Elektrische Schaltungen mathematisch beschreiben

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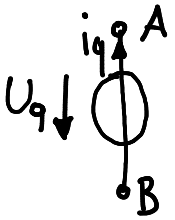
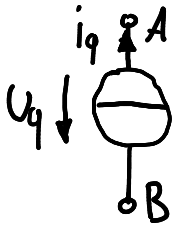
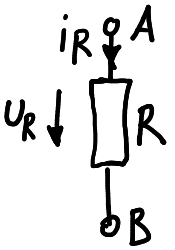
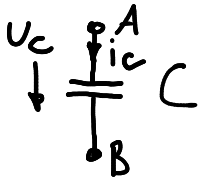
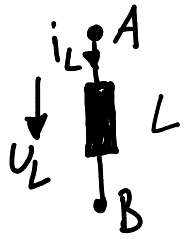
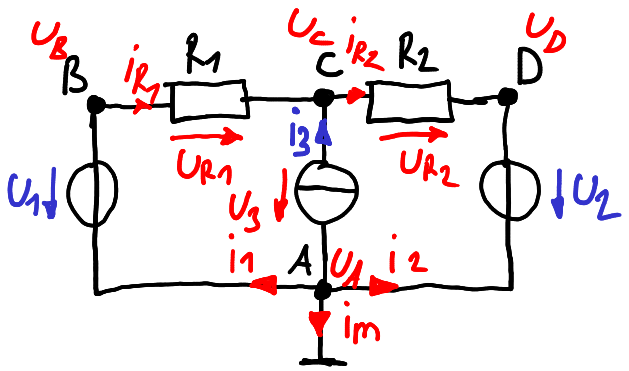
20171206

Bauteil	Symbol	Gleichungen	Unbekannte	Bekannte
Masse		$U_A = 0$	i_m	—
Knoten		$0 = \sum i$	U_A	—
Spannungs-quelle		$U_A = U_q + U_B$	i_q	U_q
Strom-quelle		$U_A = U_q + U_B$	U_q	i_q
Widerstand		$U_R = U_A - U_B$ $U_R = R \cdot i_R$	U_R, i_R	—
Kapazität		$i_C = C \cdot \frac{d}{dt} U_C$ $U_C = U_A - U_B$	$\frac{d}{dt} U_C, i_C$	U_C
Induktivität		$U_L = L \cdot \frac{d}{dt} i_L$ $U_L = U_A - U_B$	$\frac{d}{dt} i_L, U_L$	i_L

Beispiel:



U_1, U_2, i_3 gegeben

□ gesucht

	Gleichungen	Unbekannte
Masse:	$U_A = 0$	i_m
Knoten A:	$0 = -i_1 - i_2 - i_3 - i_m$	U_A
Knoten B:	$0 = i_1 - i_{R1}$	U_B
Knoten C:	$0 = i_{R1} + i_3 - i_{R2}$	U_C
Knoten D:	$0 = i_{R2} + i_2$	U_D
Widerstand R_1:	$U_{R1} = U_B - U_C$	U_{R1}
	$U_{R1} = R_1 \cdot i_{R1}$	i_{R1}
Widerstand R_2:	$U_{R2} = U_C - U_D$	U_{R2}
	$U_{R2} = R_2 \cdot i_{R2}$	i_{R2}
Spannungsquelle U_1:	$U_1 = U_B - U_A$	i_1
Spannungsquelle U_2:	$U_2 = U_D - U_A$	i_2
Stromquelle i_3:	$U_3 = U_C - U_A$	U_3

12 Gleichungen & 12 Unbekannte

↓ solve

```
(%i6)   eqns:[
          uA=0,
          0=-i1-i2-i3-im,
          0=i1-iR1,
          0=iR1+i3-iR2,
          0=iR2+i2,
          uR1=uB-uC,
          uR1=R1*iR1,
          uR2=uC-uD,
          uR2=R2*iR2,
          u1=uB-uA,
          u2=uD-uA,
          u3=uC-uA
          ]$

(%i7)   vars:[im,uA,uB,uC,uD,uR1,iR1,uR2,iR2,i1,i2,u3]$
```

```
(%i5)   makelist(disp(solve(eqns,vars)[1][i]),i,1,12)$
im = 0
uA = 0
uB = u1
uC = (R1 u2 + R2 u1 + R1 R2 i3)/(R2 + R1)
uD = u2
uR1 = -(R1 (u2 - u1) + R1 R2 i3)/(R2 + R1)
iR1 = -(u2 - u1 + R2 i3)/(R2 + R1)
uR2 = (R2 (u1 - u2) + R1 R2 i3)/(R2 + R1)
iR2 = (-u2 + u1 + R1 i3)/(R2 + R1)
i1 = -(u2 - u1 + R2 i3)/(R2 + R1)
i2 = -(-u2 + u1 + R1 i3)/(R2 + R1)
u3 = (R1 u2 + R2 u1 + R1 R2 i3)/(R2 + R1)
```