ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

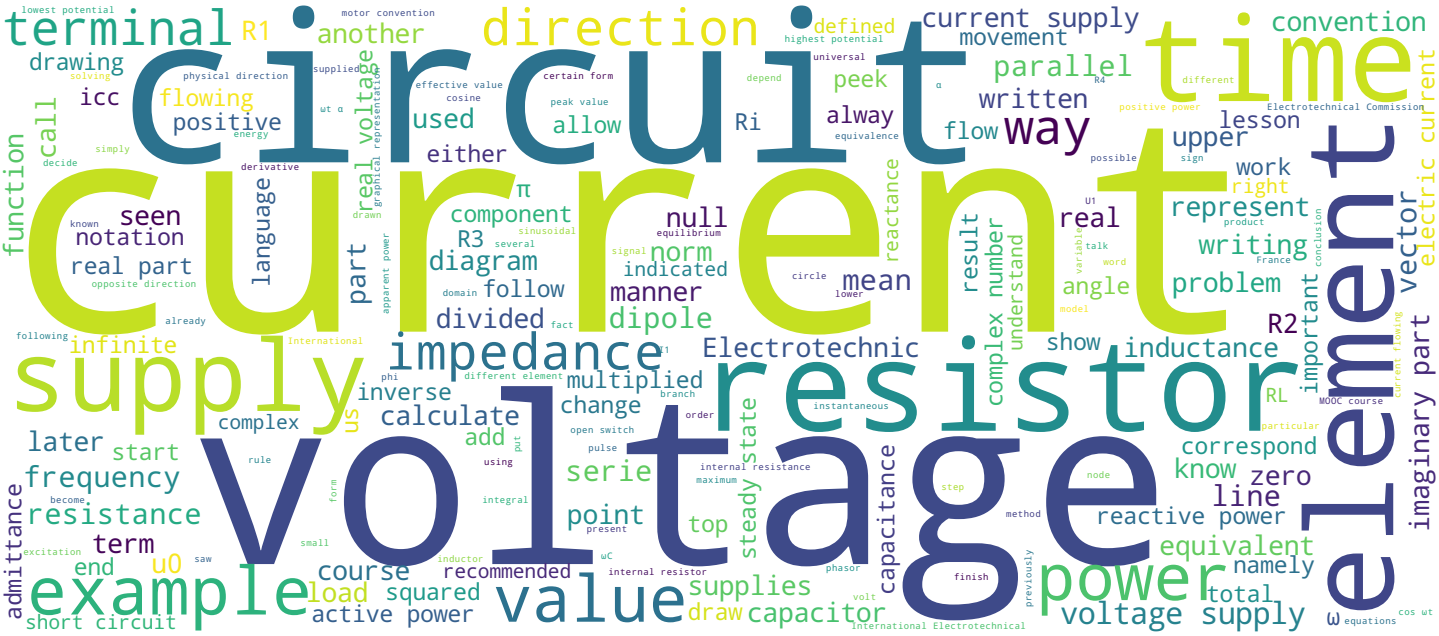
CONVENTIONS

CONVENTIONS ET REPRÉSENTATION GRAPHIQUE

LEÇON 2

Électrotechnique I

Yves PERRIARD & Paolo GERMANO
Laboratoire d'Actionneurs Intégrés



EPFL

INTRODUCTION

- Introduction
- Conventions
- Représentation graphique
- Conclusion

Electrotechnique I

Hello and welcome to this second lesson of Electrotechnics 1 in this lesson we will after the introduction see how to, together, agree with a notation for all the MOOC Electrotechnics 1 and 2 course we shall also see the way to do graphical notations that will enable a universal language or at least a common one for all the different lessons of this MOOC course The utility of a clear and universal terminology ,of a normalization of the reference systems, of mathematical symbolism, of graphics, is evident in all domains of technical sciences.

Notes

Summary

0m 03s

CONVENTIONS

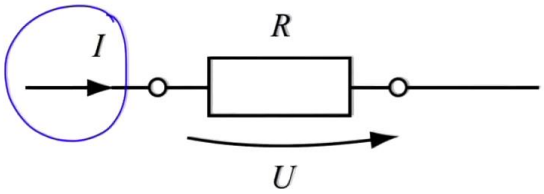
The necessity of such an effort of normalization has been recognized very, very early in electrical engineering. In order to present a coherent concept, the authors of this MOOC course have decided to follow as much as possible the recommendations developed by the international electrotechnical commission, IEC, regarding the terminology, the graphical and literary symbols; the system that will be used is the International System SI, adopted by the General Conference on Weights and Measures in 1960. The mathematical symbols are those recommended the International Organization for Standardization ISO.

Notes

Summary

0m 41s

Convention relative au sens du courant et au sens de référence de la tension



Electrotechnique I

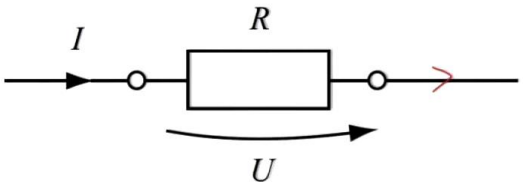
Here is the convention on the direction of current and on the reference direction of the voltage that will be used in this course; we know that physically, the electric current corresponds to a movement of electric charges, we have here a noted electric current, we arbitrarily admit that the direction of the current is the direction of movement of the positive charges and thus the reverse of the movement of negative charges, electrons, for example; in the establishing of an electric circuit calculation this physical direction of the current is generally unknown at first and very often we have, for example, an alternating current, that periodically reverses itself, thus, the electrical engineer must attribute to every current of interest a conventional direction, mathematical and completely arbitrary. In direct current, if the calculations lead to a positive numerical value the conventional direction coincides with the physical direction and in the case of a negative value the conventional and physical direction of current are in opposition; It is almost of universal use to indicate in a diagram the mathematical direction of a current with an arrow generally positioned on the line connecting different elements, as indicated here.

Notes

Summary

1m 19s

Convention relative au sens du courant et au sens de référence de la tension



Electrotechnique I

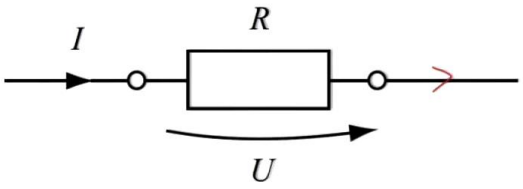
Thus, the most positive point of the voltage appearing at the terminals of a resistor crossed by a positive current is located at the current entrance terminal; so we have, like in the diagram mentionned here a voltage that is in the same direction as the current and then the current comes out from the resistor, from this side.

Notes

Summary

2m 37s

Convention relative au sens du courant et au sens de référence de la tension



Electrotechnique I

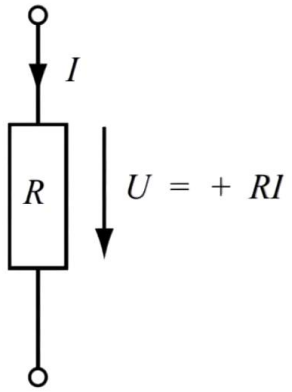
Similar to electric currents, voltages between terminal pairs in a circuit are not known at first, thus they must receive an arbitrary mathematical direction; the manner in which the positive voltage direction is graphically indicated is unfortunately not yet unanimous amongst electricians despite the efforts of the International Electrotechnical Commission, this positive direction is generally indicated on a circuit diagram either with a pointing arrow, placed along the element, as you can see in this drawing, under " International " or, by using + and - signs like in the central diagram here.

Notes

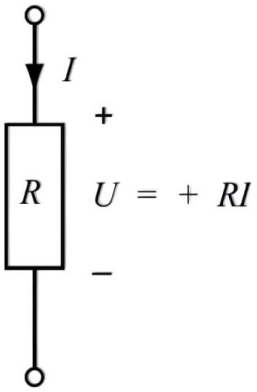
Summary

3m 00s

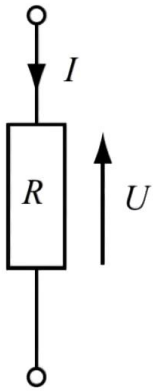
Convention relative au sens du courant et au sens de référence de la tension



International



Belgique, USA



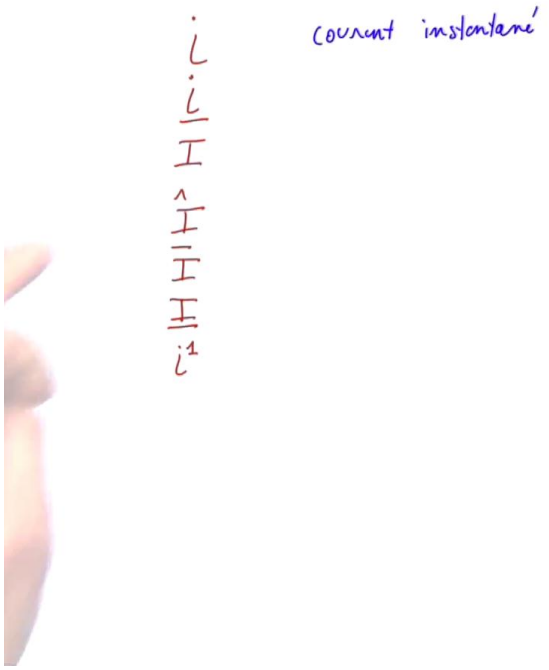
France

The three most frequently encountered ways in technical litterature are represented in these three figures on this diagram, solutions 1 and 2, I will call International or Belgium/USA are recommended by the International Electrotechnical Commission, the International solution in which the direction of reference of the voltage is indicated by a pointing arrow from the point of highest potential towards the lowest potential is of customary usage in Switzerland and will be adopted for the entirety of this Electrotechnics 1 and 2 MOOC It presents the advantage of guiding the current and voltage arrows in the same direction when these values are of the same sign; The middle solution is currently recommended by the Americans, and also used in Belgium, and the solution on the right, essentially used in France, in which the lowest potential points towards the highest potential is still frequently used in France, as I've mentioned, or in all the countries born from French tradition in education. The authors that use this kind of reference must explicitly specify it. In our case, we shall focus on the first way of writing by always writing the current, as you can see here, from the highest point to the lowest point with the voltage in the same element following the same direction.

Notes

Summary

3m 41s



Electrotechnique I

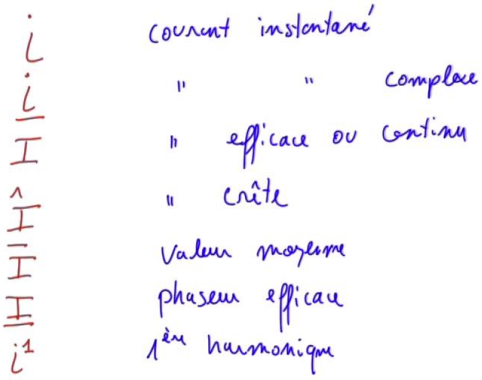
The manner of writing is fundamental to the electric engineer or electrician, indeed, the manner of writing conveys information it is thus a certain form of language. I will give you an example here especially with the currents, the symbol of the current is i, We shall also see it later on, but this letter i can be written in quite a few ways. I shall show you several of them here, first of all, a lower-case i such as here an underlined lower-case i, an upper-case I, an upper-case I with a hat, an upper-case I with a line, or also an underlined upper-case I, we can add one more another i with a 1. You can see all these ways of writing an i that, in the end, indicate a current, will have very different meanings; let's take the first : if we write an i like this, lower-case, well, it will mean that the value is instantaneous, so, an instantaneous current. an underlined current means that we are using complex number notations, so we have here, an instantaneous complex current; an upper-case I will mean an R.M.S.

Notes

Summary

5m 10s

CONVENTIONS



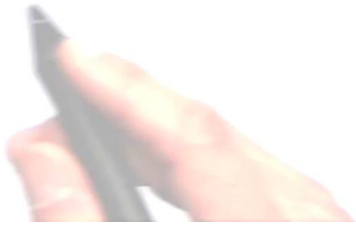
(Root-Mean-Square) current or a continuous current; an i with a hat on top will mean a peak current or a peak value so, the maximum value, we will see all of this when we study single phase AC systems an upper-case I with a line on top will indicated an average value; an underlined upper-case I will tell us that it's an effective value phaser and finally the last symbol that I've written here an i with a small 1, means that we have here the the first harmonic of the current. As you can see, all these conventions these different ways of writing, convey a different meaning, it is thus very important, fundamental even, that the engineer who is writing, who's writing the analytical calculations absolutely follows a way of writing, a convention allowing others who will continue his work to be able to follow and understand the steps of the first and understand the writings of the first.

Notes

Summary

6m 43s

conducteur parfait $R = 0$



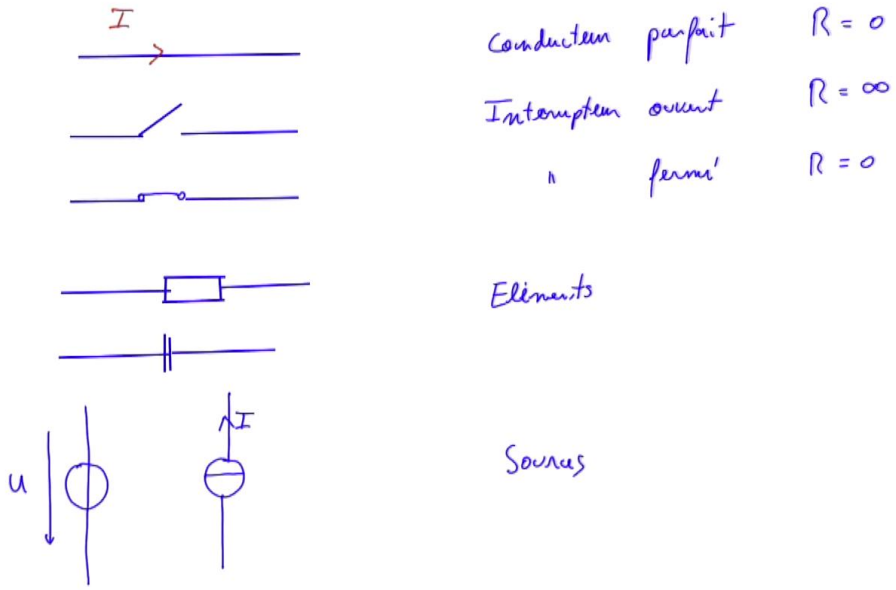
Electrotechnique I

Graphical representation is also very important since it will also convey a certain form of meaning, through the notations. The first graphical representation that I would like to show you is a simple conductor that will like the elements, we will thus draw here a line, this is a perfect conductor. Why is it perfect ? because we will decide that if we draw a line, like here, the resistance of this line is null. Thus we make the hypothesis that it is a null resistance, we make the hypothesis that every time we've drawn a line to link the components these lines are all perfect or convey a current or voltage in a perfect manner. Through this perfect conductor, a current I, for example will be able to flow that I'm drawing here; another possibility : we have the possibility of having switchs, so for example here, an open switch the open switch will mean that current is no longer flowing, thus in this open switch we are telling the person looking, interpreting the diagram, that the resistances is infinite, no current can flow through.

Notes

Summary

7m 58s



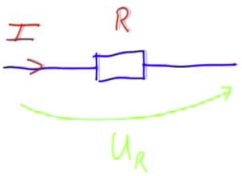
Similarly the closed switch, that will be drawn in the following manner and will mean that our resistance is once again null and that all the current is flowing through the switch without any problem; finally, we will be able to draw the elements we will detail them later these elements that, for example are formed by drawing a small box, a small rectangle, or two parallel plates, and so on, we will have here some elements and these elements, in the end, also represent but we shall see later on that the empty square represents a resistor, that the two vertical plates represent a capacitor, and thus convey, behind, the entire physical aspects linked to these different elements and finally we shall see a way of having a certain power it's what we will call a supply, we will define theses supplies together, later on, but I will already give here the two fundamental elements of this supply, supplies are symbolised by a line with a circle and we will have here a voltage, for example for the voltage supply or a circle with a horizontal line for the current supply.

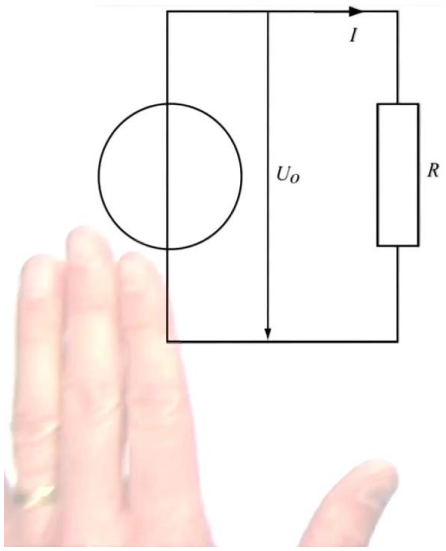
Notes

Summary

9m 35s

Conventions «moteur»





Electrotechnique I

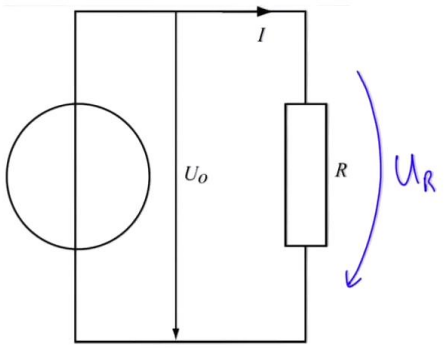
I arrive now at the convention for supplies that I just told you about and I've been very careful not to talk about, at that time at the time when I've defined the voltage, the voltage supply and the current supply, not to tell you in which direction the current flows of course we have the choice as mentioned earlier, these are only conventions, we can decide on either one or the other, what is very important it's to be constant in the manner of solving a problem from start to finish and to use the same convention from start to finish. We've seen it previously for an element such as the resistor, the flowing current will be written in the following way it enters the resistor R and the voltage at the terminals follows the same way direction as the current in this element. We can see it here in the diagram drawn on your left, we have a voltage supply connected to a resistor, but in this case, in the voltage supply, the current is flowing in the opposite way, in the direction of the voltage and this way of doing and in general, it is recommended to choose a convention for the direction known as motor type.

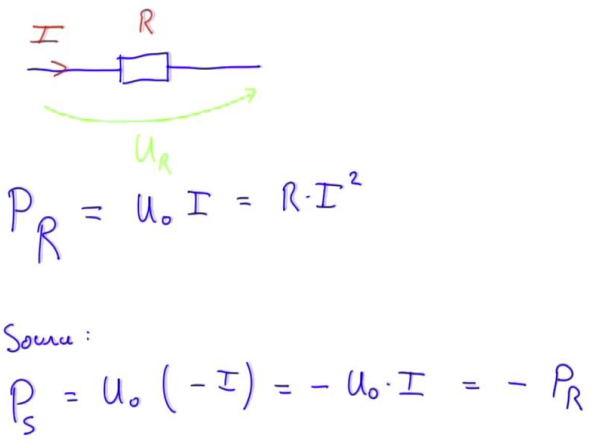
Notes

Summary

11m 19s

Conventions «moteur»





systematically as shown in this diagram; the motor convention implies automatically a positive power when it is consumed, negative when it is supplied, It's a random choice of the direction for the voltage and current but we will settle it once and for all for this course because if we change while solving a problem, this does not allow a proper interpretation of the powers. In this case, we will have in the resistor a voltage in the same direction as the current but in the supply, the current is flowing in the opposite direction; thus we write P of R the power in the resistance, is equal to u0, in other words, the voltage between the terminals of R, multiplied by the current I which will be equal to R times I squared; for the supply, we will write P of the supply is u0 and here we will have a current flowing in the opposite direction or, minus u0 times I we can see that Ps is equal to minus PR and as we can see here, the motor convention implies a positive power when it is consumed, it is what we want in the resistor, negative when it is supplied, it's what we want in the supply; thus, from now on and for the entire Electrotechnics 1 and 2 course we will use this motor convention for the supplies and the international convention for all passive elements that we will discover.

Notes

Summary

12m 43s

CONCLUSION

- Importance de l'unité des notations
- Conventions internationales
- Langage à part entière
- Langage universel

Electrotechnique I

In conclusion, we've discovered the importance of the units of notations to be absolutely clear from the beginning to the end of a problem and this international manner of agreeing on a language, a language in its own right, a universal language, but to be universal, it implies being based on a certain form of international agreement and we will thus follow the international conventions of the IEC for all the conventions of this course.

Notes

Summary

14m 34s