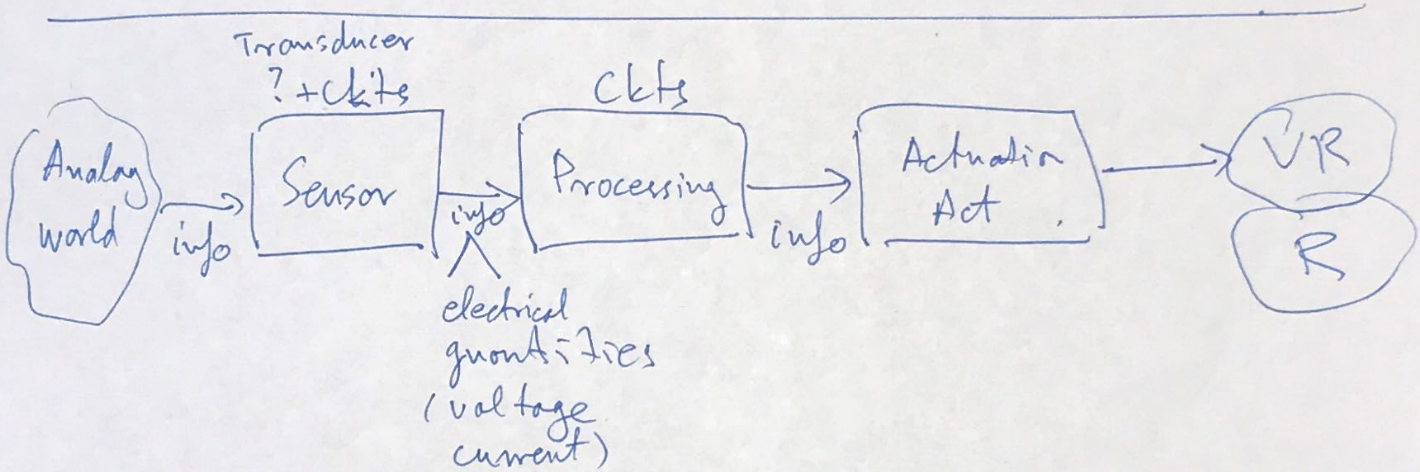
EE 16A

Lecture 1 - Module 2

Today:
* Sensing, Processing & Actuation Systems
* Circuit Analysis Algorithm (Note 11)

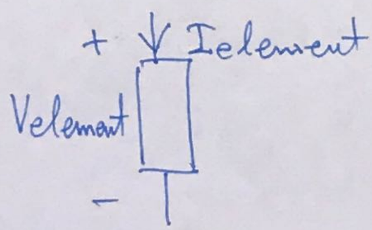


Electrical Circuit Analysis Algorithm (tool) | SPICE |

Nagel, Pederson, Rohrer

Quantities:	Analytical Symbol	Units
Voltage	V	Volts [V]
Current	I	Amps [A]
Resistance	R	Ohms [Ω]

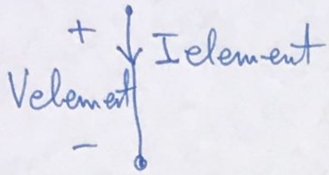
Circuit diagram (collection of elements, where each element has some voltage across it and some current through it)



(l2)

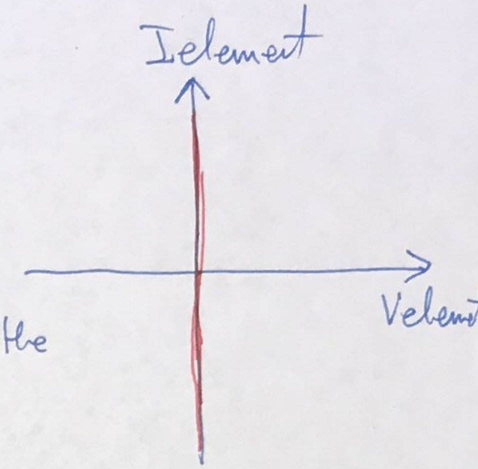
Key circuit elements:

① Wire

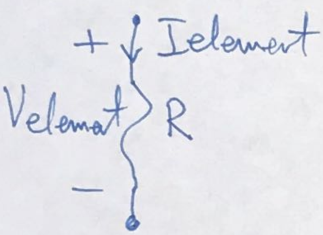


$V_{element} = 0$

$I_{element} = ?$ (set by the ext. circuit)

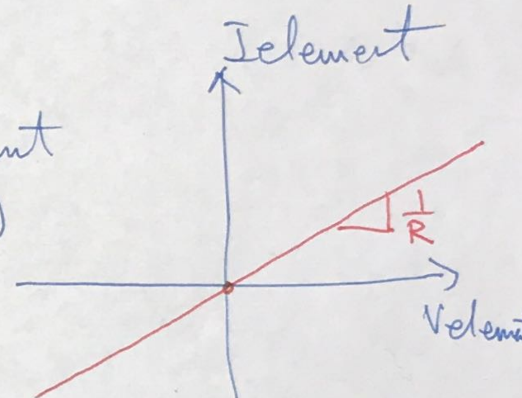


② Resistor

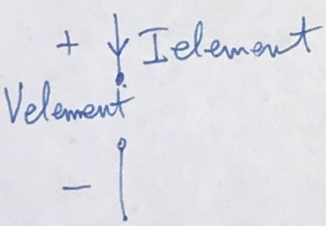


$V_{element} = R \cdot I_{element}$

$\Updownarrow$ (Ohm's law)

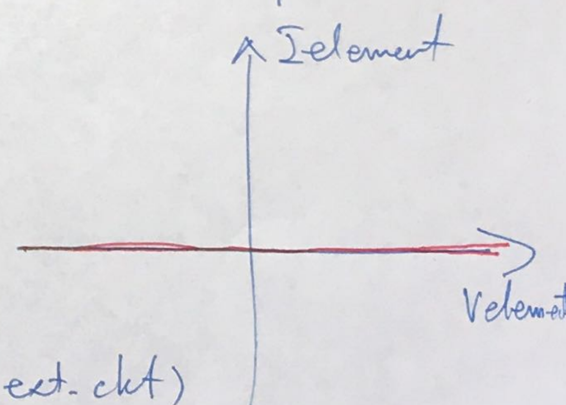


③ "Open" circuit

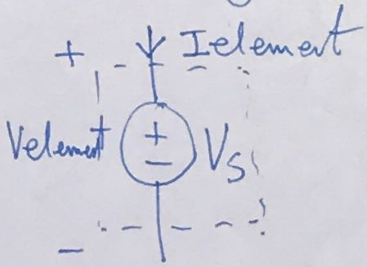


$I_{element} = 0$

$V_{element} = ?$ (set by ext. ckt)

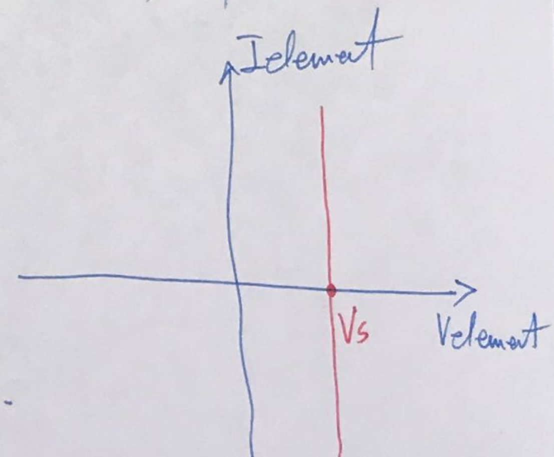


④ Voltage source



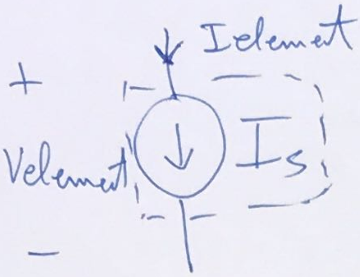
$V_{element} = V_s$

$I_{element} = ?$ (set by ext. ckt)



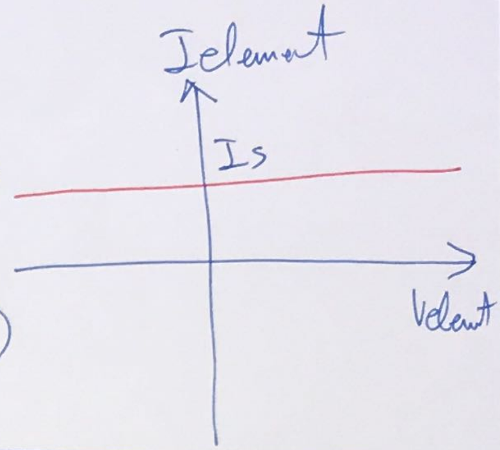
(l3)

(5) Current source



$I_{element} = I_s$

$V_{element} = ?$ (set by ext. ckt)

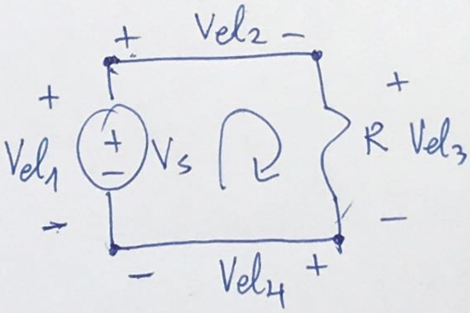


Velement and Ielement <u>can</u> be positive or negative or zero. $\in R$

Rules of circuit analysis:

(1) KVL: sum of voltages across the elements in a loop = 0

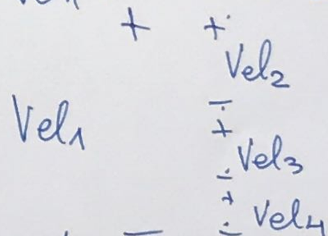
example:



$Vel_1 = Vel_2 + Vel_3 + Vel_4$

$Vel_1 - Vel_2 - Vel_3 - Vel_4 = 0$

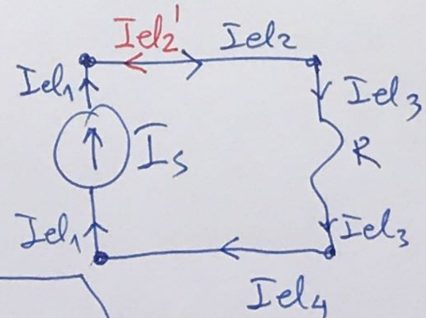
$-Vel_1 + Vel_2 + Vel_3 + Vel_4 = 0$



(2) KCL: The current flowing into any junction <u>must</u> equal the current flowing out

$Iel_1 = -Iel_2'$

$Iel_1 + Iel_2' = 0$



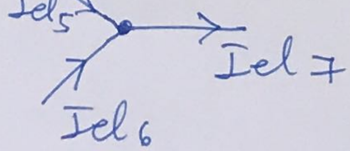
$Iel_1 = Iel_2 \quad Iel_1 - Iel_2 = 0$

$Iel_2 = Iel_3$

$Iel_3 = Iel_4$

~~$Iel_4 = Iel_1$~~

example 2:

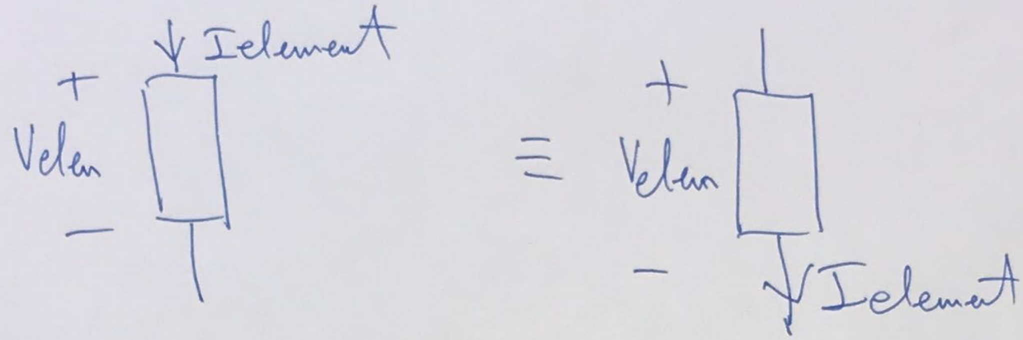


$Iel_5 + Iel_6 - Iel_7 = 0$

$Iel_5 + Iel_6 = Iel_7$

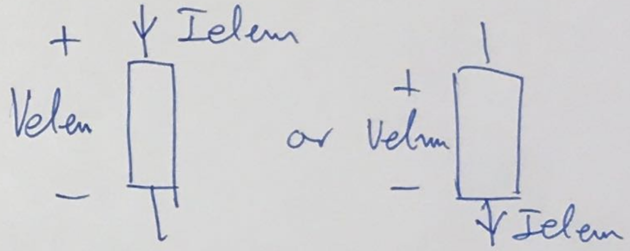
(14)

KCL within the element:



Passive-sign convention:

Ielement goes into a + or out of a − terminal label of Velem.

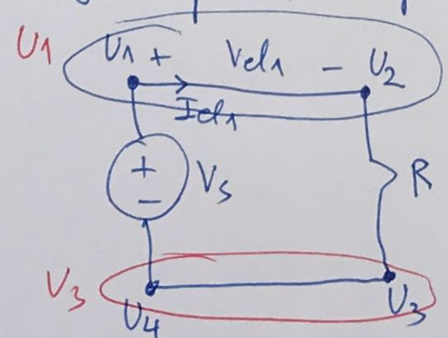


Circuit analysis algorithm:

(V_{jk}) voltage = difference of two potentials (U_j, U_k)

$V_{jk} = U_j - U_k$

Find: currents through elements and potentials of inputs/outputs of each element (junctions)



$U_{1,\dots 4}$ potentials

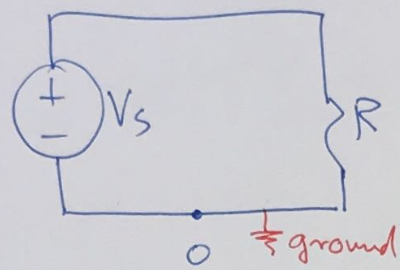
$Vel_1 = U_1 - U_2$

def: $Vel_1 = 0 \Rightarrow 0 = U_1 - U_2 \Downarrow U_1 = U_2$

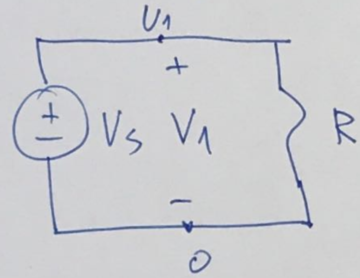
node is an equi-potential part of the ckt.

- collapse junctions into nodes

step 1: Pick a "reference" node and label as a "0" potential. All voltages relative to this node.

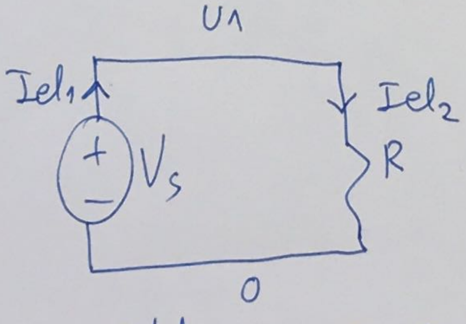


step 2: Label all remaining nodes as potentials U_i
$[U_1 \ldots U_{N-1}]$



$U_1 - 0 = V_1$ (voltage between node 1 and node "0")

step 3: Label all branch currents with Iel_m. Arbitrarily pick directions of Iel_m
$[Iel_1 \ldots Iel_K]$



step 4: Add ± Vel (element voltages) to each element following the passive-sign convention (indep. of what is in the element)