ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

PRINCIPE DE SUPERPOSITION

LEÇON 9

Électrotechnique I

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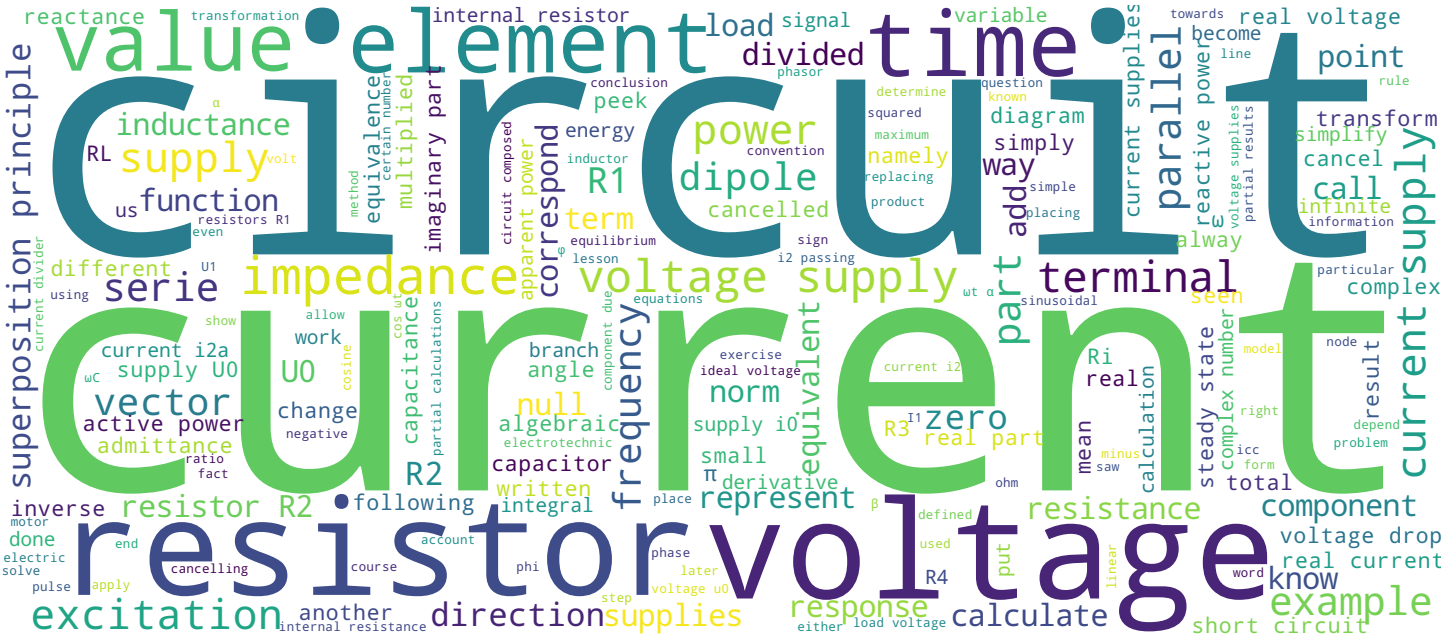


Video

Généralités

- Excitation et réponse d'un circuit
- Énoncé du principe de superposition
- Annuler une source
- Buts et avantages
- Exemple

Electrotechnique I

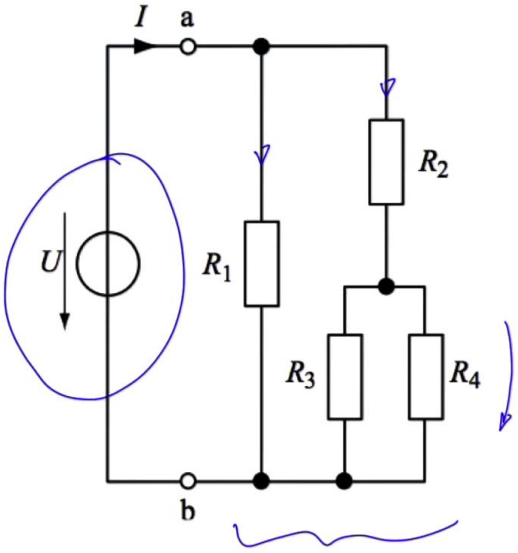
Hello. In today's lesson, we will present a method whose goal is not to simplify or to transform a circuit but to consider its subdivisions and to treat them separately, one by one, and then to reassemble the partial results to obtain a general result. It is what we call the superposition principle. To do so, we will see what are the excitation and the response of a circuit to this excitation. Then, we will formulate the superposition principle. We will then see what it means to cancel out a voltage or current supply. Then, we will see the aims and mostly the advantages of such a method. And finally, we will do an exercise.

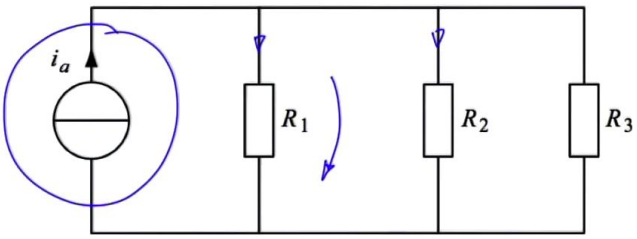
Notes

Summary

0m 04s

Excitation d'un circuit et réponse du circuit à une excitation





Electrotechnique I

If we consider the following two circuits, we see that there is a part that we can call the excitation, it is this voltage supply here, and the response of this circuit, all this part here, to this excitation, which will be currents in each branches and voltage drops at the terminals of each elements. Likewise for a second example in the case of a current supply, so an excitation which is a current supply. This supply will induce currents in the circuit and the response of the circuit to this supply will be a series of currents for each element and also a voltage drop at the terminals of each element.

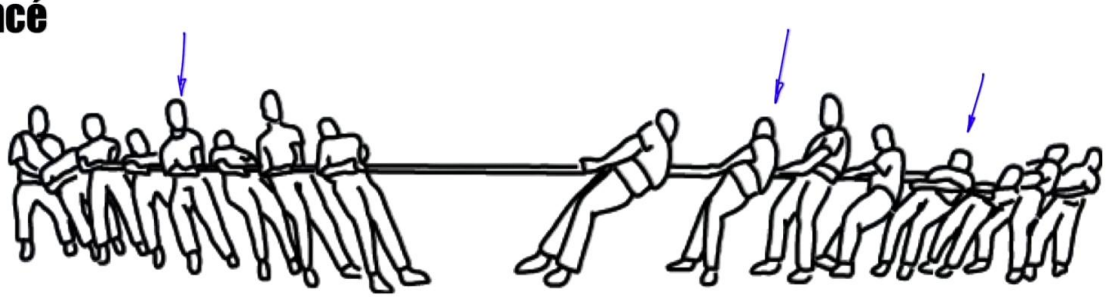
Notes

Summary

0m 49s

PRINCIPE DE SUPERPOSITION

Énoncé



La réponse du système à une somme d'excitations
est égale à
la somme des réponses dues à chaque excitation prise séparément.

Electrotechnique I

The superposition principle states that one of the most fundamental properties of systems made up of linear elements, whether they are electrical or not, one must know that the response of the system to a sum of excitations, we see here several excitations, some small, some big, positive, negative, well the response of the system to a sum of excitations is equal to the algebraic sum -- so one must be careful about the direction of the response to the excitation -- so the algebraic sum of the responses due to each excitations considered separately.

Notes

Summary

1m 38s

Buts et avantages

- Eviter une méthode d'analyse globale souvent lourde
- → Succession de calculs partiels
- A chaque étape, une seule source est prise en compte
- Les autres sont annulées
- Le résultat total est la somme algébrique des résultats partiels

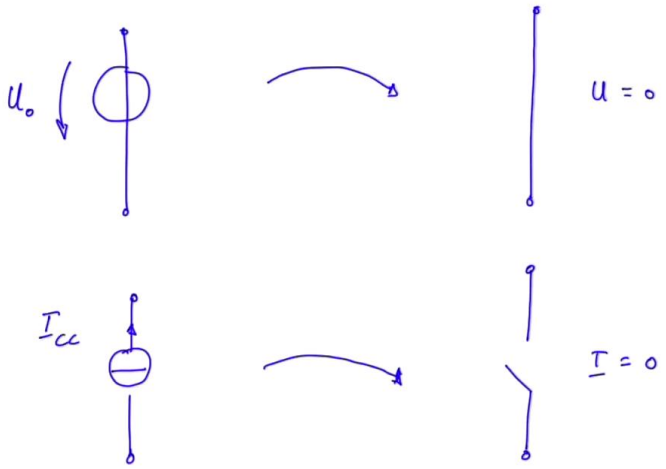
Applied to the case of electrical circuits, the superposition principle lets us avoid a global analysis method, often burdensome, by replacing it by a succession of partial calculations. These partial calculations are done on simplified circuits. At each step, only one of the original circuit's supplies is taken into account, all the others are cancelled out. The total result is the algebraic sum of the partial results. So in the notion of algebraic sum, one must take into account the directions of the currents or voltages.

Notes

Summary

2m 12s

Que signifie « annuler une source » ?



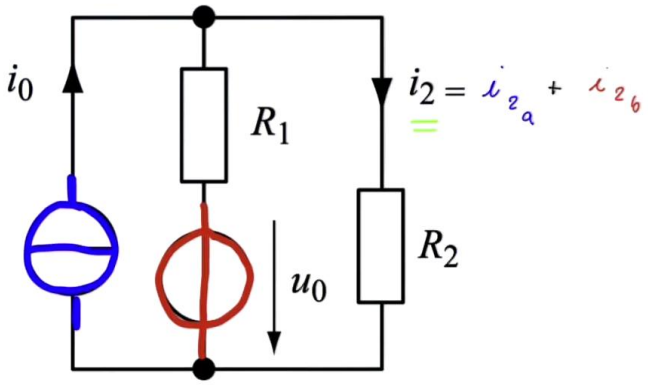
We have just talked about cancelling out a supply, but what does that mean exactly? Cancelling out and ideal voltage supply, that I represent here, the voltage u0 for example, well, for the voltage to be cancelled out, it must be null so we will replace this supply, to cancel it out, by a continuous line, namely a zero voltage drop between these two points. It is the case of a short-circuit. To cancel out an ideal current supply such as this one, that provides a current Icc, well, cancelling out this supply to get a current I equal to 0 corresponds to an open circuit or an infinite resistance. In this case, U is equal to 0. In that case, I is equal to 0.

Notes

Summary

2m 49s

Exemple



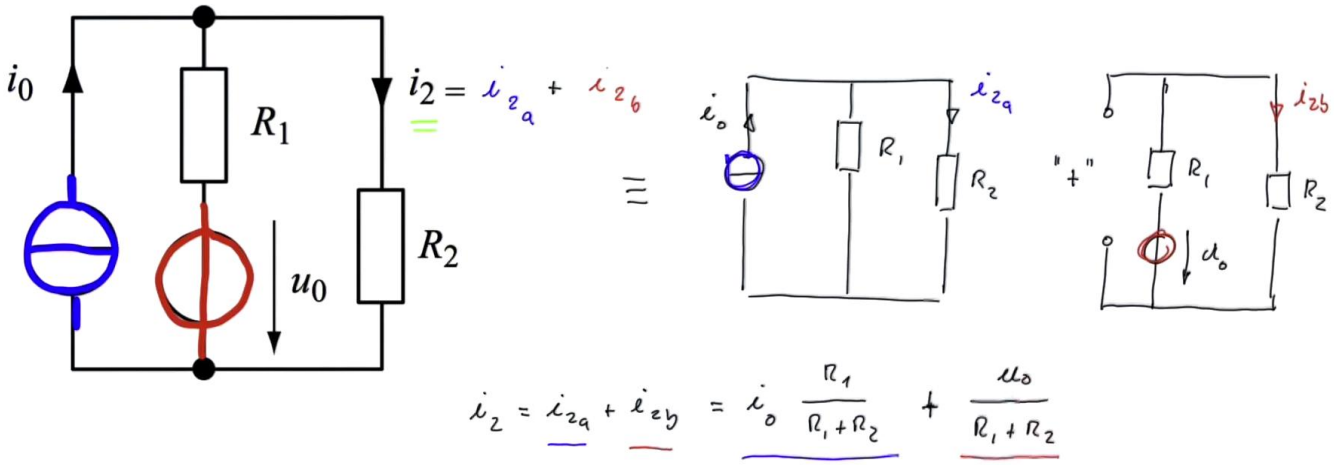
Lets now consider the following example. It is question of a circuit composed of two supplies, such as represented here on the figure, for which we would like to determine the current i2 passing through the resistor R2. We see that the circuit's two excitations are the current supply i0 and the voltage supply u0. Under the equivalence of real voltage supplies and real current supplies, we could transform this middle branch here in a real current supply and combine the current supplies that are in parallel. However, if we wanted to transform this real current supply here, with this resistor R2, we could make the transformation but we would lose the information on the current that is in the resistor R2. So, we will apply here the superposition principle. To calculate the current i2 passing through the resistor R2, we see that this current has two components. A first component that we call i2a, the subscript a corresponding to a response due to the excitation of the current supply, plus a component due to the voltage supply, that we call i2b. According to the superposition principle, we can redraw this circuits in two parts that correspond to the two components of the supplies.

Notes

Summary

3m 52s

Exemple



We have a first component that only corresponds to the supply i0. We represent the resistor R1 with the voltage supply u0 that is cancelled out and the resistor R2 stays in place. The current i2a is given here and we can easily calculate it. We have that i2 is the sum of i2a plus i2b and the current i2a, we recognise here the current divider, is i0 multiplied by R1 over the sum of the two resistors R1 plus R2 to which we add the component due to the supply at the excitation U0, and so we represent the circuit without the supply i0. R1 is here with the voltage supply U0, the only one we consider in this second exercise of this second part. And here, the part 0 which is from i0 to have a null current and so we have the second component i2b which is given by the supply U0. So this term i2b is simply the ratio of U0 over the sum of the resistors R1 plus R2. In this particular example, we see that the current i2a and the current i2b are going in the same direction which is why we add them, but in another example one of the two currents might be in the opposite direction to the current one has made default going towards the bottom in the original drawings, in which case we would have to subtract this current.

Notes

Summary

5m 29s

In conclusion, we can say that from a relatively complex circuit composed of more than one excitation, by applying the superposition principle we can get circuits, a certain number of circuits, that are easier to deal with and by adding the results we get the global result. One must keep in mind that the elements must be linear on one hand and on another hand pay attention to the signs of the currents and voltages obtained.

Notes

Summary

7m 59s