Electric Circuits, Rehearse ①

<u>25.03.19</u>

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  .jpg

  ⋮

- what we need:

▷ Kirchhoff law 1: $\sum_{k=1}^{n} I_k = 0$

▷ Kirchhoff law 2: $\sum_{k=1}^{n} U_k = 0$

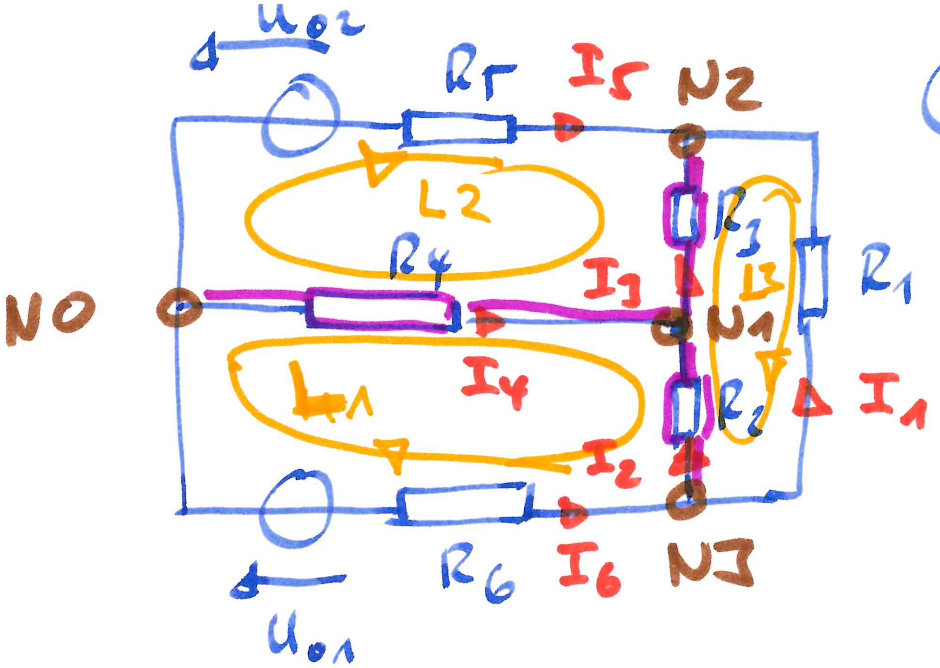
▷ Ohm's law $U = R \cdot I$

②

▷ if our network consists of n nodes, ~~we~~ we get <u>$n-1$</u> equation of this from Kirchhoff 1

▷ the rest of the equations we get from Kirchhoff 2. Therefore we need a tree.

▷ We learn on an example



- In reality: Sources are given and cables, losts are given. We take this also:

U_{0i}, R

goal of the calculation:

=> To calculate the currents in the branches. (Each

branch has a current!

If we have z branches, we need z currents => We get an z x z equation system.

1.) We number the branches from 1 ... z

2.) In the branches we define the currents from I_1 .. I_z

3.) We number the nodes from N0 ... $N_n - 1$ and do not take N0

4.) We sketch a tree in to

5

- number of equations

4 nodes gives 3 equations

6 loop " 6 "

9 " !

we need 6 currents =

6 equations ⇒

3 equations from nodes

3 " " loops

6 "

we get this 3 independent

equations, ~~node~~ with the tree

6

- tree is a construction

with all nodes but without

any loop ⇒ branches

of the tree is node number

-1 ! (n-1) ≡ the

number of equations we

get from Kirchhoff 1.

- not-tree-branch = z-(n-1)

= 3

We build loop with (only) one

not-tree-branch. L1, L2, L3

So we get 3 independent

equations.

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$N1: +I_2 + I_4 - I_3 = 0$

$N2: I_1 + I_3 + I_5 = 0$

$N3: +I_6 - I_2 - I_1 = 0$

$L1: R_4 I_4 - R_2 I_2 - R_6 I_6 + U_{01} = 0$

$L2: R_5 I_5 - R_3 I_3 - R_4 I_4 - U_{02} = 0$

$L3: R_3 I_3 - R_1 I_1 + R_2 I_2 = 0$

$$\begin{pmatrix} 0 & 1 & -1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 \\ -1 & -1 & 0 & 0 & 0 & 1 \\ 0 & -R_2 & 0 & R_4 & 0 & -R_6 \\ 0 & 0 & -R_3 & -R_4 & R_5 & 0 \\ -R_1 & R_2 & R_3 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ -U_{01} \\ U_{02} \\ 0 \end{pmatrix}$$

8 Example with values

$R_i = i \cdot 10\,\Omega \; ; \; U_{0i} = i \cdot 100\,V$

Equation system

$$\underline{A} \cdot \underline{x} = \underline{b} \qquad \underbrace{\begin{pmatrix} a_{11} & a_{12} & \cdots \\ a_{21} & a_{22} & \\ a_{31} & \cdots & \end{pmatrix}}_{\underline{A}} \underbrace{\begin{pmatrix} x_1 \\ x_2 \\ \vdots \end{pmatrix}}_{\underline{x}} = \underbrace{\begin{pmatrix} b_1 \\ b_2 \\ \vdots \end{pmatrix}}_{\underline{b}}$$

We want to calculate $\underline{x}$:

$$\underbrace{\underline{A}^{-1} \cdot \underline{A}}_{} \cdot \underline{x} = \underline{A}^{-1}\, \underline{b}$$

$$\underline{E} = \underline{1}$$

$$\underline{1}\, \underline{x} = \underline{x} = \underline{A}^{-1}\, \underline{b}$$

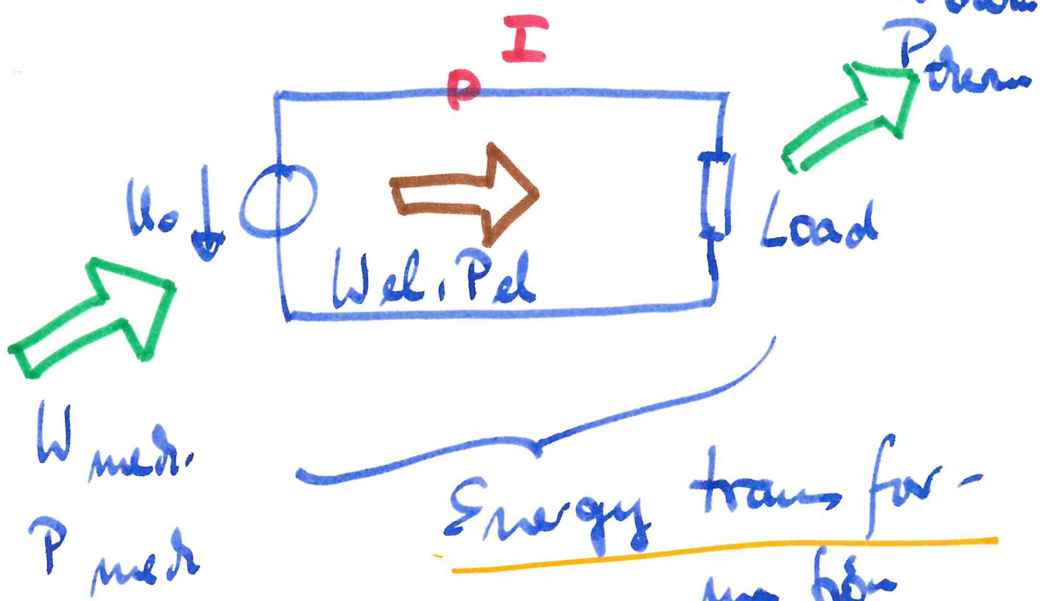
! Do not use the $\boxed{\text{OK}}$ button, use $\boxed{\text{Shift}}$ + $\boxed{\text{Strg}}$ + $\boxed{\text{Enter}}$!

Electric Circuits, Resume (1)

25.3.19 (2)

Energy, Power, losses on transmission lines

Our standard circuit



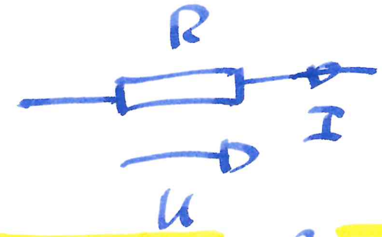
Energy transformation

W: Work ; P: Power

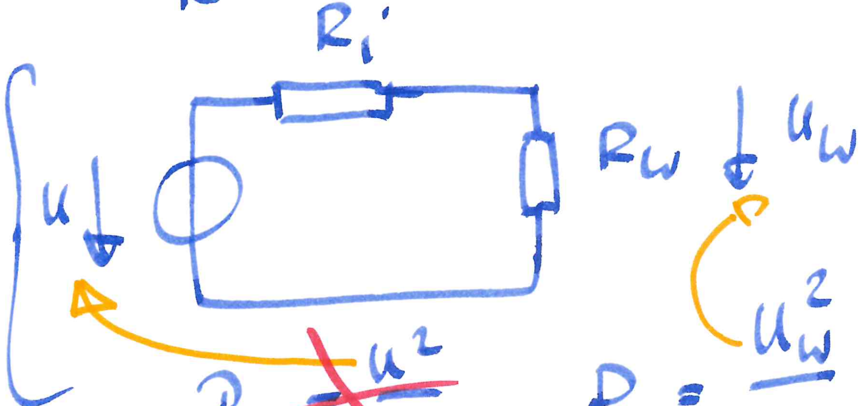
(2) $P = U \cdot I$ → Power in W

$W = \int P\,dt$ → Work in Ws

if we have



$$\boxed{P = \overset{I \cdot R}{U} \cdot \underset{\frac{U}{R}}{I} = I^2 \cdot R = \frac{U^2}{R}}$$



$\cancel{P_W = \frac{U^2}{R_W}}$ $\quad P_W = \frac{U_W^2}{R_W}$

3 formats of power!

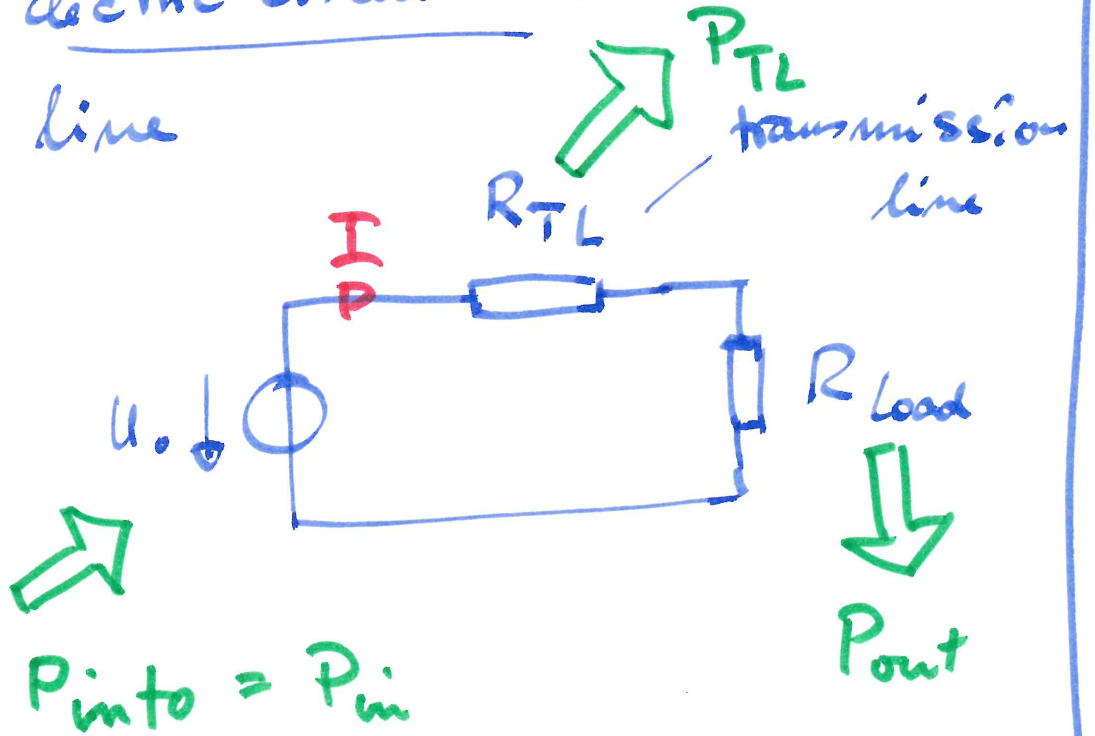
3

$[P] = W = V \cdot A$

From Power to Work = Energy:

$$\boxed{W = \int_0^t P(t)\,dt}$$ in Ws

Electric circuits with transmission line



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$$\boxed{\eta_P = \frac{P_{out}}{P_{in}} = \frac{P_{out}}{P_{TL}+P_{out}} = < 1}$$

efficiency factor

Similar:

$$\boxed{\eta_W = \frac{W_{out}}{W_{in}} \leq 1}$$

→ Energy