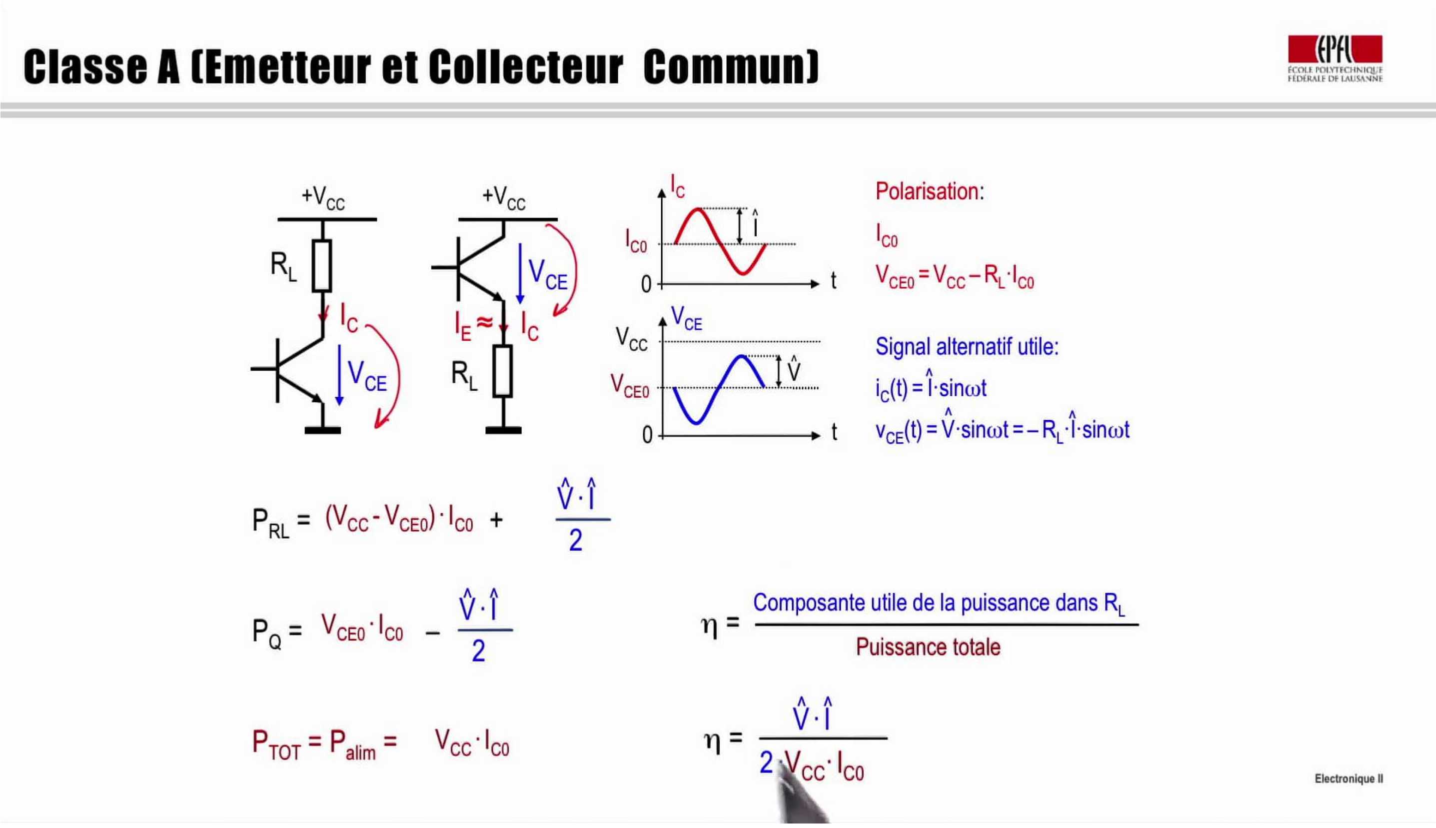


So you're going to have an AC component also in this resistance but doesn't correspond to a sound coming out of a speaker but again you will have a sound in the speaker but which part of it has been lost in this resistor which serves to polarize the transistor. So generally th, we will see that the performance will be better. Here it is used because it has a poor performance. And here it is excellent in terms of performances but as we have not talked of inductive charges and inductive couplings I will not tackle it. However I'll talk about both types of setups because we studied the active loads and we will see that to win the fact that we decouple a loudspeaker when we plug it to a DC node we could do it in this way. That is, we'll take a transistor and then we will put a current source and you can put the current here so like that our speaker has no DC current. So we will study this and this. Of course in common transmitter or common connector. This and this is the realization of this same setup drawn with a real transistor.

Notes

Summary

17m 27s

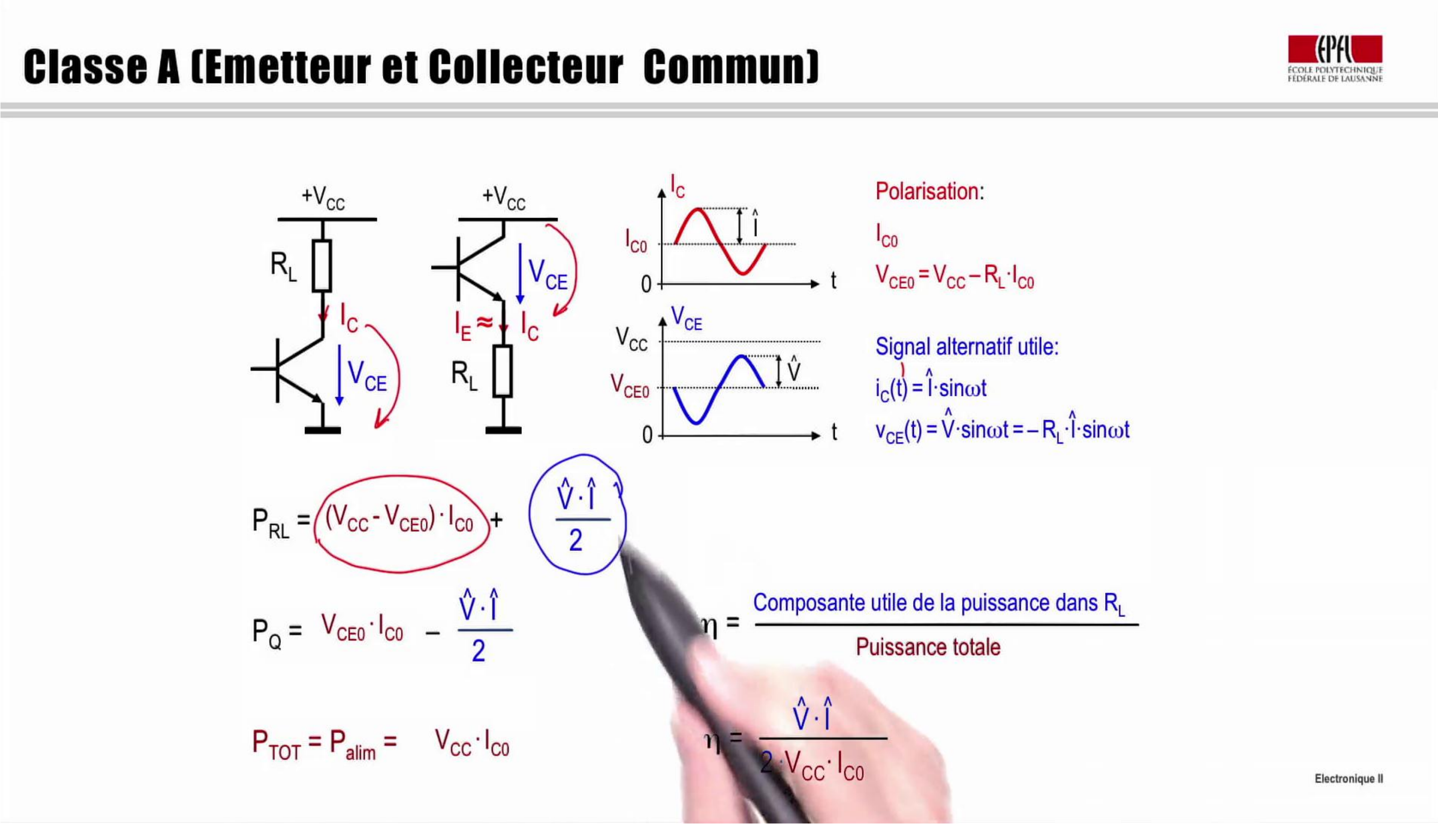


I begin with the class A amplifier So you know very well these two setups. We studied the common transmitter and we brought each time to analysis of the gain and polarization. This time, I will bring our thinking to performance analysis and power that we will send to our charge in relation to what will be injected as signal at the input. So we will think in terms of performance. When you take the common transmitter setup or common connector and you have a signal if this is your charge you always have a DC component that will go through your charge. So the current you see here IC = IC or IE in the common connector will be an average value of any signal you impose So here if you look in terms of polarization you have your load carrying an IC0 current. The voltage that appears UCE0, so this voltage that I see from here to there. Or from here to there. This is the voltage drop IC x RL - VCC is what will remain for VCE. Sorry I had to use the minus sign not in the right place. This is the VCC - ICRL if I have a phase problem. So UCE0 voltage or VCE0 it is the difference of this tension here minus the voltage drop I have on this resistor which is written here.

Notes

Summary

18m 38s

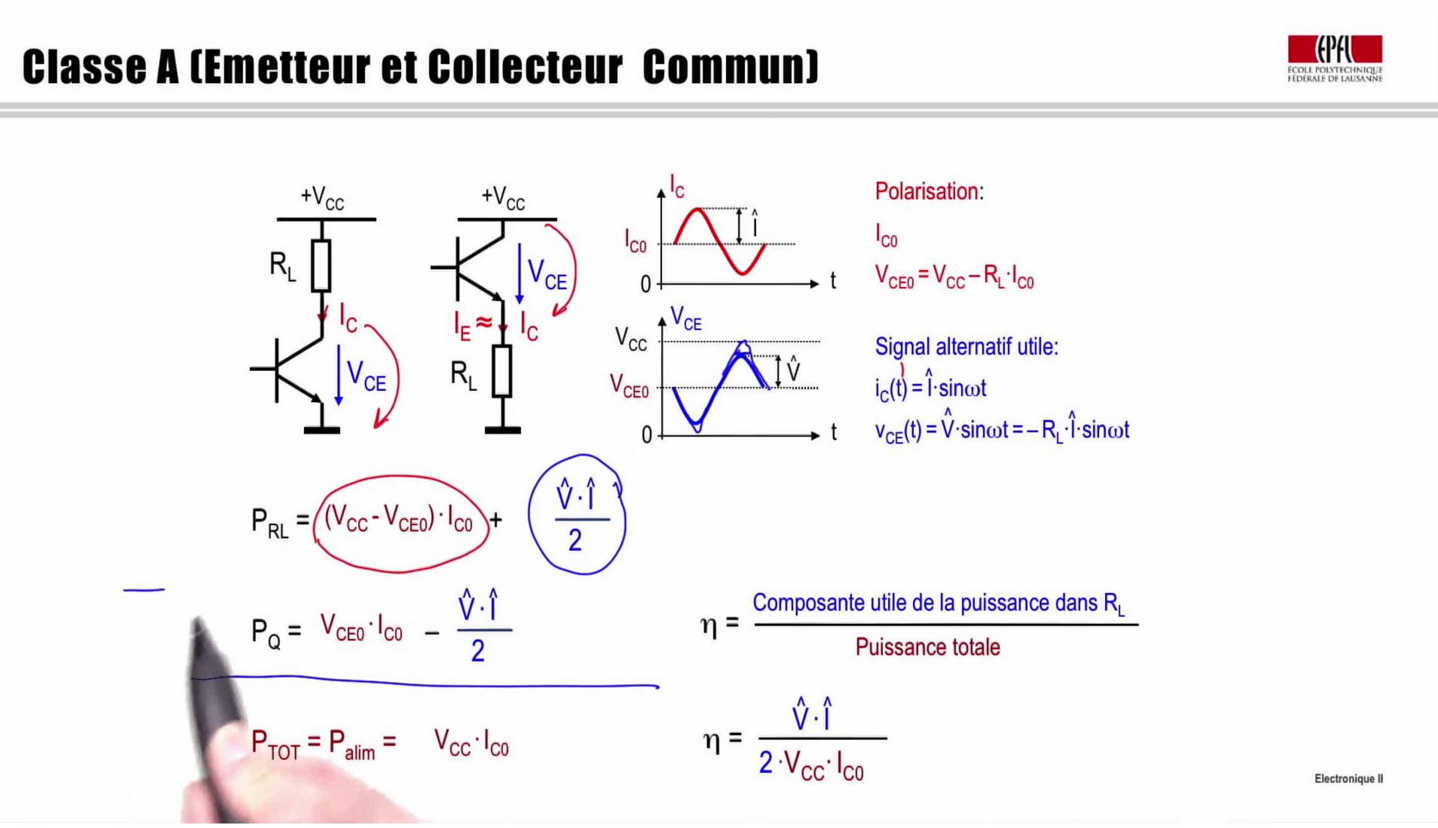


So if you inject a useful alternating signal it is this one, if it was music, it is that you would have heard in your speaker and it is one that will vibrate your speaker membrane. Here you can talk of an increase in current variation a small IC2T current which is equal to peak i, sinωT. The VCE0 voltage is the peak V, sinωT. In other words it is the phase with a minus sign: - RL sinωT when I talk about this setup shown here. So there's a phase inversion with a minus sign. Let's talk about power. It introduced the concept of power and said there is a DC component and there is another component that will likely be of AC nature. The DC component in the charge is the one we just saw here. And the AC component is the peak i sinωT times voltage times current. We said we will do especially watch the peak values, given that cosΦ in this case, is 1. So that's why I do not see it here. So I have peak V times peak i divided by 2. I could talk about the efficient values but we'll talk all the time of peak values because it is this value here that is important to us if we want to see if this voltage is equal to VCC.

Notes

Summary

20m 04s

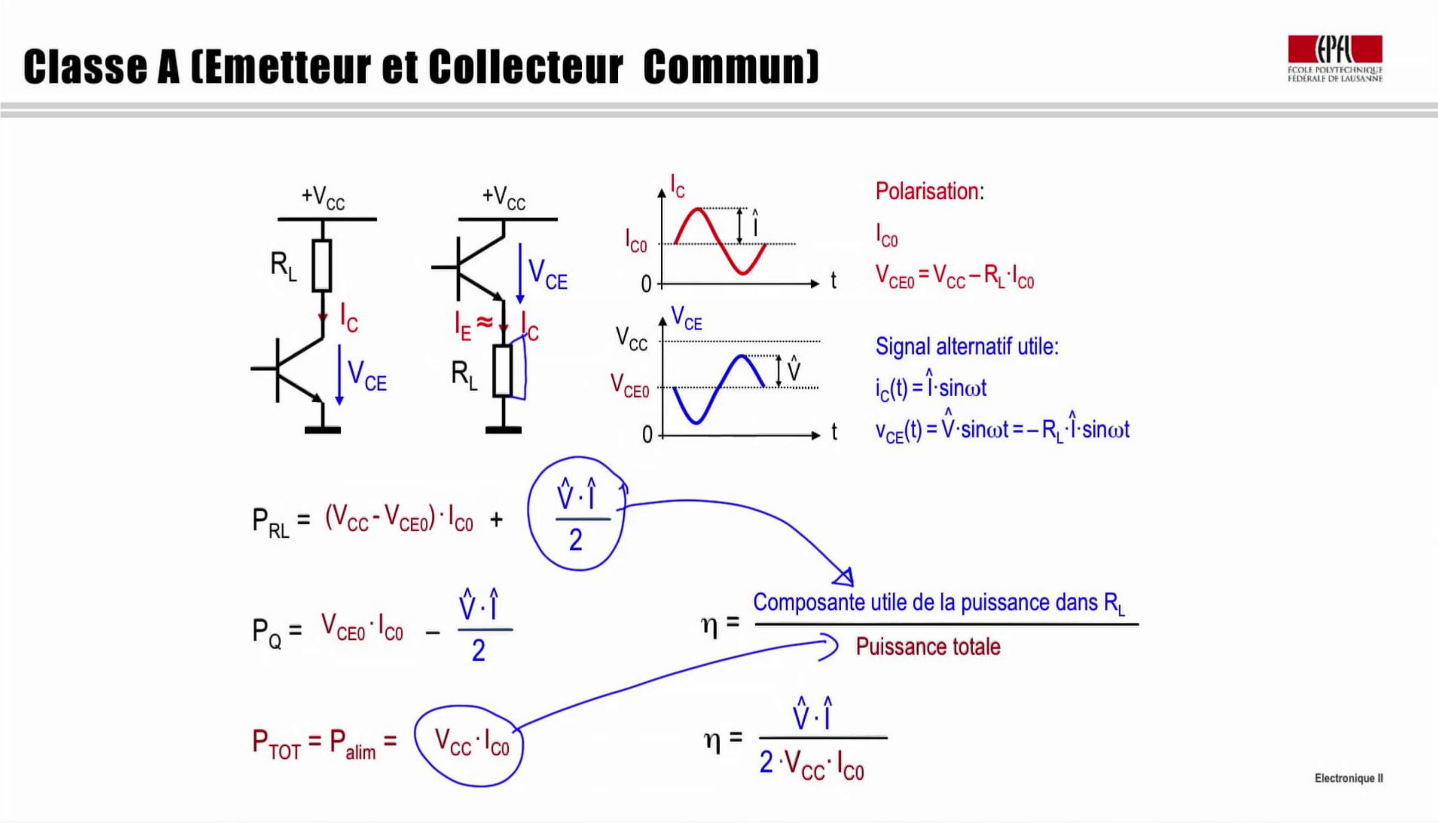


That is to say, the sine goes through a maximum when the transistor is blocked and so it goes through the voltage VCC and when your transistor is saturated that is when VCC = 0 I'll talk about the peak component here. This is why we talk all the time of peak value, because we see the true dynamics. And here it is polarized, that is we put the DC component in the center of the charge graph, we will have a dynamic exactly equal to VCC. In the transistor, as voltage and current are reversed So the minus sign indicates that current and voltage are in a reverse phase, and I see it here. It's the same, I'll find the DC component UCE0 at rest multiplied by the current IC0 flowing through the transistor which is the same as in the charge minus the peak i divided by two. The power supply is a voltage IC so the one that is polarization multiplied by the supply rails. In this instance, we have VDC. So we have a total power that the power should provide which is equal to VCC IC0 which is nothing but the sum of these two. If you add these two things, you have that, and a plus sign and a minus sign will disappear so you'll have the -VCE0 IC0 and + VCE0 IC0 it will you keep the VCC IC0 which is here.

Notes

Summary

21m 36s

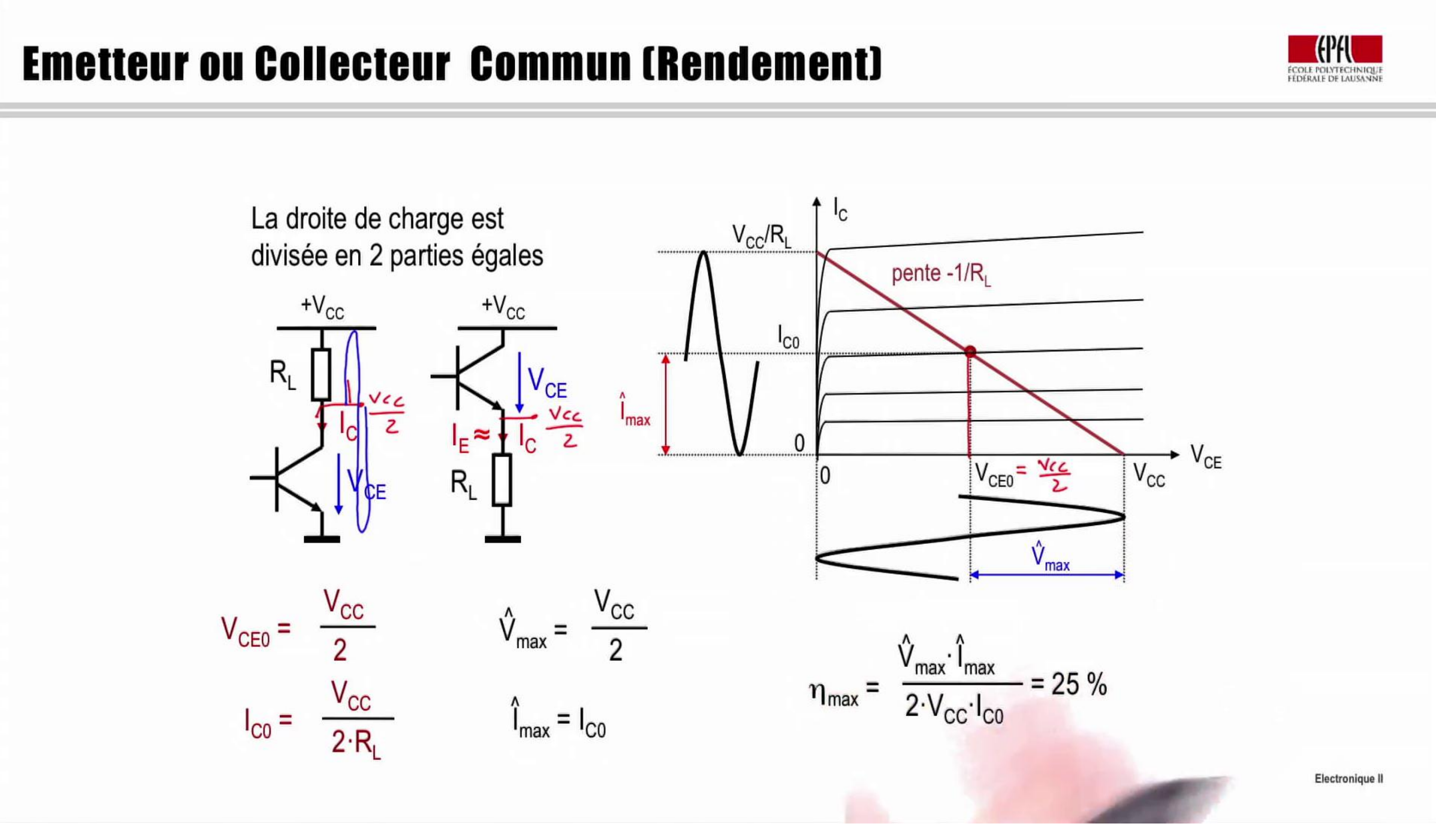


So the power will provide the supply voltage multiplied by the polarized current. Now write, the useful power which is in the charge divided by the total power. So I'll erase everything that I added and here it is. The whole component useful is only this one. That's is the useful power sent to my load. So if you connect a speaker here Your speaker will definitely move the membrane and send the acoustic wave with a power which is equal to the peak multiplied by the peak value divided by two. And it will be the useful component that I will use and I have to divide by the power component. That which comes from the supply So I find the peak V, peak I divided by two divided by the DC component coming from the power supply.

Notes

Summary

23m 05s



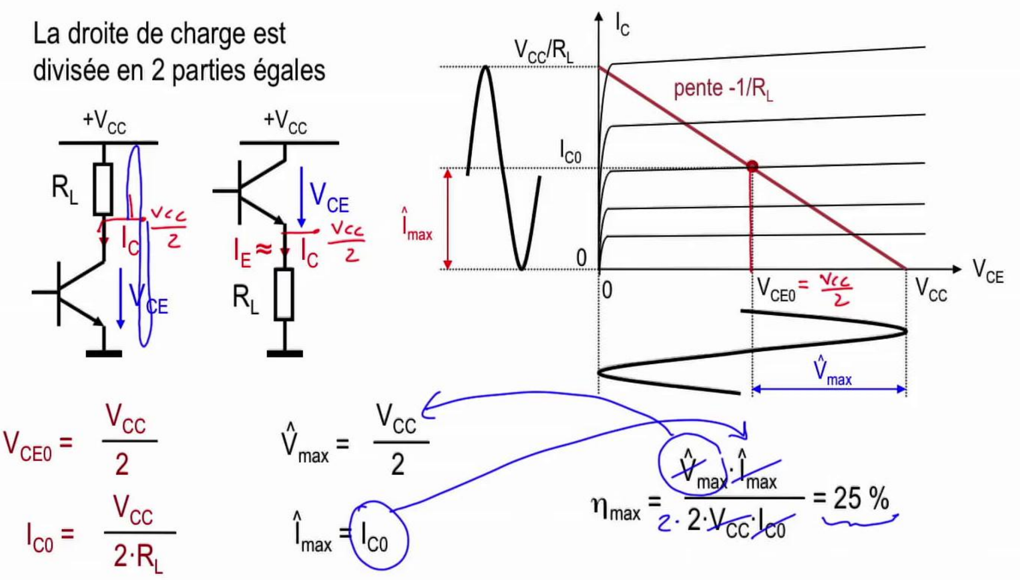
I repeat the same thing just now. Both setups common transmitter and common connector. I put my charge line at the output and I am in the condition where I really have the maximum yield. My performance is greatest when I put my charge line and I impose a polarization in my charge line that is in the middle of my charge line. So I have the positive part, the part where the sinuses goes through an average value which is equal to the voltage VCE0. The positive part of this, the part that goes from VCC until VCE0 is VC0 to 0 will give me a sine which has a peak value Vmax is equal to VCC / 2. So when I apply a polarization equal to VCC / 2 therefore when this node here is at VCC / 2 at rest as here, of course, So here if I am at VCC / 2 I'm sure the dynamic I see at the exit I have to put it in blue, it would be better, So the dynamic rising happens, it hits against the supply voltage here it will go down It will hit against the mass. Here the transistor blocks, here the transistor saturates. And I end up with a dynamic at the exit which is maximum. So I just have to say that at this moment the peak value will be the maximum value of the peak equal to VCC / 2.

Notes

Summary

24m 07s

Emetteur ou Collecteur Commun (Rendement)



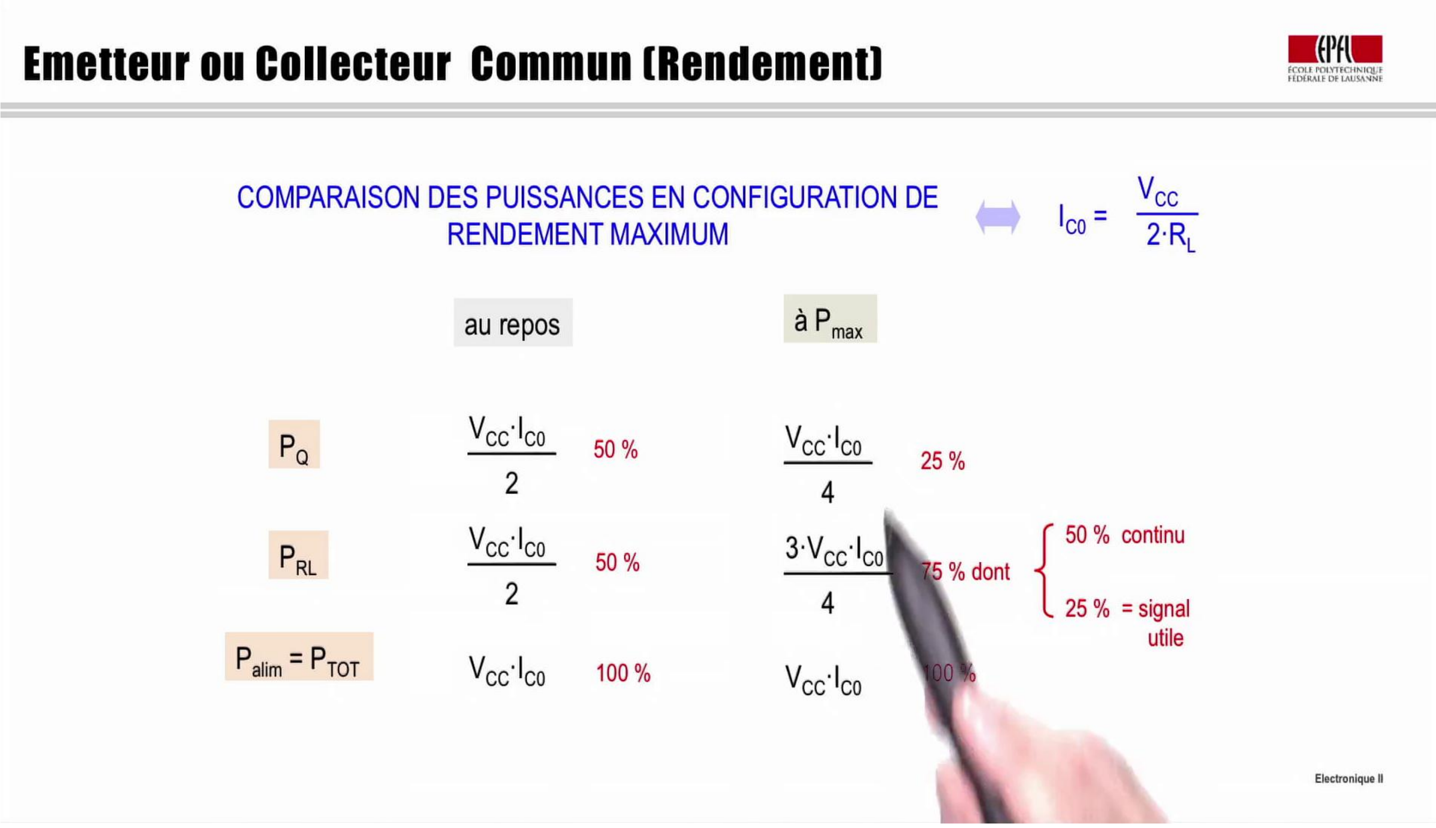
Electronique II

When I polarize the transistor in the middle of the supply rails, it is very important to remember, this is what was said when we learned the concept of dynamics and saw that when the dynamic is maximum when it has the power rails and we move to the middle. And at that moment the expression of our performance I need to replace the Vmax by VCC / 2 and Imax by IC0 and here I simplified this and that, I simplify this and that. And I'll be left with VCC / 2, which would be added here. So I replace VCC / 2, the VCC that is in here I will be left with 1/2 times the 2 that is left here. It gives me 1/4, so 25%. We come to realize that taking a transistor and using it as a common connector which is the ideal class A amplifier and polarizing it correctly in the middle of the charge line gives us a maximum theoretical yield equal to 25% and we can not do better.

Notes

Summary

25m 44s

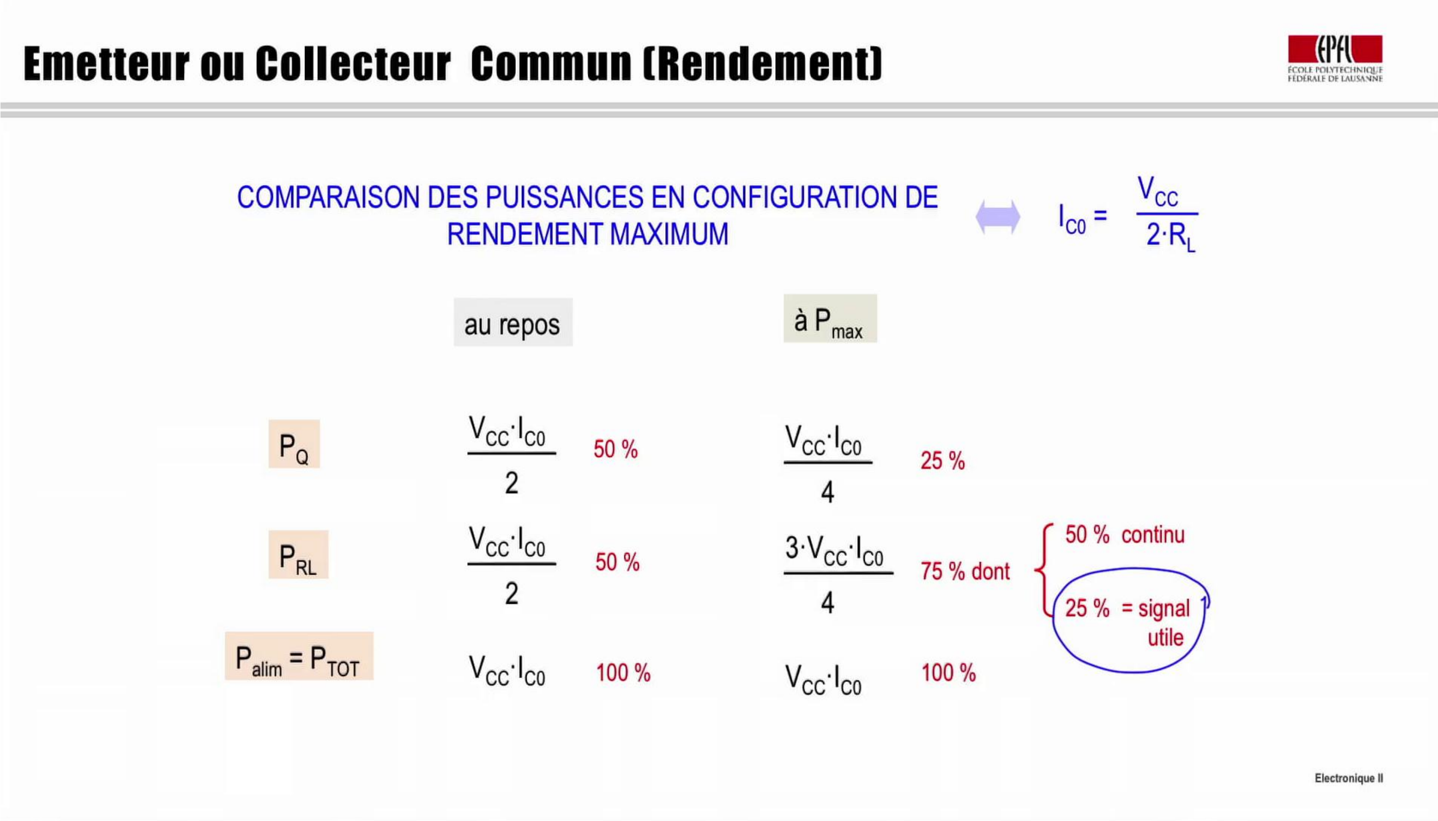


Let's analyze it. So I look at the rest. This is what we concluded earlier. At rest, when I polarize at VCC / 2 so I keep half the of supply voltage shared with my transistor and on my charge. I lost 50% of the components, I have not yet imposed a variable signal so I do not listen to music. As soon as you turn on an amplifier of this nature, you will have in your care a dissipated DC power IC0 of VCC / 2. So your speaker it will move by the current flowing through it and after it remains static in one place but it begins to dissipate this power here. Transistors and charges dissipate the same power at rest. Then you take your signal and we will see what will appears here. We saw the rest, we will look at the maximum power that can be drawn. There is a quarter that was in the transistor that will pass to the charge. So there, in this 50% which was heated in this transistor at rest which becomes the useful component which will add to this DC component that was in the charge. So if you look at what is happening here you can see the useful signal So the AAC component that was in your charge came from the transistor and you'll keep 50% of the DC component in the charge which continues to be dissipated.

Notes

Summary

26m 55s



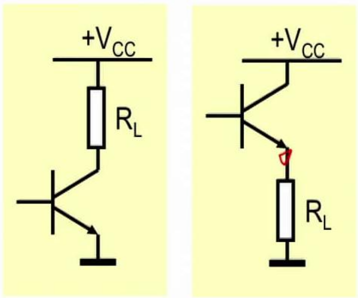
And at that time your transistor it loses some of its DC power because it converted it into AC towards the charge. So we can not do better than 25%. And in practice it is less than this because we need electronics around and remember that a class A amplifier is simply a common collector that is used and would allow a signal to be amplified. And that's the best qualities of amplifiers because the transistor is always conducting and we do not lose the transition from one state to the other of this transistor. But we have all the time a DC component in our speakers and this we do not like it, the speaker do not like it either.

Notes

Summary

28m 35s

Emetteur ou Collecteur Commun (Conclusions)



- Puissance d'alimentation constante
- Rendement maximum de 25%
- La puissance dissipée dans le transistor est maximum au repos, égale à $P_{alim}/2$
- La charge est parcourue en permanence par une composante de courant continu

☹ Inadmissible pour un haut-parleur

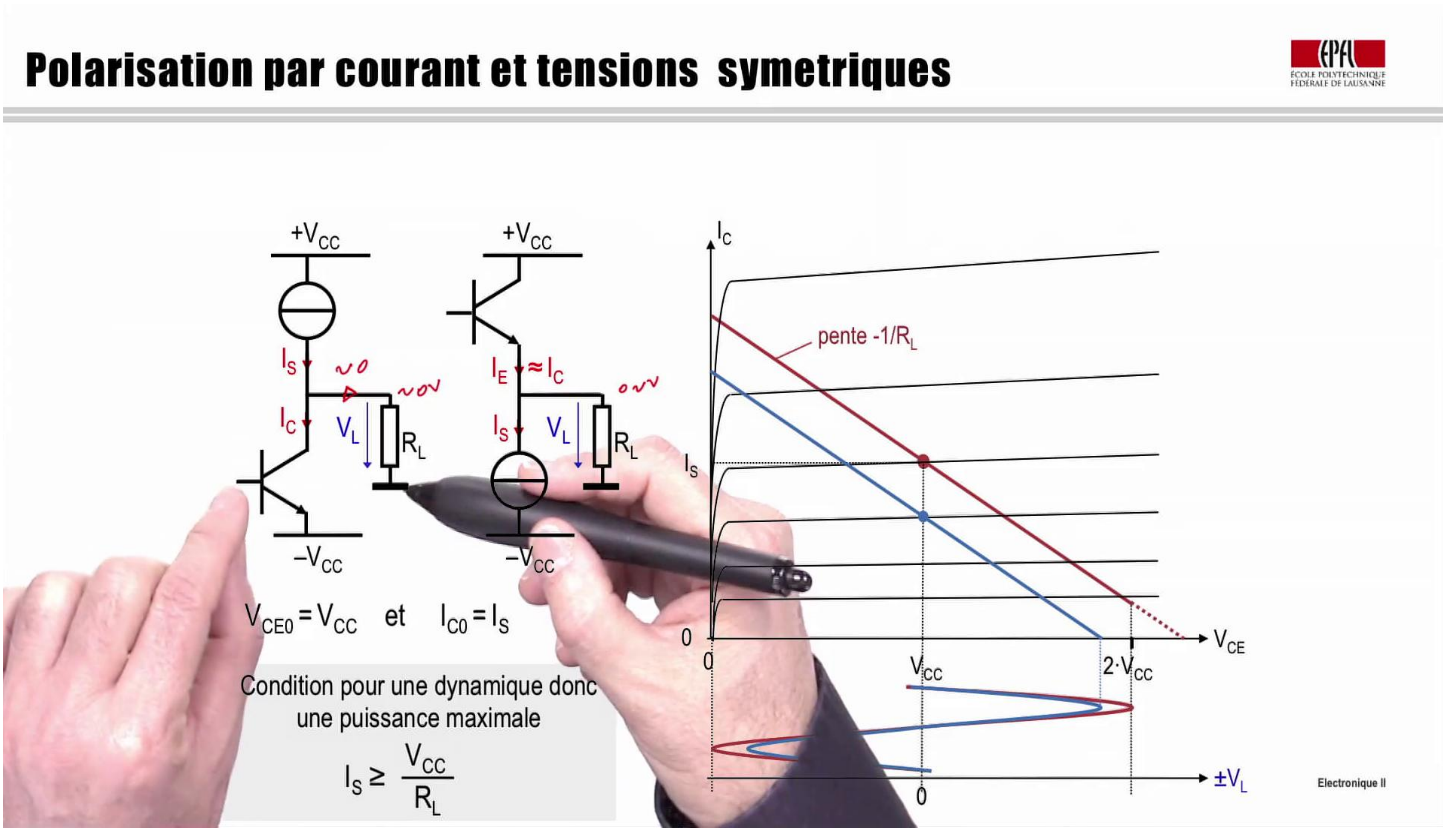
Electronique II

So if I have to comment what we just saw and draw some conclusions we need a constant supply and it is a supply which should provide plenty of power compared with the power that we take on the charge. Because there is 75% of the power that is supplied which will be lost to draw only 25% of the loudspeaker. and all this, the supply that is here unfortunately is providing it all the same. So the power dissipated in the transistor and maximum rest, is equal to the power supply divided by 2 and once you start putting a signal the transistor begins to evacuate the part that was lost as heat because it turns it into a useful charge. And unfortunately there is a DC current which will spend all the time in your load in this kind of installation. And the burden is covered permanently by a continuous current component. Which is unacceptable for a speaker. As we saw, you send a direct current, your speaker moves, and it will remain in this situation with a DC dissipation.

Notes

Summary

29m 18s



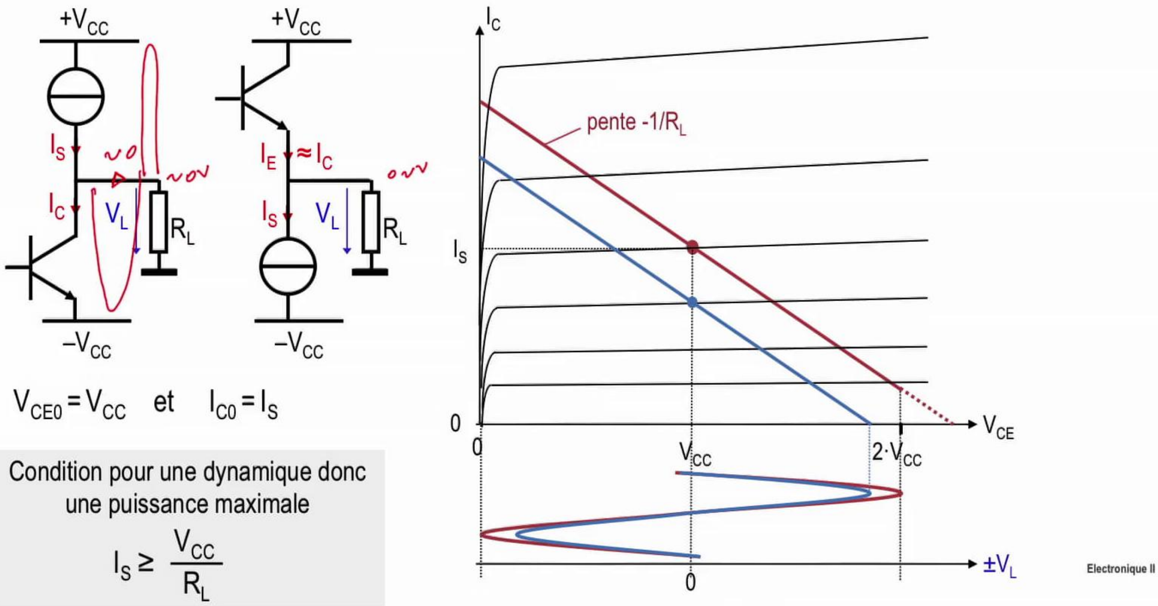
We can remedy this DC history by making a setup where the active filler is used. And here we talk of a polarization current and voltage symmetrical. That is to say, instead of having a supply voltage VCC as earlier we have more or less a VCC. And like that our load, it can be placed at a midpoint. So again at rest we are in the middle of the dynamics. As earlier, but the middle of the dynamics can be polarized to something of the order of magnitude of zero volts. So the charge at rest will be between the mass and something that could be found around zero volts with a little offset. So there can be a current that passes in our charge. So it is always the same idea: half of the dynamics. Because you put VCE0 = VCC. And you keep part of the VC voltage on the speaker. Then you arrange that all the current you polarize with be taken by your transistor so if IS = IC you may well say that there is no polarization current So at rest, the current here in red is approximately equal to zero because all the current will pass like this. After you start changing the voltage So you push this current into the charge when you lower the current IC. So that means that the voltage has dropped.

Notes

Summary

30m 26s

Polarisation par courant et tensions symetriques



$V_{CE0} = V_{CC}$ et $I_{C0} = I_S$

Condition pour une dynamique donc une puissance maximale

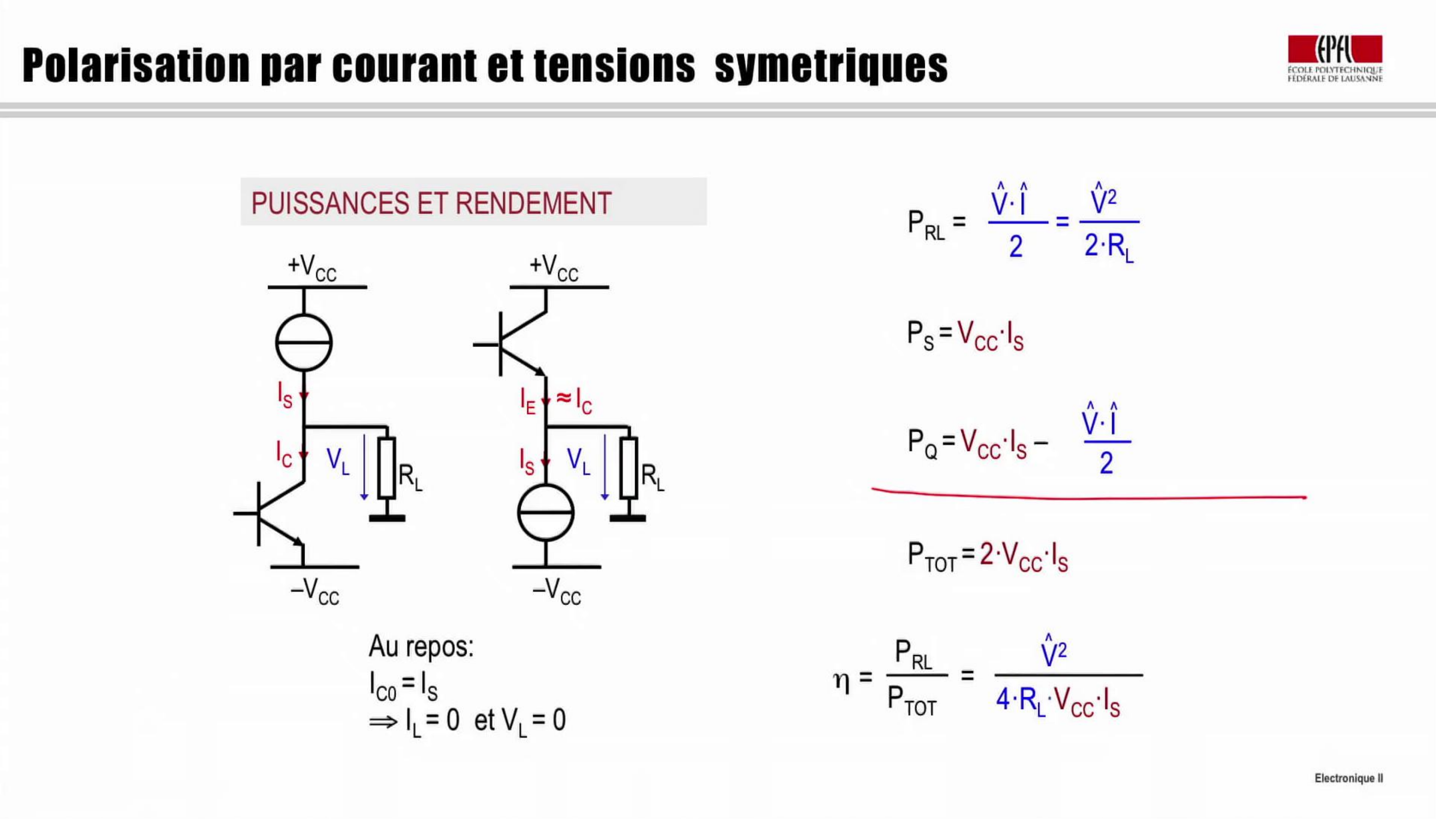
$$I_S \geq \frac{V_{CC}}{R_L}$$

but when you increase the voltage you will draw more current here which exceeds the current IS and which will be taken from the ground and descend via your transistor. So the ideal situation is that if you can make a setup exactly where all the current that is there is equal to the current which is here you arrange to end up with an ICRL = AVCC. That is, at rest, you find yourself with an alternation when all the current passes through the charge the tension rises to VCC. After all when the current is practically passing through the transistor you will lower this alternation here arriving towards -VCC. And like that you have a dynamic that is equal to 2 x VCC. And in practice it takes a little more than 2 x VCC because we need some additional current So there will be a small current to balance the difference of the two currents which is drawn from the charge to be pushed into the charge but we're no longer in the condition of a class A amp where all the polarization current was already in the charge. So we managed by a setup like this to avoid having an excessive DC current especially if this is a loudspeaker.

Notes

Summary

31m 59s



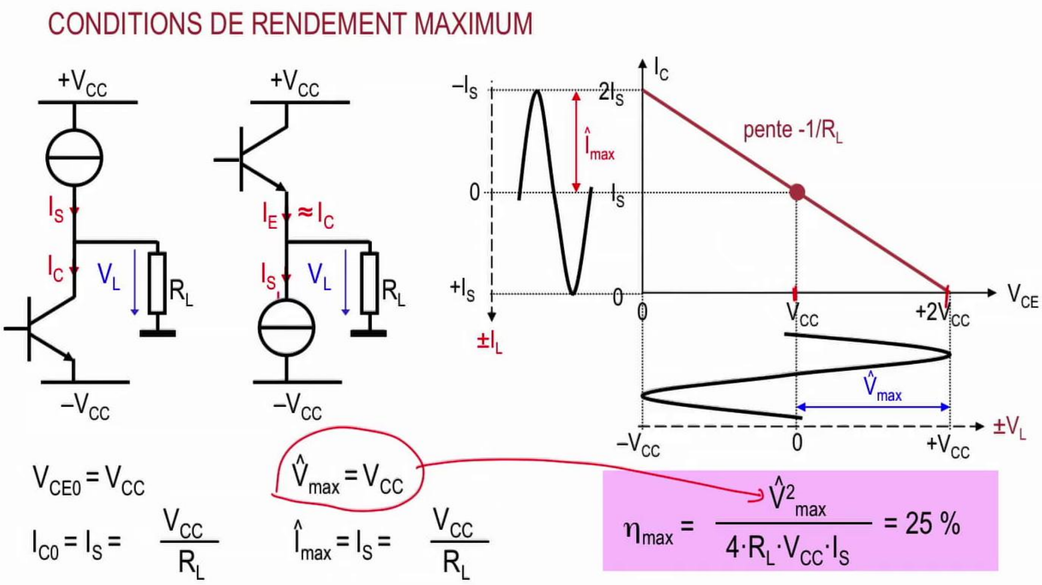
And I want to analyze. I'll analyze as earlier. So in the charge we always have peak v peak i divided by two. So it is V squared divided by times RL. If I replace peak v by peak i in RL. And the power that the supply should have given it should be the total power is the sum of what I will have in the source so it's VCC x IS and the transistor will take the VCC x IS minus what I had in charge the peak v peak i divided by 2. So if you add up what appears here well you will see that the total power is 2VDC times IS. Now you analyze, you do the power in the charge, the peak v on 2RL you replace it here. The total power, this one you fall back to an expression peak v/ 4RL by the DC component which is VCC IC. We will see at once that we did not gain in returns actually we avoided that there be a DC current passing through the speaker and we avoided that this DC current be all the time in a charge that does not like this kind of current. And unfortunately we kept the same performance, normally. Because we multiplied the supply voltage by two.

Notes

Summary

33m 16s

Polarisation par courant et tensions symetriques



Let's analyze this. We are in the same condition as earlier: we want to have maximum dynamic and the maximum dynamic is obtained when we start in the middle of the supply rails. That is, we are between 0 and VCC on one side and 0 and -VCC on the other side and seen here between 0 and -VCC and 0 and VCC. And when you have a signal that shows the variation around VCE we will see that this voltage rises to 2 VCCC and down to -VCC therefore the peak value from here to here is equal to VCC. And that is what is written here. So your peak value is equal to VCC and the maximum current that you can send in your charge is exactly what we said! this current Is that can pass through the charge be pushed in this direction be pulled in that direction so it's VCC / R. You now replace the value of peak V with VCC Here, you will end up with a yield equal to 25% and we will have gained nothing. So you replace the Is by its value and V peak by its value and you end up with a quarter So you end up with a yield of 25%. This is the same returns we got before. Typically, Class A amplifiers are around this kind of setup. That is to say, we take a common manifold a current source is carried out and it is this power source that will provide the current Is that will pass into our transistor; To analyze what we have just seen so we will make a comparison at rest.

Notes

Summary

34m 44s

Polarisation par courant et tensions symetriques

COMPARAISON DES PUISSANCES EN CONFIGURATION DE RENDEMENT MAXIMUM ⟺ $I_S = I_{C0} = \frac{V_{CC}}{R_L}$

	au repos		à P_{max}	
P_Q	$V_{CC} \cdot I_S$	50 %	$\frac{V_{CC} \cdot I_S}{2}$	25 %
P_S	$V_{CC} \cdot I_S$	50 %	$V_{CC} \cdot I_S$	50 %
P_{RL}	0	0 %	$\frac{V_{CC} \cdot I_S}{2}$	25 % = signal utile
$P_{alim} = P_{TOT}$	$2 \cdot V_{CC} \cdot I_S$	100 %	$2 \cdot V_{CC} \cdot I_S$	100 %

Electronique II

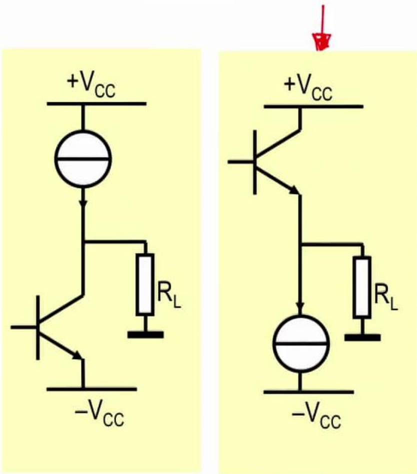
This is the same report as earlier. Remember we added a power source which was not in the pure class A amplifier without an active charge. Here we find that the charge as there is no direct current, so at rest, this we gained over it, there is no more current content. But it added an additional component who took the balance of the DC current which was in the charge. If we now look at what happens when we have an Ac component we will end up with what we had seen earlier: your transistor gives 25% this time it will come from here to there. While having a current source that will continue to lose this DC component which will remain at 50%. And the 25% that the active transistor lost will move into the charge and we find ourselves with a total power of Vcc Is which is the 100% so the sum of everything we see here.

Notes

Summary

36m 29s

Polarisation par courant et tensions symetriques



- Puissance d'alimentation constante
- Rendement maximum de 25%, identique au simple EC ou CC
- Puissance dissipée par le transistor maximum au repos, égale à $P_{alim}/2$, égale à la puissance constante dissipée par la source de courant

☺ Pas de composante continue dans la charge

- Bonne solution pour un ampli audio de classe A, surtout le collecteur commun.

Electronique II

Lets do a small analysis of what has been found with these polarizations with a current source and more VCC - VCC. So we have once again constant supply voltages. This is typically the setup that is used to achieve power amps although this is a class A amp with a common emitter but generally the power levels have voltage followers. Their goal is to boost the current they take from the supply and passes towards the outlet. And above all they have a very low output impedance. because it comes on a transistor emitter. So the yield remains low The power dissipated by the transistor is maximum at rest is equal to the power supply divided by two. And then we can say we gained by this setup compared to the first that is we do not have a DC component in the charge and this is a good solution for a class A audio amplifier especially in common collector, what we just discussed. And you are in the market full of amplifiers which are based on an active transistor which may be a bipolar amplifier, MOS or a tube amplifier that maybe, you do not know because we did not speak of it in this course. But it is still, to this day used in tube amplifiers which are used as active elements.

Notes

Summary

37m 30s

Amplis classe A de forte puissance

EPFL
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

- La tension d'alimentation totale et le courant de repos sont adaptés à la puissance à fournir
- L'étage de sortie est réalisé avec des Darlingtons ou des MOS
- L'étage de sortie est généralement précédé de deux étages :
  - Un étage "driver" qui est un ampli de classe A avec un gain en tension élevé (généralement à charge active). Parmi les variantes possibles:
    - ampli émetteur commun
    - ampli différentiel
    - ampli symétrique à émetteurs communs
  - Un étage d'entrée qui est le plus souvent un ampli différentiel dont la sortie est adaptée à la commande de l'étage driver sélectionné.

Electronique II

And I would like to finish this video with the following conclusions. All that has been said and repeated is that class A amplifiers are amplifiers, quite often, not with very strong powers because if we look for extremely high powers, there are so many losses in the Class A amps that we prefer the Class AB amplifier. Nevertheless, it remains the great high quality amplifiers because your transistor is all the time in its linear region. It is all the time controlling a current in a charge without blocking or saturating. And quite often and this in an exercise you will see when we make a class A amplifier we add a gain level we have a conducting level for counter reaction. I'll give an exercise later, to do with the use of a voltage gain level before attacking the current gain or what is done with class A or we mainly amplify the power. And I would like to just remind that the Darlington is part of the landscape when it is a bipolar transistor and that otherwise the MOS transistor as there is no current in the grid is an excellent candidate because it does not charge the driver level that is before. And often we need an input level to perform the counter reaction and this is done with differential amplifiers. The exercise will be the best way to understand what's going on with a market amplifier of class A type.

Notes

Summary

38m 59s