Using Excel in DC Circuit Analysis

ME 120 Notes

http://me120.mme.pdx.edu

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The Goal

These slides provide a very brief analysis of a DC circuit.

The goal is to set up an analysis that is performed in Excel.

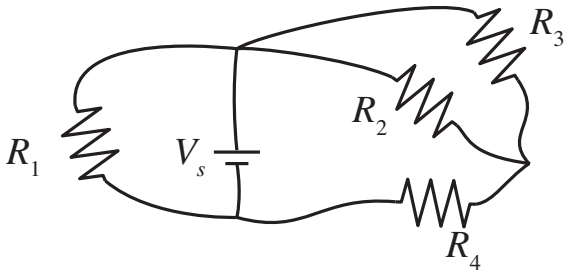
There are no Excel computations in these slides.

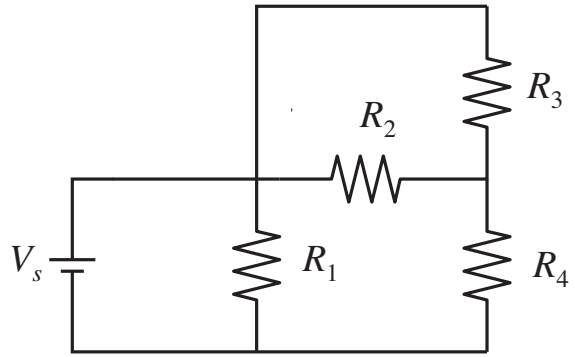
There is nothing special about Excel. Once the equations are obtained these computations could be performed using any number of tools, including

- Excel or other spreadsheets
- MathCAD
- MATLAB
- Maple, Mathematica
- Python, R, C, . . .

The Problem

What is the total power consumed by the circuit, and the power consumed by resistor R_4 for the following two circuits?

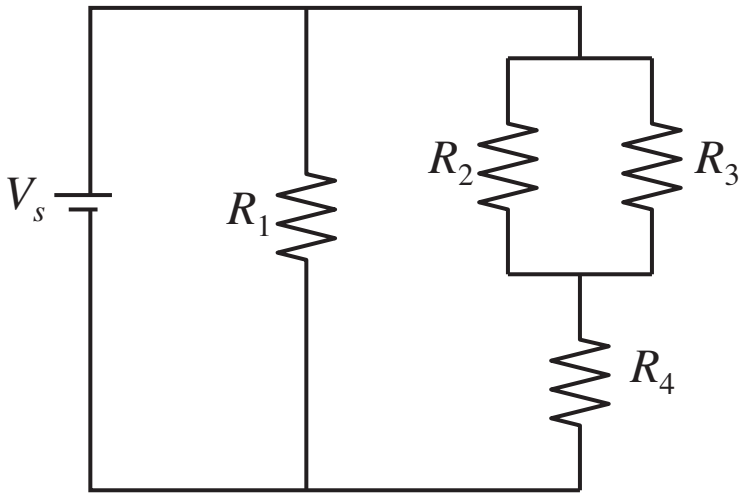




Use $R_1 = R_2 = 330\,\Omega$, $R_3 = 470\,\Omega$, $V_s = 24\,\mathrm{V}$ and let R_4 vary from $10\,\Omega$ to $1000\,\Omega$.

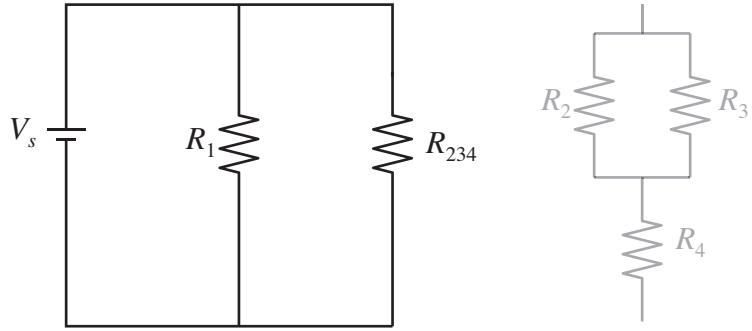
The Problem in Standard Form

Examination of the two circuits shows that they are both equivalent to the following.



Circuit Simplification

Resistors R_2, R_3, and R_4 can be combined to yield the equivalent resistance R_{234}.



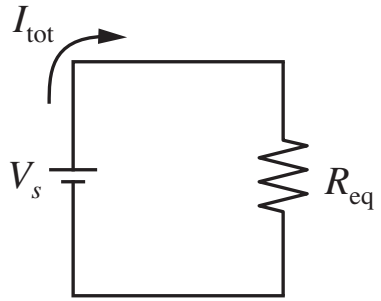
$$R_{234} = \frac{1}{\frac{1}{R_2} + \frac{1}{R_3}} + R_4$$

or

$$R_{234} = \frac{R_2 R_3}{R_2 + R_3} + R_4$$

Circuit Simplification

R_1 and R_{234} can be further combined to give the equivalent resistance for the circuit



$$R_{\text{eq}} = \frac{1}{\dfrac{1}{R_1} + \dfrac{1}{R_{234}}} = \frac{R_1 R_{234}}{R_1 + R_{234}}$$

With R_{eq} known, the total current from the voltage supply is

$$V_s = I_{\text{tot}} R_{\text{eq}} \Longrightarrow I_{\text{tot}} = \frac{V_s}{R_{\text{eq}}}$$

and the total power delivered by the voltage supply is

$$P_{\text{tot}} = I_{\text{tot}}^2 R_{\text{eq}}$$

Current and Power through R_4

It turns out that we don't need to know I_{tot} or R_{eq} to compute P_4.

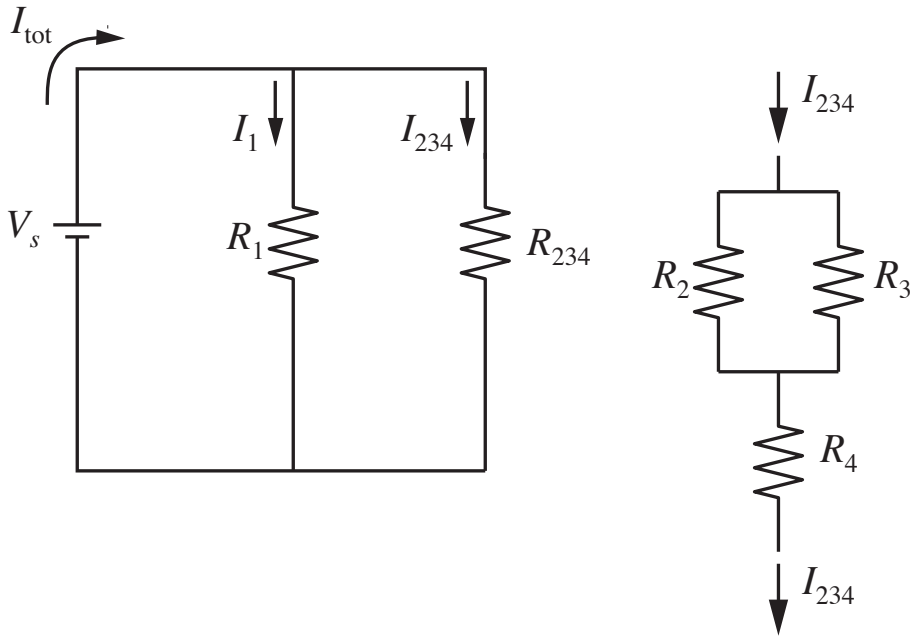
R_1 and R_{234} are in parallel with V_s, therefore

$$V_s = I_{234} R_{234} \implies I_{234} = \frac{V_s}{R_{234}}$$

Finally, with I_{234} known, the power dissipated by R_4 is

$$P_4 = I_{234}^2 R_4$$

because R_4 is in series with the parallel combination of R_2 and R_3.



Recap

The goal is to compute the power dissipated by R_4 for a range of values of R_4, and fixed values of R_1, R_2, R_3 and V_s. The formulas needed are

$$R_{234} = \frac{R_2 R_3}{R_2 + R_3} + R_4 \quad (1)$$

$$I_{234} = \frac{V_s}{R_{234}} \quad (2)$$

$$P_4 = I_{234}^2 R_4 \quad (3)$$