EECS 16A Module 2, Lecture 6

Logistics

- MT scores released.
- OH today : 1-1 Conversations
- Advising today 4pm.

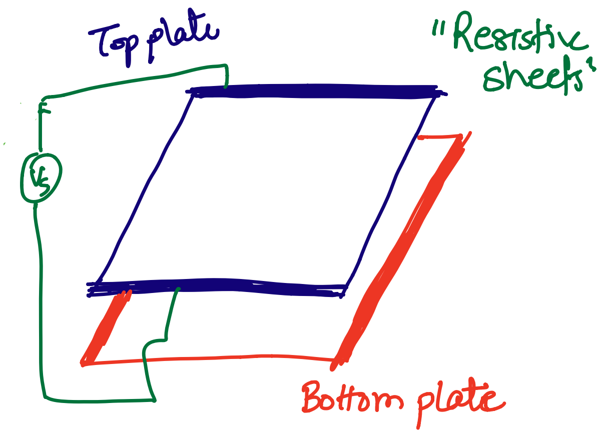
Today:

- What does it mean to "make a model"?
- 2D Touchscreen recap.
- Equivalence: Resistance in series and parallel
- Superposition : Power of Module 1 in Module 2.
  Linearity of circuits.

- Page Rank
- Power of modeling

Physical Reality:

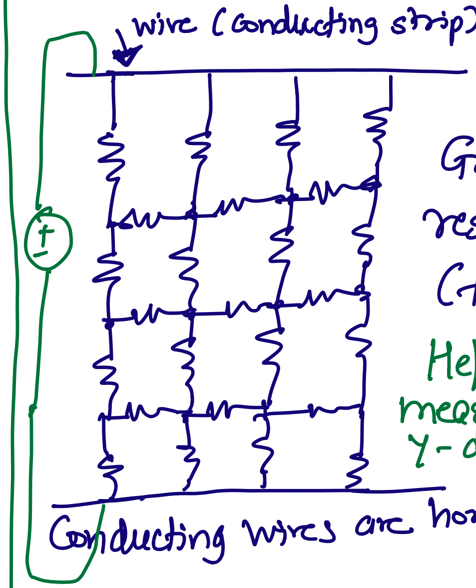
Two resistive sheets.



Dark shaded areas / or / are conducting strips like wires.

The grid of resistors is a MODEL for the physical reality of the continuous plate.

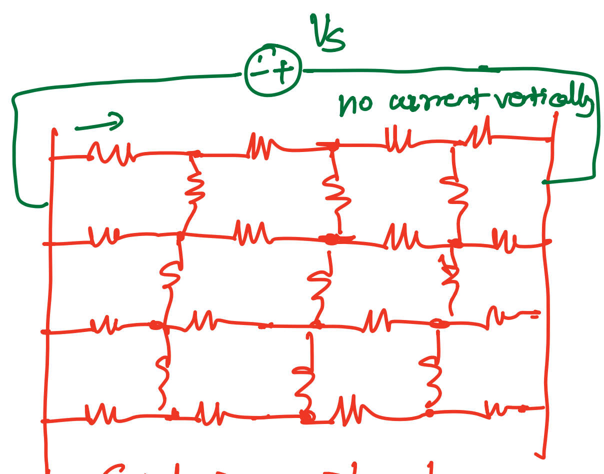
Model for reality.



Grid of resistors (top)

Helps measure Y-direction

Conducting wires are horizontal

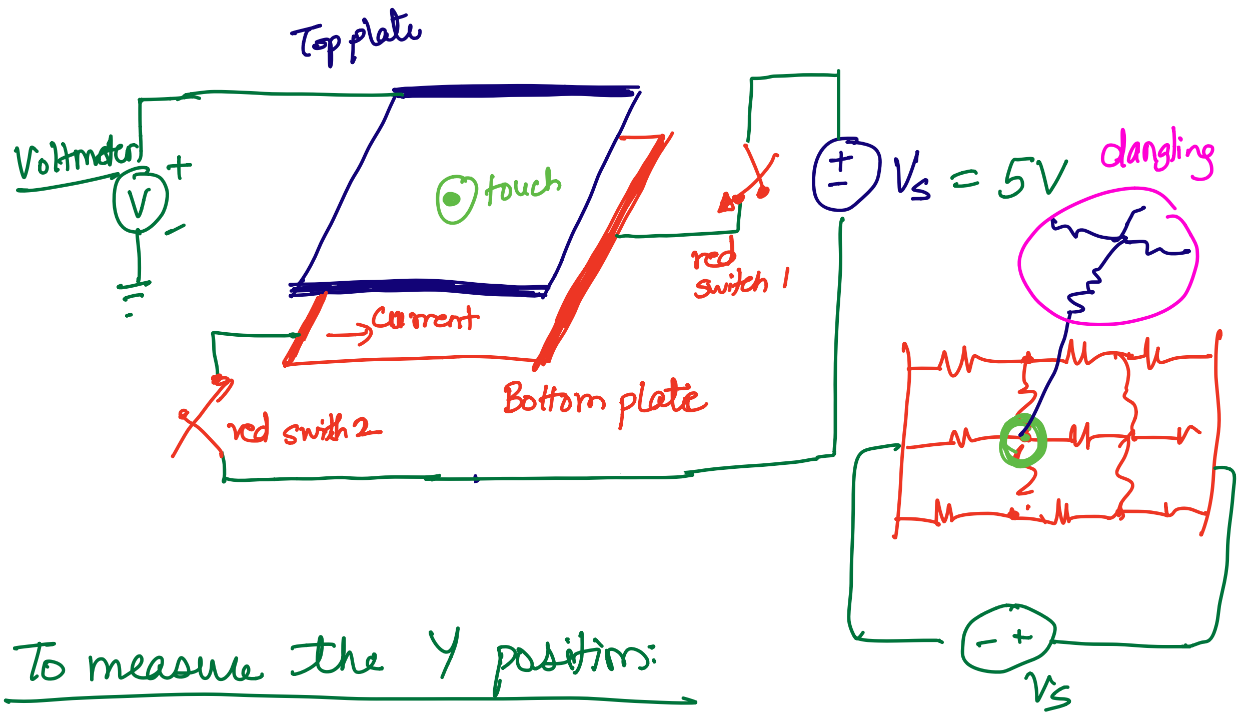


Grid of resistors to model bottom plate

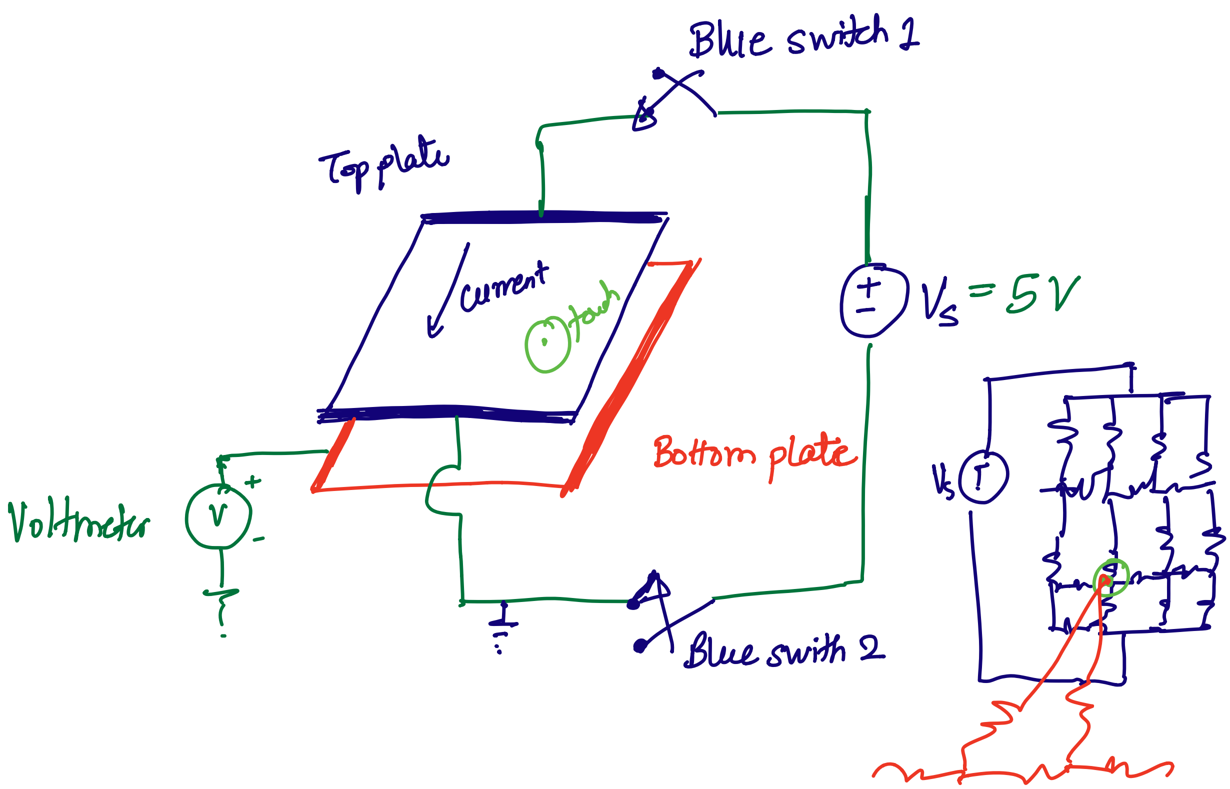
Conducting wires are vertical

Helps measure the x direction.

To measure the X position (horizontal position)

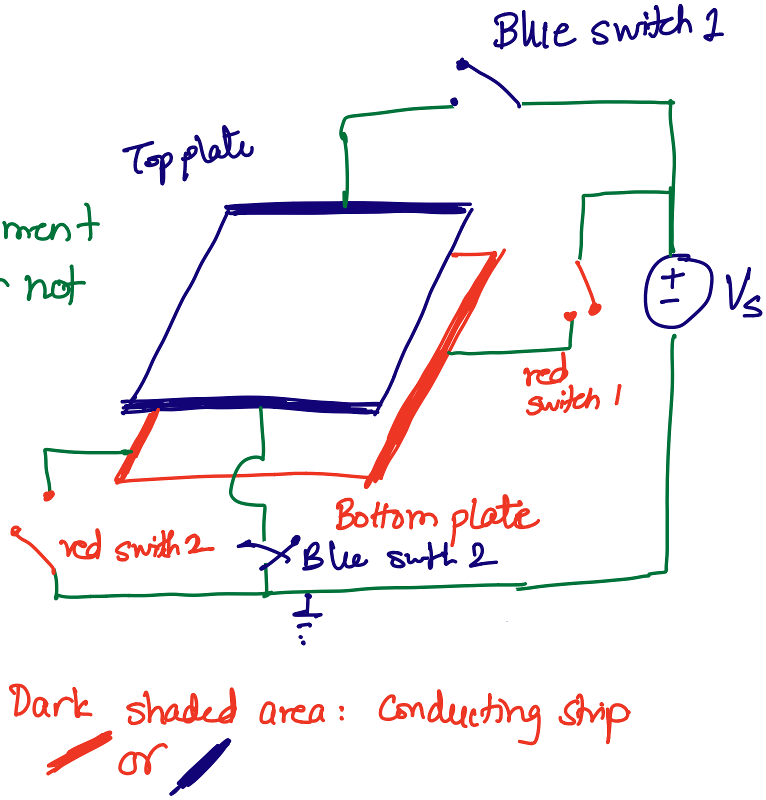


To measure the Y position:



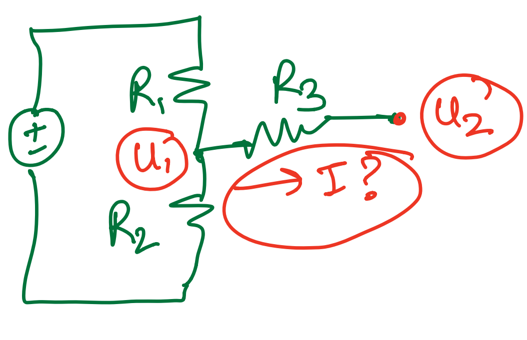
Putting it together:

Measurement voltmeter not shown for clarity



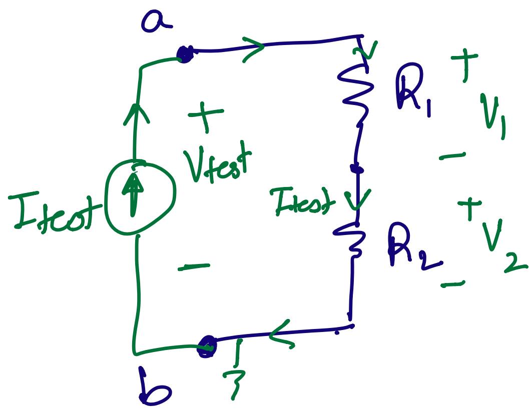
Turn both blue switches on, red OFF

red ON blue OFF



$\boxed{u_1 = u_2}$

Equivalence : I - V at nodes a, b
Current and voltage to be the same for both circuits.



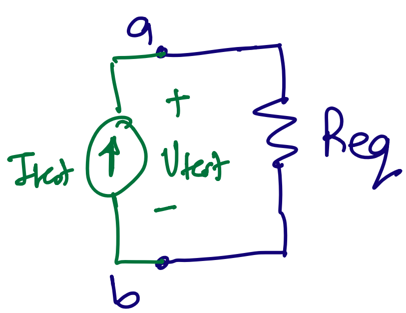
$$V_1 = I_{test} \cdot R_1$$

$$V_2 = I_{test} \cdot R_2$$

$$V_{test} = V_1 + V_2 \quad (KVL)$$

$$= I_{test} \cdot R_1 + I_{test} \cdot R_2$$

$$= I_{test} \cdot (R_1 + R_2)$$



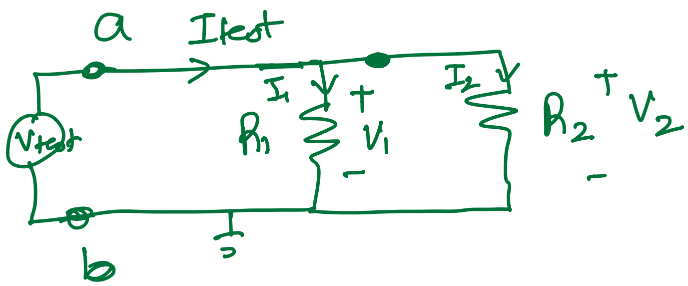
$$V_{test} = I_{test} \, (R_{eq})$$

$$\Longrightarrow \quad R_{eq} = R_1 + R_2$$

"Equivalence of circuits"

Resistors in series.

Equivalence 2: Resistance in parallel.



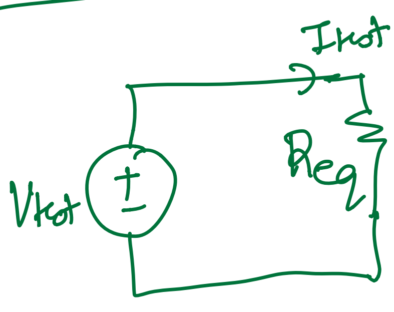
$$I_{test} = I_1 + I_2.$$

$$V_1 = I_1 R_1 \quad , \quad V_2 = I_2 R_2$$

$$V_1 = V_2 = V_{test}$$

$$V_{test} = I_1 R_1 \quad , \quad V_{test} = I_2 R_2$$

$$I_{test} = I_1 + I_2 = \frac{V_{test}}{R_1} + \frac{V_{test}}{R_2} = V_{test}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$



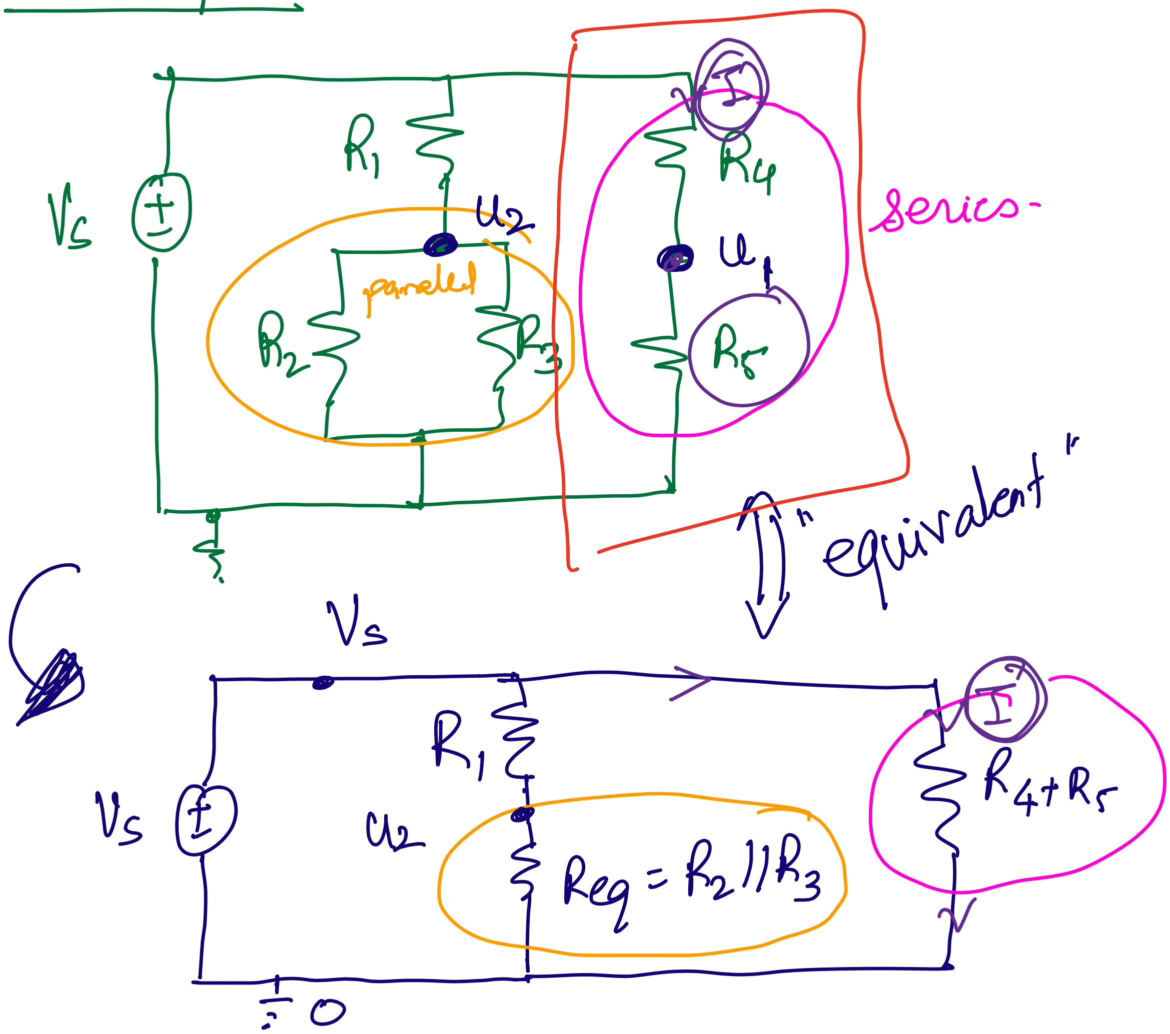
- $V_{test} = I_{test} \cdot R_{eq}$

$$\Rightarrow I_{test} = \frac{V_{test}}{R_{eq}}$$

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$ Resistance in parallel

Notation: $R_{eq} = R_1 \,//\, R_2$

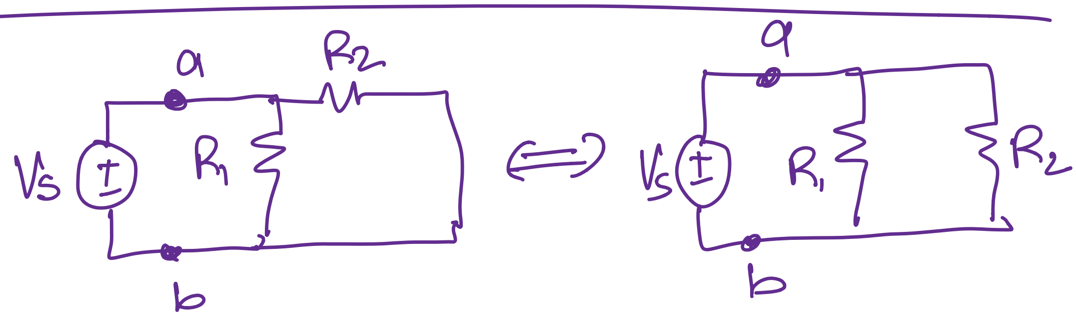
Example:



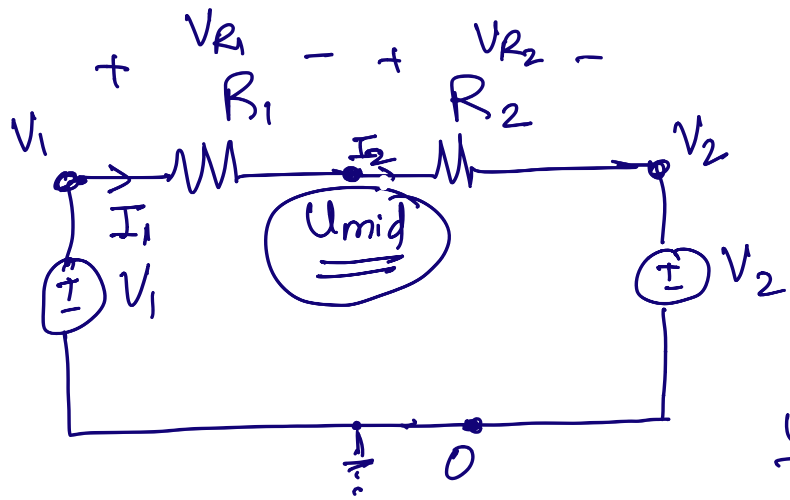
What happend to u_1?

$$u_2 = \frac{R_2 // R_3}{R_1 + (R_2 // R_3)} \cdot V_s$$

$$V_S = I(R_4 + R_5)$$



Superposition : Power of the linarity of circuits



NVA

Unknown:

U_{mid}, I_1

Known: V_1, V_2, R_1, R_2

KCL: $I_1 = I_2$

Element eqns: $V_{R_1} = I_1 R_1$, $V_{R_2} = I_2 R_2$

Substitue:

$$V_{R_1} = V_1 - U_{mid} = I_1 R_1 \quad (1)$$

$$V_{R_2} = U_{mid} - V_2 = I_2 R_2 = I_1 R_2 \quad (2)$$

(1) $\Rightarrow$

$$U_{mid} + I_1 R_1 = V_1$$

(2)

$$U_{mid} - I_2 R_2 = V_2$$

$$I_1 = \frac{V_1 - V_2}{R_1 + R_2}$$

$$U_{mid} = \frac{R_1 V_2 + R_2 V_1}{R_1 + R_2}$$

$$\vec{x} = \begin{bmatrix} U_{mid} \\ I_1 \end{bmatrix}$$

$$\underbrace{\begin{bmatrix} 1 & R_1 \\ 1 & -R_2 \end{bmatrix}}_{A} \begin{bmatrix} U_{mid} \\ I_1 \end{bmatrix} = \underbrace{\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}}_{\vec{b}}$$

$$\vec{x} = A^{-1} \vec{b}$$