(P1)

Module 2, Lecture 4

EECS 16A
Panos Zarkos

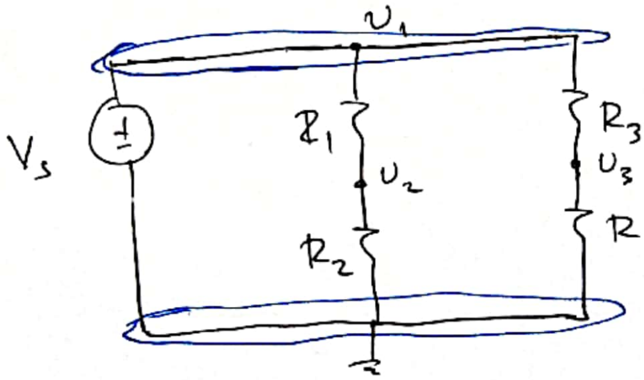
Last time:
* 1D Touchscreen Revisited
* Measuring Voltage and Current
* Power

} Note 13

Today:
* An interesting circuit
* 2D Resistive Touchscreen
* Superposition

} Note 14

An interesting circuit:

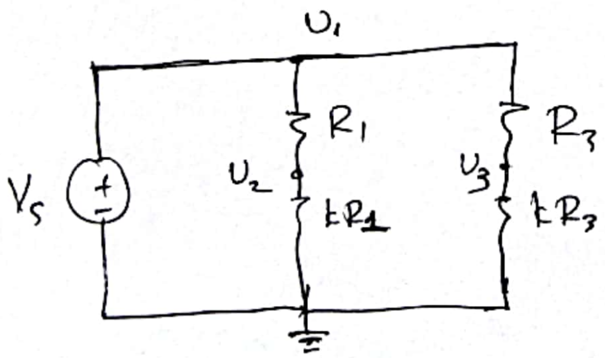


What are u_2, u_3?

$$u_2 = \frac{R_2}{R_1+R_2} \cdot V_s, \quad u_3 = \frac{R_4}{R_3+R_4} \cdot V_s$$

Two voltage dividers!

What if $R_2 = kR_1$, $R_4 = kR_3$?



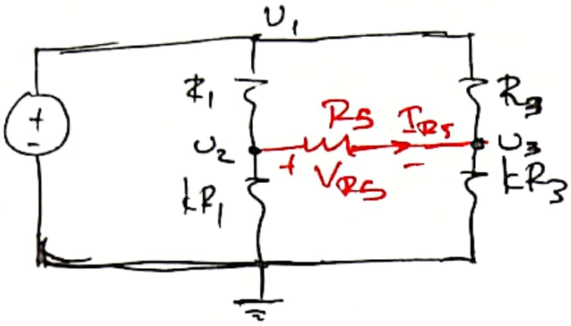
$$u_2 = \frac{kR_1}{R_1 + kR_1} \cdot V_s = \frac{k}{k+1} \cdot V_s$$

$$u_3 = \frac{kR_3}{R_3 + kR_3} \cdot V_s = \frac{k}{k+1} \cdot V_s$$

$$\Rightarrow \boxed{u_2 = u_3}$$

P2

Let's add a resistor:



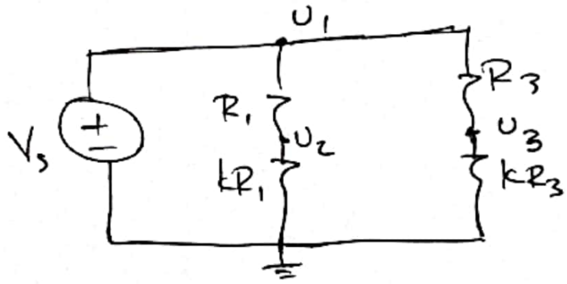
$V_{R5} = v_2 - v_3$ (element voltage def)

$V_{R5} = I_{R5} \cdot R_5$ (Ohm's law)

Bold assumption $v_2 = v_3$!

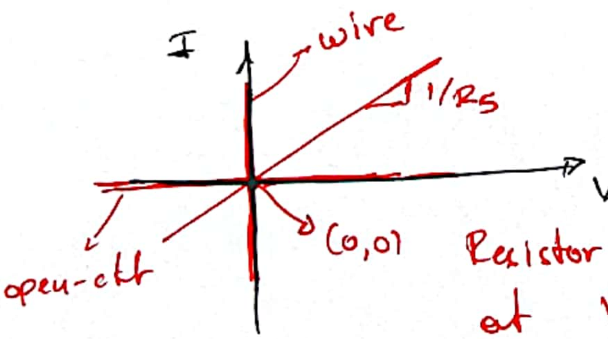
Guess: $v_2 = v_3 \Rightarrow V_{R5} = 0 \Rightarrow I_{R5} = 0 \Rightarrow$

My ckt looks like:



Analysis (from prev. page): $v_2 = \frac{k}{k+1} \cdot V_s$, $v_3 = \frac{k}{k+1} \cdot V_s$

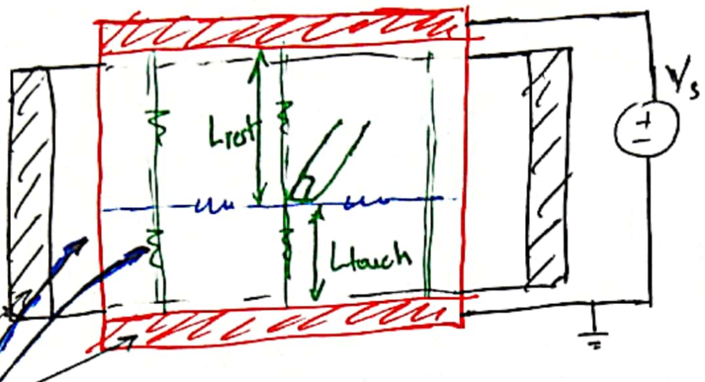
$\Rightarrow v_2 = v_3$ so my guess is validated! :)



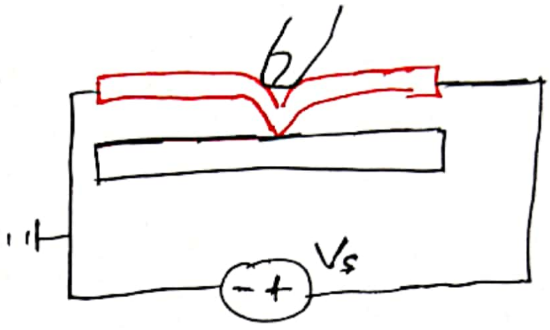
Resistor, wire and open-ckt behave the same at $V_{elem} = 0$, $I_{elem} = 0$

2D - Resistive Touchscreen

Top - View:

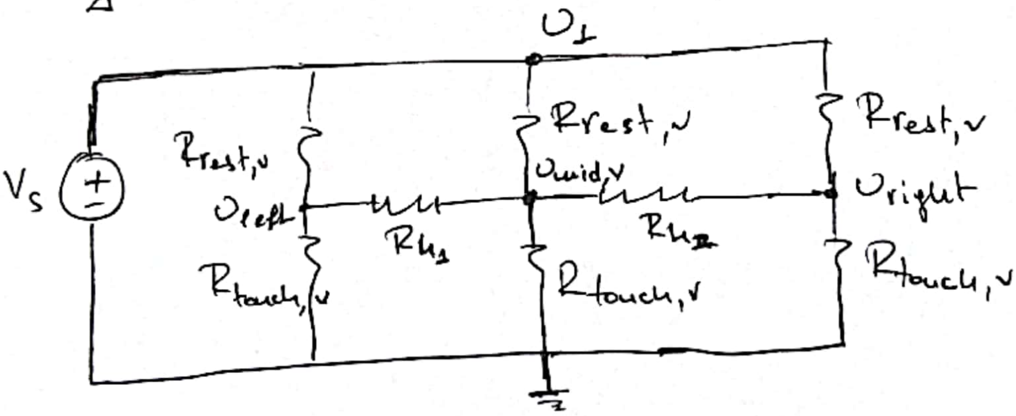


Side - View:



good conductors (low ρ - materials)
→ model as wires
poor conductors (high ρ - material)
→ model as resistors

Model of top plate



This is our "interesting" circuit!

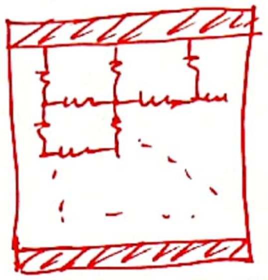
→ $U_{left} = U_{mid,v} = U_{right}$

$$U_{mid,v} = \frac{R_{touch,v}}{R_{rest,v} + R_{touch,v}} \cdot V_s = \frac{\rho \cdot \frac{L_{touch,v}}{A}}{\rho \frac{L_{rest,v}}{A} + \rho \frac{L_{touch,v}}{A}} \cdot V_s$$

$$\Rightarrow \boxed{U_{mid,v} = \frac{L_{touch,v}}{L_v} \cdot V_s}$$

→ vertical finger position information

Do I need a more precise model?

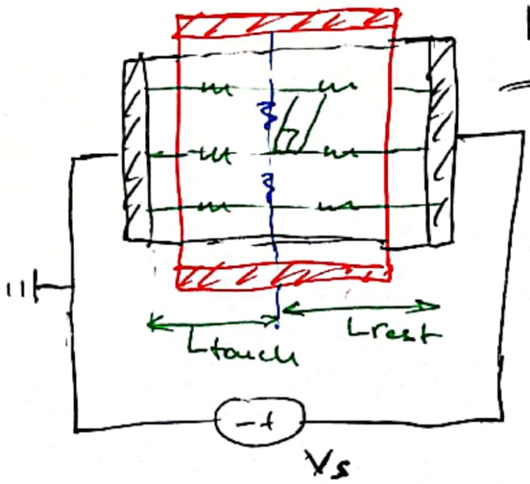


ALWAYS START SIMPLE WHEN MODELING!

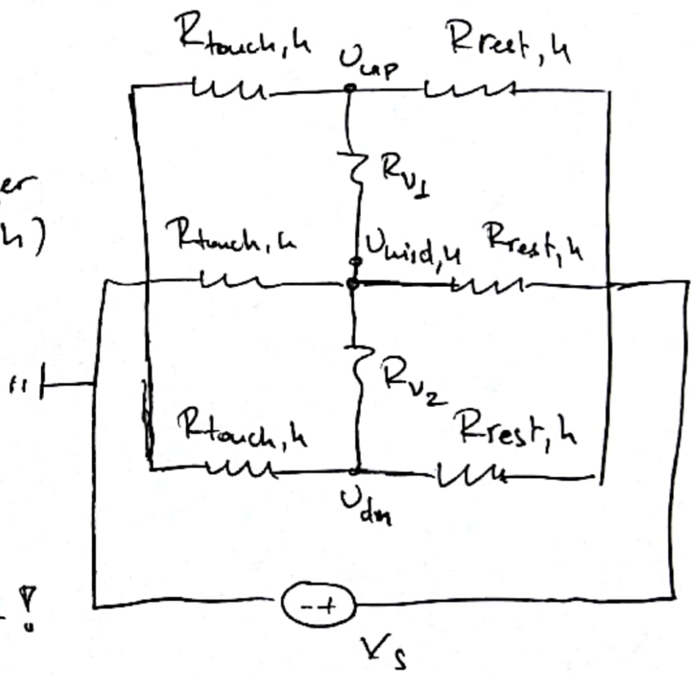
Drawbacks of this model:

1. It's too complicated
2. It doesn't help us get intuition
3. It gives the same result!

Horizontal Measurement:



Model the bottom layer (mesh) →



Also equiv. to "interesting" ckt!

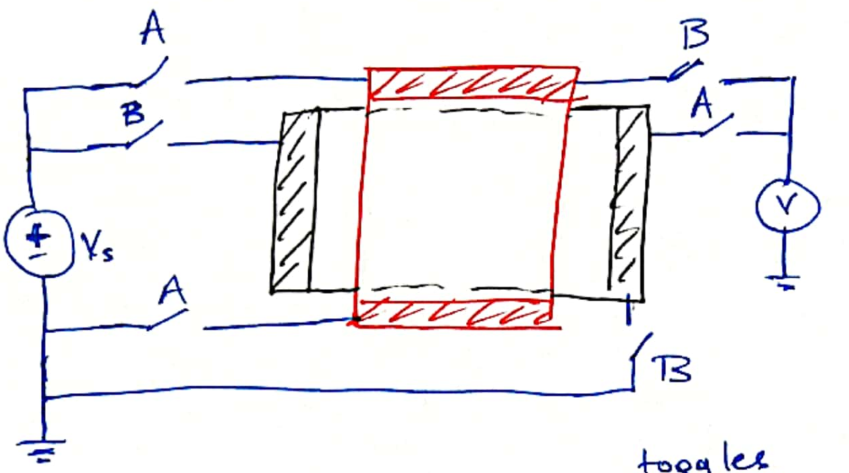
$$U_{up} = U_{dn} = U_{mid,h}$$

$$U_{mid,h} = \frac{R_{touch,h}}{R_{touch,h} + R_{rest,h}} \cdot V_s \Rightarrow$$

$$\boxed{U_{mid,h} = \frac{L_{touch,h}}{L_h} \cdot V_s}$$

→ horizontal finger position information!

Let's complete the picture!



A microcontroller ~~controls~~ toggles switches A and B very fast (sub-ms) to get horizontal and vertical position info during a single touch.

Superposition (aka ckt Jedi technique #1)

Reminder: Linear ~~fun~~ function: $f(x+y) = f(x) + f(y)$

Imagine a ckt w/ multiple sources (voltage and/or current sources)

Superposition says that I can analyze the ckt by looking at the effect of these voltages one at a time and then adding up the results.

* Procedure:

1. For each source k we zero-out all other sources and look at the output due to k, $V_{out,k}$
2. $$\sum_k V_{out,k} = V_{out}$$