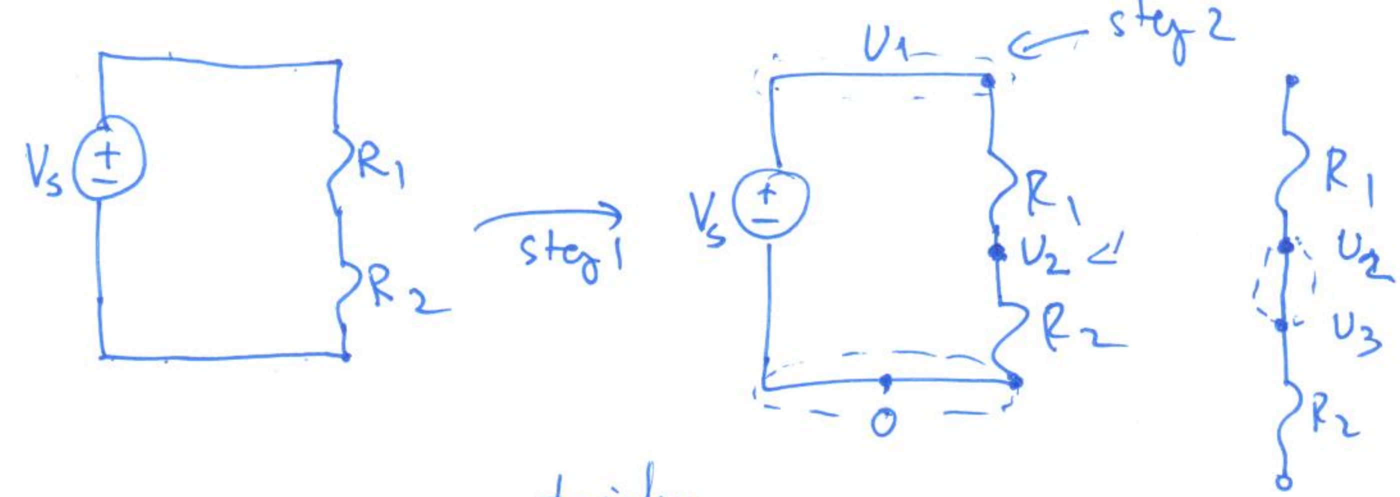
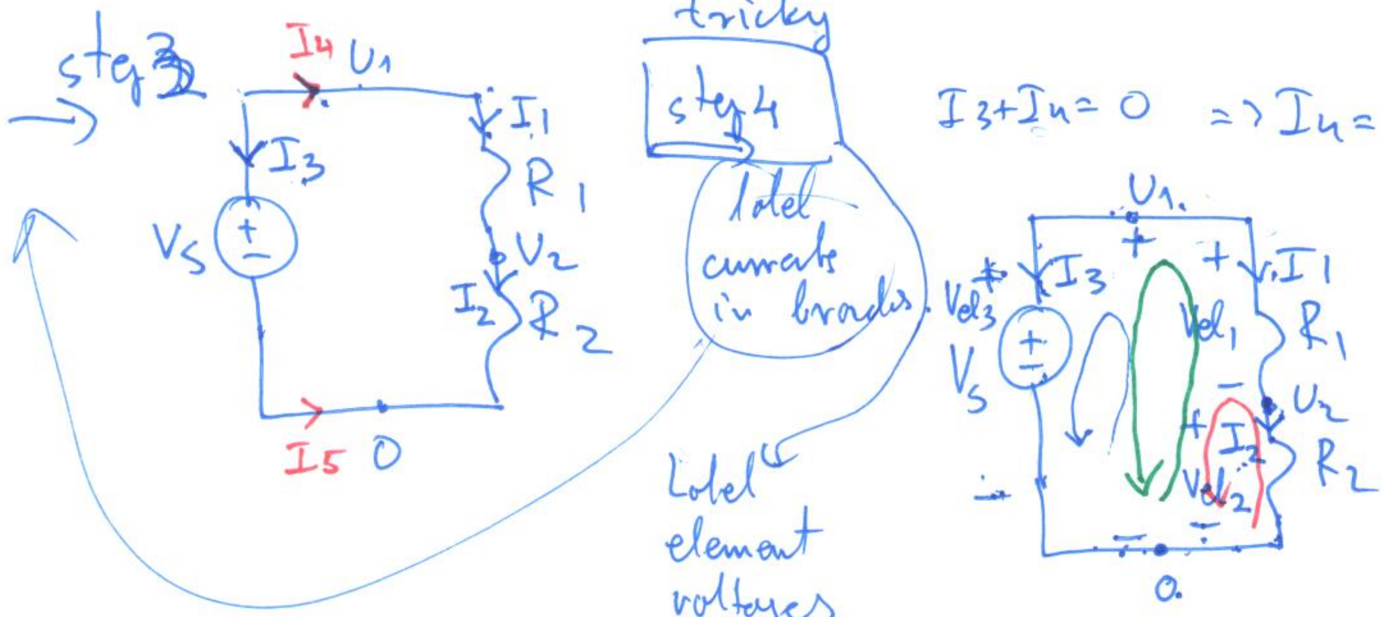
1.1 2/24/18

EE16A Touchscreen Lecture 2

Today:
- Review ckt analysis (voltage divider example)
- Touchscreen construction
- Modeling
- Analysis + Modeling to design touchscreen





$I_3 + I_4 = 0 \Rightarrow I_4 = -I_3$

by "passive-sign" convention

step 5

$$\vec{x} = \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ U_1 \\ U_2 \end{bmatrix}$$

step 6 KCL

$$I_1 + I_3 = 0 \quad (1)$$

$$I_1 = I_2 \Rightarrow I_1 - I_2 = 0 \quad (2)$$

step 7

$$Vel_3 = V_S \qquad Vel_1 = I_1 R_1 \; ; \; Vel_2 = I_2 R_2$$

$$U_1 - Vel_3 = 0 \Rightarrow U_1 = Vel_3 \Rightarrow \boxed{U_1 = V_S} \; (3) \qquad U_2 - Vel_2 = 0$$

$$\boxed{U_2 - I_2 R_2 = 0} \; (4)$$

(l3) $V_1 \neq$

$$Vel_2 + Vel_1 - U_1 = 0$$

$$U_2 + Vel_1 - U_1 = 0$$

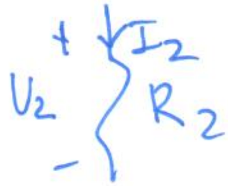
$$\underline{U_2 + I_1 R_1 - U_1 = 0} \quad (5)$$

$$R_1 I_1 + 0 \cdot I_2 + 0 \cdot I_3 + (-1) \cdot U_1 + U_2 = 0$$

$$\begin{bmatrix} 1 & 0 & 1 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & -R_2 & 0 & 0 & 1 \\ +R_1 & 0 & 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ U_1 \\ U_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ V_s \\ 0 \\ 0 \end{bmatrix}$$

$$I_1 = \frac{V_s}{R_1 + R_2}, \quad I_2 = \frac{V_s}{R_1 + R_2}, \quad I_3 = -\frac{V_s}{R_1 + R_2}$$

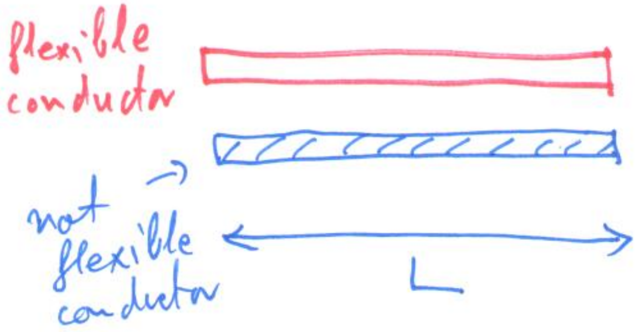
$$U_1 = V_s, \quad \boxed{U_2 = \frac{R_2}{R_1 + R_2} V_s} = \frac{V_s}{1 + \frac{R_1}{R_2}}$$

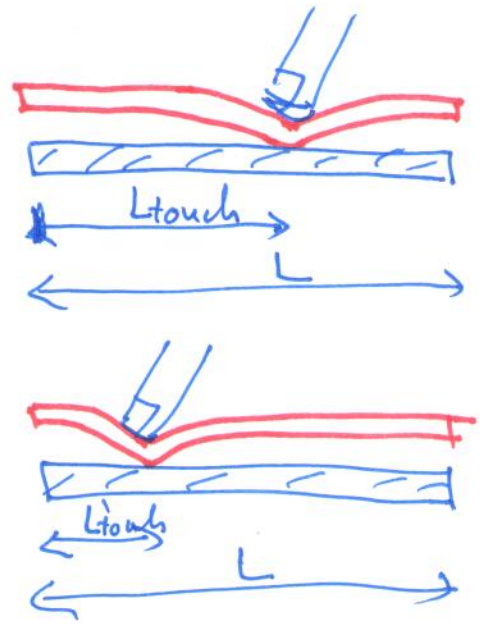


(voltage divider)

Resistive touchscreen:

1D





Want to measure $\frac{L_{touch}}{L}$

Need to convert to electrical quantities.

16A Physics

* Charge – can be either positive or negative
  basic element of electrical "stuff" (electron) flows
  Unit: Coulomb [C]
* Current
  Net amount of charge that passes through some cross-section area over some period of time:

$$I = \frac{dQ}{dt}$$

I ← [A], dQ ← [C], dt ← [s]

* Voltage : Represents the energy to move a unit of charge from one point to the other

Unit of charge [C]

V_{AB} $B \rightarrow A$

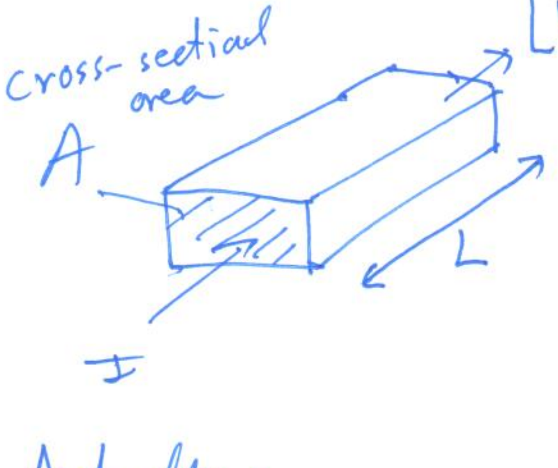
$$[V] = \frac{[J]}{[C]}$$

* Resistance : Real pieces of metal always require a certain amount of energy to be spent to allow charge to flow through

Unit [Ω]

$$V = I \cdot R$$

$$[V] = [A] \cdot [\Omega]$$



$$\underset{[\Omega]}{R} = \underset{[\Omega \cdot m]}{\rho} \cdot \frac{L_{[m]}}{A_{[m^2]}}$$

↑ materials property (resistivity)

Actually :

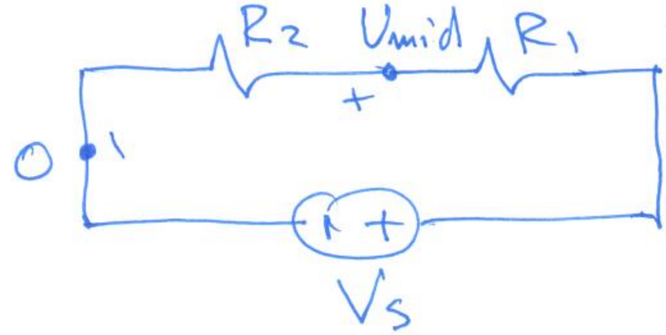
$$R_2 = \rho \cdot \frac{L_{touch}}{A}$$

Model :

$$R_1 = \rho \cdot \frac{L_{rest}}{A}$$

(26)

Build a circuit using this model to measure $\frac{L_{touch}}{L}$ as an electrical quantity (voltage)



$$U_{mid} = \frac{R_2}{R_1 + R_2} \cdot V_s$$

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

$$U_{mid} = \frac{L_{touch}}{L} \cdot V_s$$

always measure $\frac{L_{touch}}{L}$ regardless of the material

What I really have: