Uzbekistan State Committee of Communications, Information and Telecommunication Technologies

Tashkent Information Technologies University

Department of Physics

Project work on

"The calculation of the current in an electric circuit"

The work made by the student of 224–12
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PLAN:

The theoretical part

About program Crocodile Technology…

To create this project work, I have used the program *Crocodile Technology 609.*

Crocodile Technology combines electronic design, PIC programming, 3D mechanisms and 3D PCB simulation.

Design using updated electronic simulation - with over 100 new chips.

Include powerful PICs, and write programs easily.

Add inputs, outputs and mechanisms to a 3D circuit board; real-PCB autoroutes and autoplaces your circuitry.

To make the product, export the PCB design and send your program to a real PIC.

Finally, use the 3D simulation and a new digital millimeter for testing.

About Kirchhoff's rules…

Gustav Robert Kirchhoff
(12 March 1824 –
17 October 1887)

In this project work, I used the rules Kirchhoff…

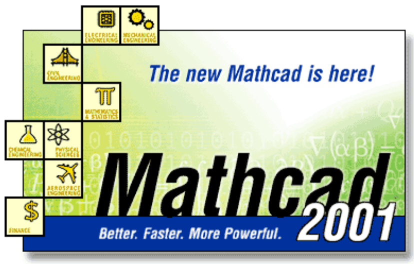
1. Voltage Rule

This is based on the conservation of energy: "the sum of voltages around a closed conducting loop (that is, a circuit) must be zero". In other words, since voltage and work are related, we are saying the net work done must be zero.

2. Current Rule

Algebraic sum of the voltage drops on all the branches belonging to any closed loop circuit is equal to the algebraic sum of the branches of the EMF circuit.

About MathCad program…



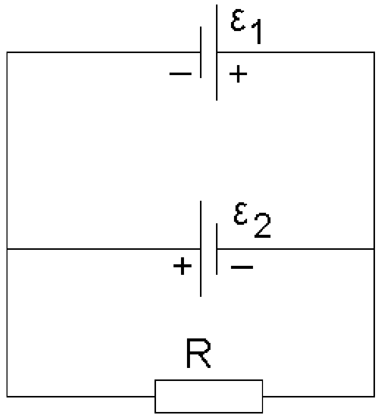
In preparing this project work, I use the program MathCad 2001.

Mathcad, Parametric Technology Corporation's engineering calculation solution, is used by engineers and scientists in various disciplines – most often those of mechanical, chemical, electrical, and civil engineering. Originally conceived and written by Allen Razdow (of MIT, co-founder of Mathsoft), Mathcad is now owned by PTC and is generally accepted as the first computer application to automatically compute and check consistency of engineering units such as the International System of Units (SI), throughout the entire set of calculations. Mathcad today includes some of the capabilities of a computer algebra system, but remains oriented towards ease of use and simultaneous documentation of numerical engineering applications.

The main part

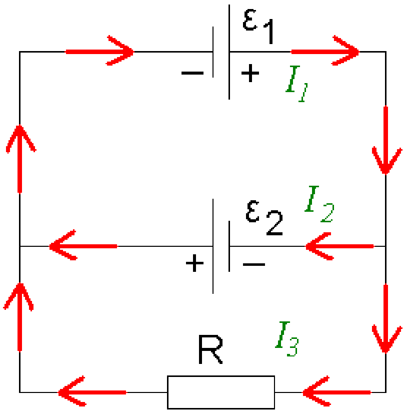
So, initially the task to the following:

Two battery packs ($\varepsilon_1 = 10\,V;\ r_1 = 1\,\mathrm{Ohm};\ \varepsilon_2 = 8\,V;\ r_2 = 2\,\mathrm{Ohm}$) and resistor (R=6 Ohm) are connected as shown in the figure. Find the current in batteries and resistor.



But the resistors of this circuit after assembly in Crocodile Technology, exploded. So I changed the resistance of the rheostat from 6 to 60 Ohms.

Show the direction of the currents in this diagram:



And as shown above, the following notation flowing currents. Let the two battery packs and the currents flow I_1 and I_2 respectively, and the current flows through the resistor I_3.

Now calculate the currents, using the Kirchhoff. To do this, set up a system of three equations in three unknowns:

$$\begin{cases} I_1 + I_2 - I_3 = 0 \\ I_1 r_1 - I_2 r_2 = \varepsilon_1 - \varepsilon_2 \\ I_3 R + I_1 r_1 = \varepsilon_1 \end{cases}$$

Now that we know the value of each resistance, substitute them into the system:

$$\begin{cases} I_1 + I_2 - I_3 = 0 \\ I_1 - 2I_2 = 2 \\ I_1 + 60I_3 = 10 \end{cases}$$

And calculate the system, using the method of Cramer (method qualifiers):

$$\Delta = \begin{vmatrix} 1 & 1 & -1 \\ 1 & -2 & 0 \\ 1 & 0 & 60 \end{vmatrix} = \begin{vmatrix} -2 & 0 \\ 0 & 60 \end{vmatrix} - \begin{vmatrix} 1 & -1 \\ 0 & 60 \end{vmatrix} + \begin{vmatrix} 1 & -1 \\ -2 & 0 \end{vmatrix} = -120 - 60 - 2 = -182$$

$$\Delta I_1 = \begin{vmatrix} 0 & 1 & -1 \\ 2 & -2 & 0 \\ 10 & 0 & 60 \end{vmatrix} = -\begin{vmatrix} 2 & 0 \\ 10 & 60 \end{vmatrix} - \begin{vmatrix} 2 & -2 \\ 10 & 0 \end{vmatrix} = -120 - 20 = -140$$

$$\Delta I_2 = \begin{vmatrix} 1 & 0 & -1 \\ 1 & 2 & 0 \\ 1 & 10 & 60 \end{vmatrix} = \begin{vmatrix} 2 & 0 \\ 10 & 60 \end{vmatrix} - \begin{vmatrix} 0 & -1 \\ 10 & 60 \end{vmatrix} + \begin{vmatrix} 0 & -1 \\ 2 & 0 \end{vmatrix} = 120 - 10 + 2 = 112$$

$$\Delta I_3 = \begin{vmatrix} 1 & 1 & 0 \\ 1 & -2 & 2 \\ 1 & 0 & 10 \end{vmatrix} = \begin{vmatrix} -2 & 2 \\ 0 & 10 \end{vmatrix} - \begin{vmatrix} 1 & 0 \\ 0 & 10 \end{vmatrix} + \begin{vmatrix} 1 & 0 \\ -2 & 2 \end{vmatrix} = -20 - 10 + 2 = -28$$

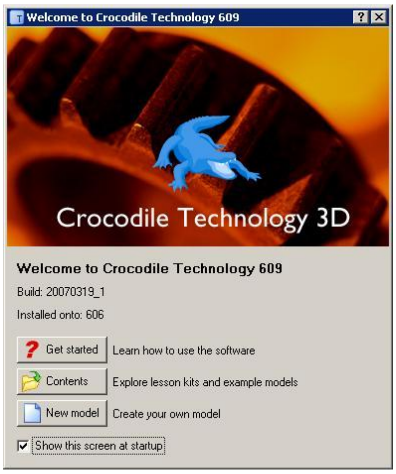
$$I_1 = \frac{\Delta I_1}{\Delta} = \frac{-140}{-182} \approx 0{,}769\ \text{A} = 769\ \text{mA}$$

$$I_2 = \frac{\Delta I_2}{\Delta} = \frac{112}{-182} \approx -0{,}615\ \text{A} = -615\ \text{mA}$$

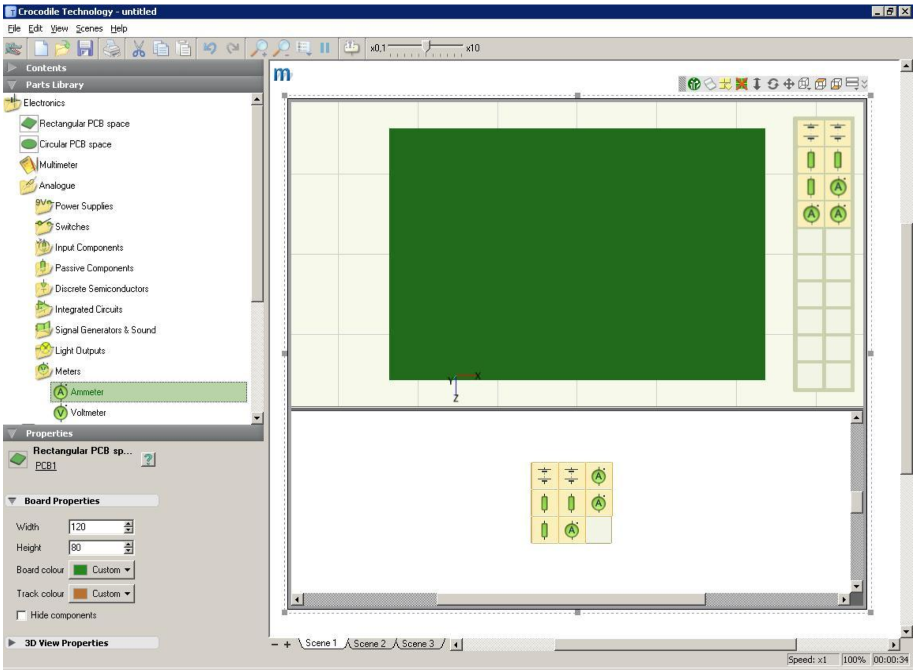
$$I_3 = \frac{\Delta I_3}{\Delta} = \frac{-2}{-18}$$

> In fact, there are many other ways to solve this system. For example, time-consuming matrix method, or Gauss, also called the method of successive elimination of unknowns. It is shown below:
>
> $$\left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 1 & -2 & 0 & 2 \\ 1 & 0 & 60 & 10 \end{array}\right) \sim \left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & -3 & 1 & 2 \\ 0 & -1 & 61 & 10 \end{array}\right) \sim \left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & -3 & 1 & 2 \\ 0 & 0 & 182 & 28 \end{array}\right) \Rightarrow \begin{cases} I_3 = \frac{28}{182} \approx 0{,}154\ A \\ I_2 = \frac{2 - 0{,}154}{-3} = -0{,}615\ A \\ I_1 = 0{,}154 + 0{,}615 = 0{,}769\ A \end{cases}$$
>
> So, to get the same results!

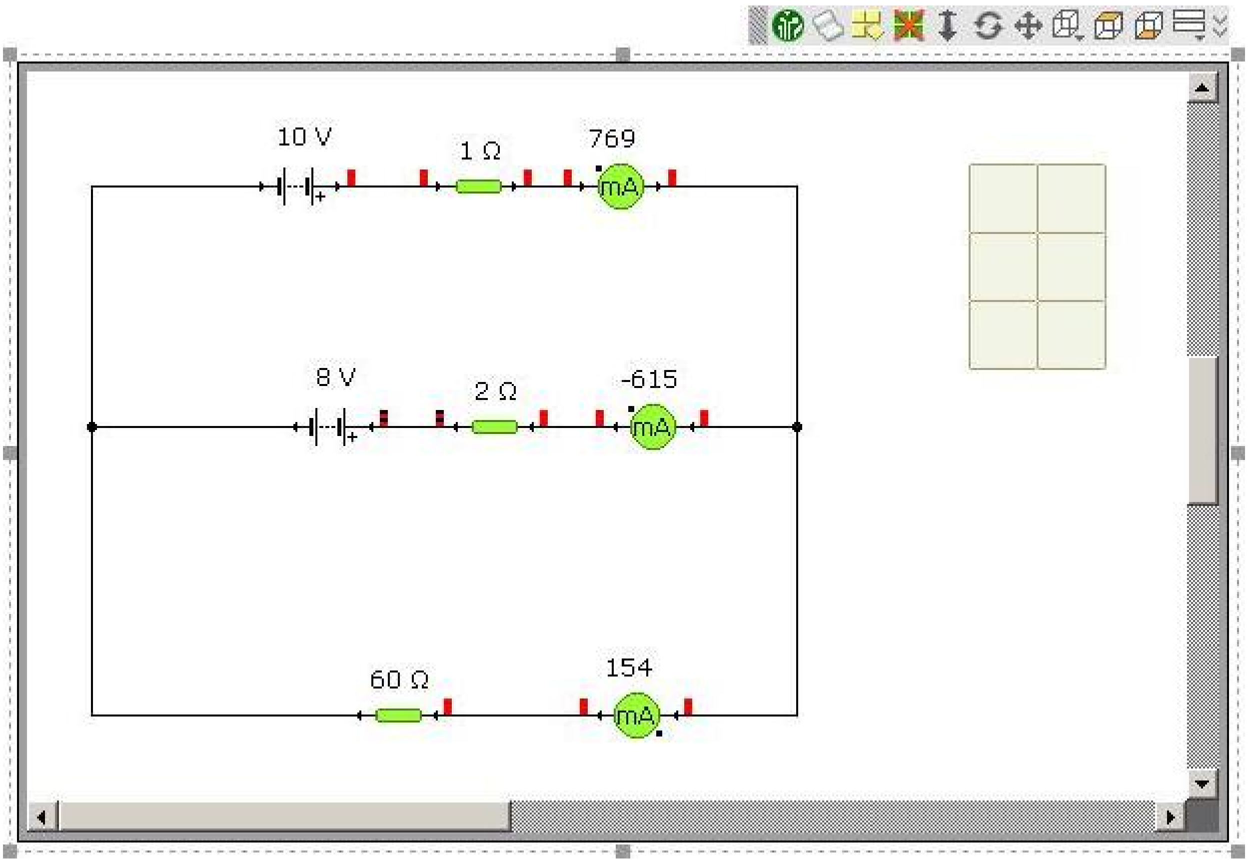
So now all three current calculated – I_1, I_2 and I_3. Now calculate this same circuit using Crocodile Technology. Open up the program and select the "Create a new model":



Then create a workspace and drag with the left panel items that we need. It – two batteries, three resistance and three ammeters. Essentially, it are not ammeters, it are milliammeters.



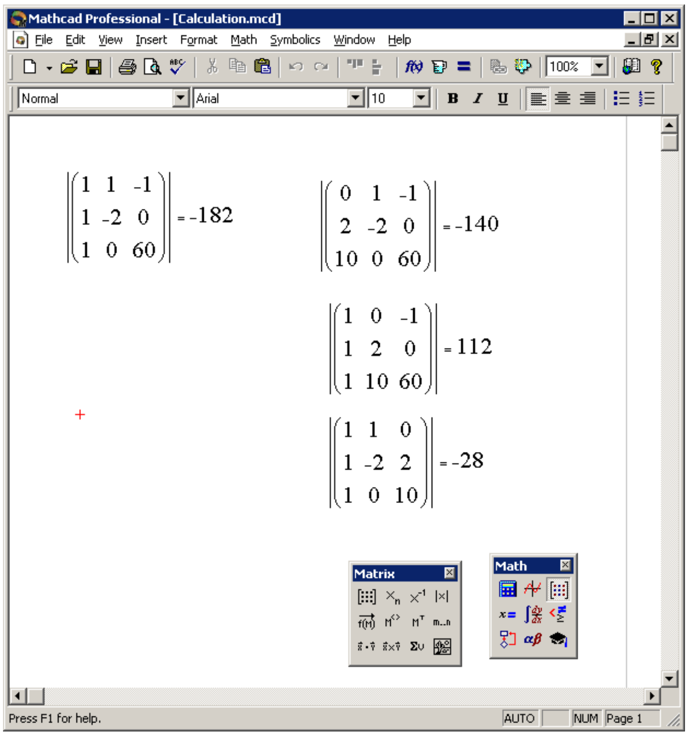
Now make our chained three meter. They show the same results! The results agreed, then calculate made true:



Note. Instead ammeter could use a multimeter.

Note. In order to expand the work area on the screen, you press the button m in the upper left.

Now make those calculations, which made up manually, using applied mathematical program – MathCad.



Conclusion

So, I learned to count by the currents flowing in the circuit to different sites, using the Kirchhoff method and Cramer. I also learned how to collect chain environment *Crocodile Technology and MathCad*, there is a current measure of virtual appliances. If the results match, so calculations are correct!

The amount of incoming and outgoing currents in the circuit node is zero. The amount of voltage drop in the circuit is the sum of the EMF of the circuit. Kirchhoff's two rules form the basis of calculations that are applied in this job.

Kirchhoff's rules are applied nature and allow alongside and in conjunction with other techniques and methods (method of equivalent generator, superposition principle, the method of preparation of the potential diagram) to solve the problem of electrical engineering. Kirchhoff's rules have been widely used because of the simplicity of the formulation of equations and their possible solutions by standard linear algebra (by Cramer, Gauss method, etc.).