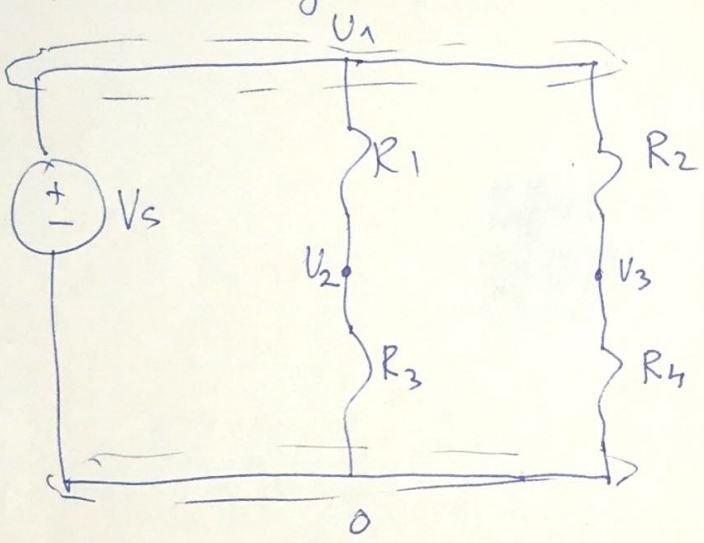
Lecture 4 – Module 2

* An interesting circuit – continued
* 2D Touchscreen
* A faster ckt analysis

An interesting circuit:



$V_2 = ?$ $\quad V_3 = ?$

$$V_2 - 0 = \frac{R_3}{R_1 + R_3} \cdot V_s$$

$$V_2 = \frac{R_3}{R_1 + R_3} V_s$$

$$V_3 = \frac{R_4}{R_2 + R_4} \cdot V_s$$

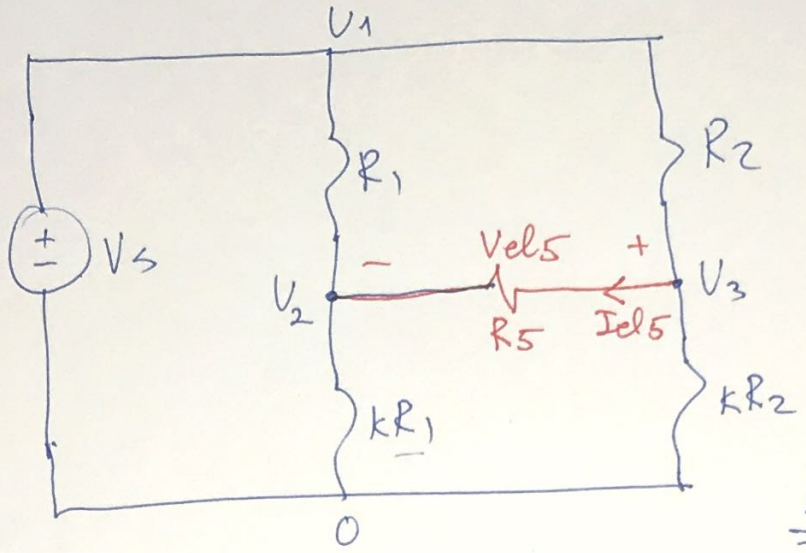
Let's have: $R_3 = kR_1$ & $R_4 = kR_2$

$$V_2 = ? = \frac{kR_1}{R_1 + kR_1} V_s = \frac{k}{1+k} V_s$$

$$V_3 = ? = \frac{kR_2}{R_2 + kR_2} V_s = \frac{k}{1+k} V_s$$

$$\Rightarrow V_2 = V_3$$

(12) Let's add a resistor:



$Vel_5 = V_3 - V_2$ (voltage def)

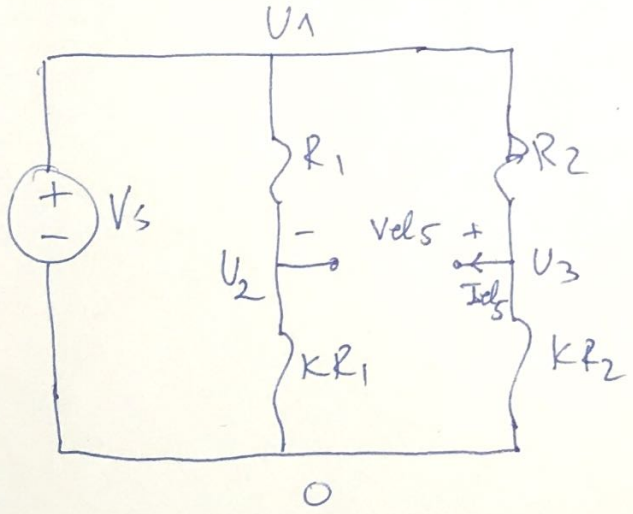
$Vel_5 = Iel_5 \cdot R_5$ (elem. def)

Bold assumption:

$Vel_5 = 0$

If $Vel_5 = 0 \Rightarrow Iel_5 = \frac{Vel_5}{R_5} = \frac{0}{R_5} = 0$

$\Rightarrow$ If $Iel_5 = 0 \Rightarrow$ the ckt is the same as the one we already analyzed (w/o R_5)



$Iel_5 = 0$

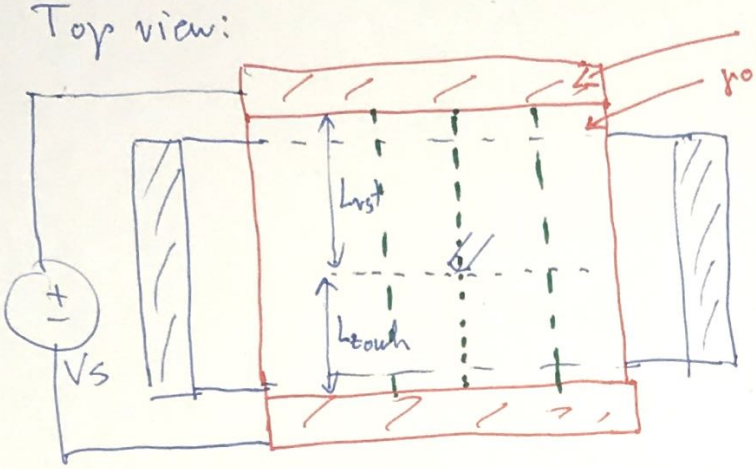
$V_2 = \frac{k}{1+k} V_s$

$V_3 = V_2 \Rightarrow Vel_5 = V_3 - V_2 = 0$

(l3)

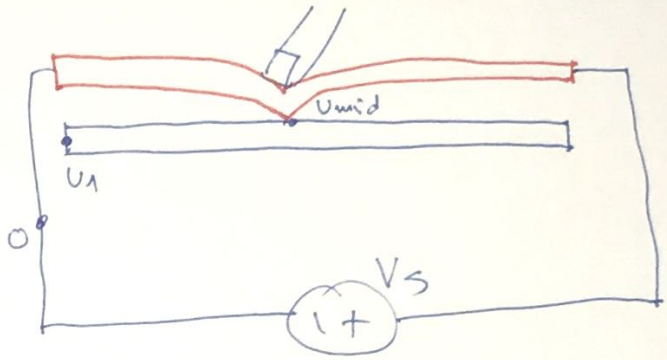
2D Touchscreen:

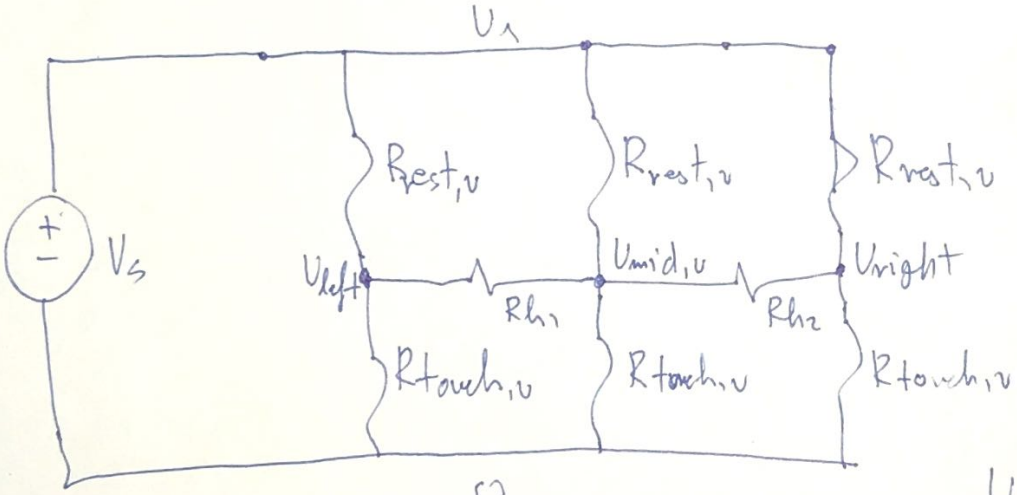
Top view:



- model as wires
- model as R's

Side view:





This is our "interesting" circuit

$$U_{mid,v} = U_{left} = U_{right}$$

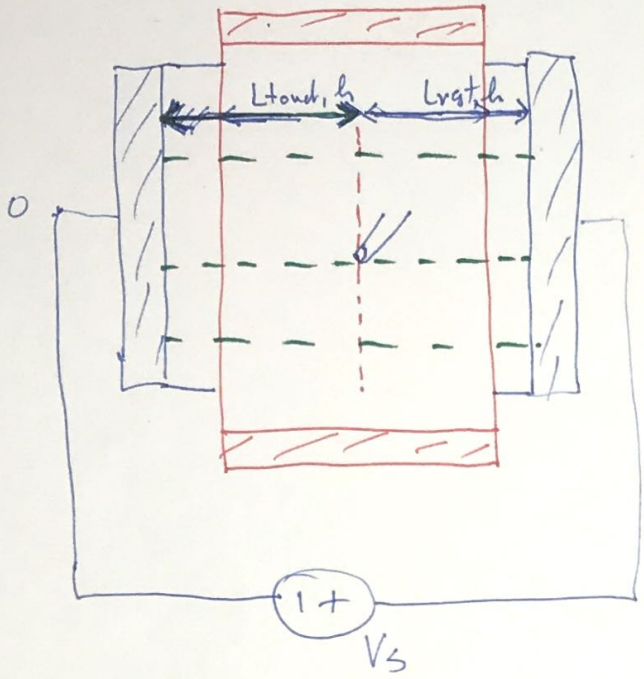
$$U_{mid,v} = \frac{R_{touch,v}}{R_{rest,v} + R_{touch,v}} \cdot V_s$$

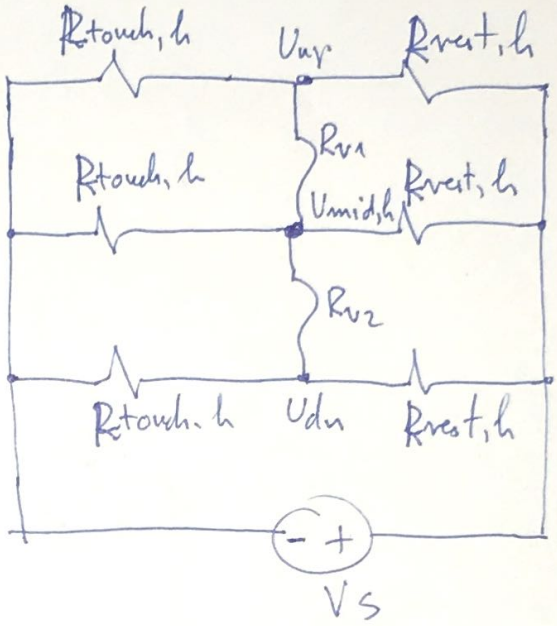
$$U_{mid,v} = \frac{\rho \cdot \frac{L_{touch,v}}{A}}{\rho \cdot \frac{L_{rest,v}}{A} + \rho \cdot \frac{L_{touch,v}}{A}} \cdot V_s$$

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

vertical finger position information.

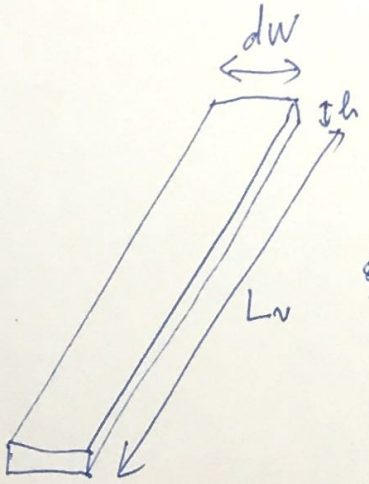
(l4) How do we determine the horizontal position?





$U_{ur} = U_{mid,h} = U_{dr}$

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



$A = dW \cdot h$

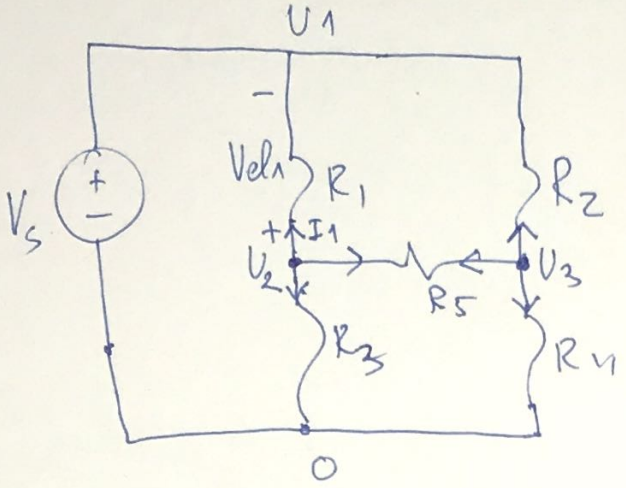
$$dR = \rho \cdot \frac{L_v}{A}$$

$$= \rho \cdot \frac{L_v}{dW \cdot h}$$

horizontal information

(15)

Faster ckt analysis:



Step 1: Label the nodes (unknowns & the ref. node)

Step 2: Write equations for nodes that have voltage sources between them.

$$U_1 - 0 = V_s \Rightarrow U_1 = V_s$$

Step 3: Write KCLs & IR element combo including any possible current sources:

$$I_1 = \frac{U_2 - U_1}{R_1} \quad \overset{Vel_1}{}$$

① $Vel_1 = I_1 \cdot R_1$ (elem. def)

$Vel_1 = U_2 - U_1$ (voltage def)

Magic:

Apply to U_2: $\frac{U_2 - \cancel{U_1}^{V_s}}{R_1} + \frac{U_2 - 0}{R_3} + \frac{U_2 - U_3}{R_5} = 0$

Apply to U_3: $\frac{U_3 - \cancel{U_1}^{V_s}}{R_2} + \frac{U_3 - U_2}{R_5} + \frac{U_3 - 0}{R_4} = 0$

$$U_2\left(\frac{1}{R_1} + \frac{1}{R_3} + \frac{1}{R_5}\right) - \frac{1}{R_5} U_3 = \frac{V_s}{R_1}$$

$$U_2 \cdot \left(-\frac{1}{R_5}\right) + U_3 \cdot \left(\frac{1}{R_2} + \frac{1}{R_5} + \frac{1}{R_4}\right) = \frac{V_s}{R_2}$$

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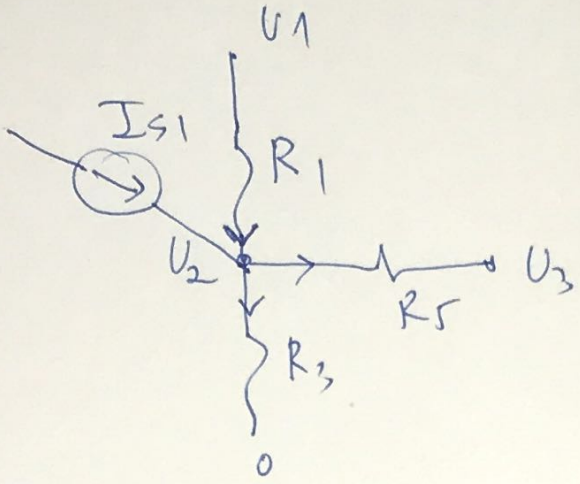

$$-I_{s1} - \underbrace{\frac{U_1 - U_2}{R_1}}_{\frac{U_2 - U_1}{R_1}} \quad \frac{U_2 - 0}{R_3} + \frac{U_2 - U_3}{R_5} = 0$$