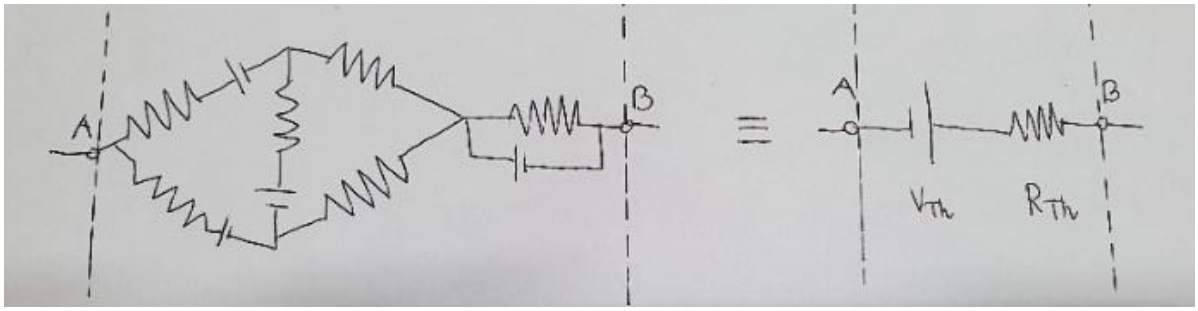
Lecture 3 - Thevenin equivalent circuit

: To simplify complex circuit of Resistors and Voltage sources into simple serial circuit of Vth (Thevenin voltage) and Rth (Thevenin resistance).

: Any two terminal network of resistors and voltage sources is equivalent to a single voltage source Vth in series with a single resistor Rth

This method is called as Thevenin's method for "Circuit Fragmentation"

<Thevenin's Equivalent Circuit>



Networks of Resistors and Voltages ≡ Vth + Rth (in series)

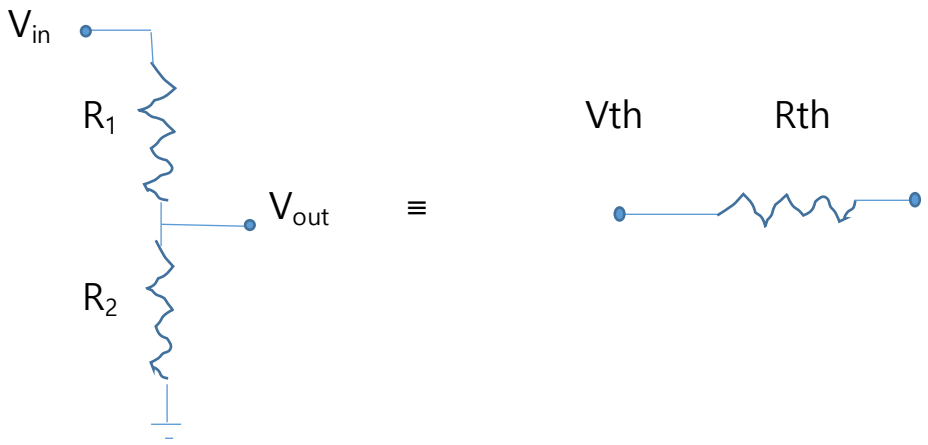
Circuit Simplification/Fragmentation by Thevenin's equivalent circuit, Vth=Thevenin voltage, or

Open circuit voltage at B when nothing is attached to B, or

Voltage measured/calculated at B when $R_{in\ B}=\infty$

Rth≡Vth/I_{sc} and $I_{sc}=I_{short\text{-}circuit}$=Current flowing from the circuit to ground when B is shorted, or connected to ground, or saturation current.

For the voltage divider,



Vth=Open voltage at $V_{out}=V_{in}R_2/(R_1+R_2)$

I_{sc}=Current flowing when V_{out} is shorted=V_{in}/R_1 (why?)

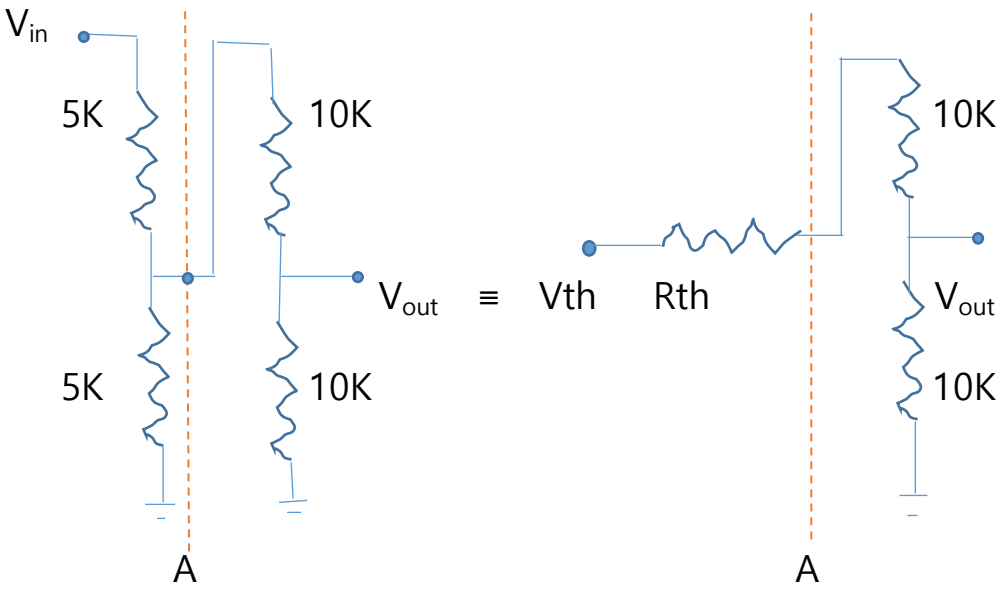
Thus $Rth\equiv Vth/I_{sc}=R_1R_2/(R_1+R_2)=1/(1/R_1+1/R_2)=R_1 \,||\, R_2$

=Parallel resistance of resistors viewed from V_{out}

This is a great knowledge, and there are so many applications!

Ex) Multiple voltage divider

V_{out}?



$Vth=V_{in}(5K)/(5K+5K)=V_{in}/2$, $Rth=5K \parallel 5K=2.5K$

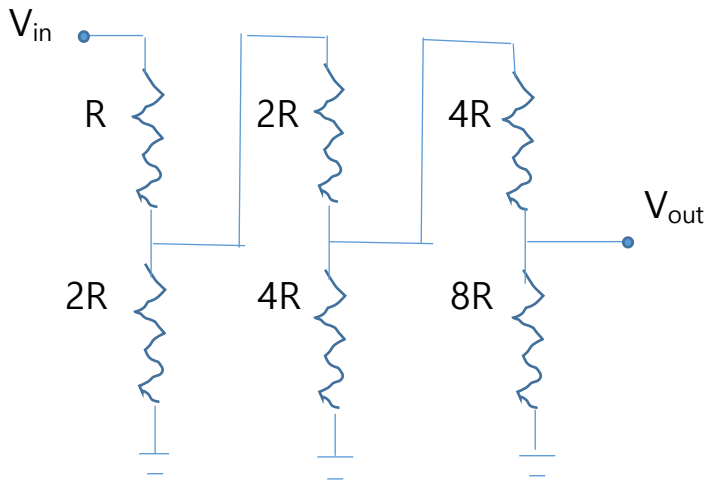
$\therefore V_{out}=Vth(10K)/(2.5K+10K+10K)=10Vth/22.5=5V_{in}/22.5=0.222V_{in}$

This example demonstrates the strength of fragmented circuit using the Thevenin method!

It might be very difficult to solve without the Thevenin method.

HW2)

Given the multiple voltage divider, derive V_{out} as the function of Vin and R. Also calculate V_{out} when V_{in}=10V, and R=5KΩ



Revisit to Generalized Voltage Divider

Vth is the open circuit voltage, and it is the same as V_{out}

I_{SC}=Saturation Current=Current when V_{out} is ground.

Thus $I_{SC}=V_1/R_1+V_2/R_2$

Rth

$=R_1 \text{ II } R_2=R_1R_2/(R_1+R_2)$

And,

$V_{out}=Vth=Rth*I_{SC} = (R_2V_1+R_1V_2)/(R_1+R_2)$

$=V_2 + (V_1-V_2)R_2/(R_1+R_2)$

∴ Thevenin method gives simplification and insight.