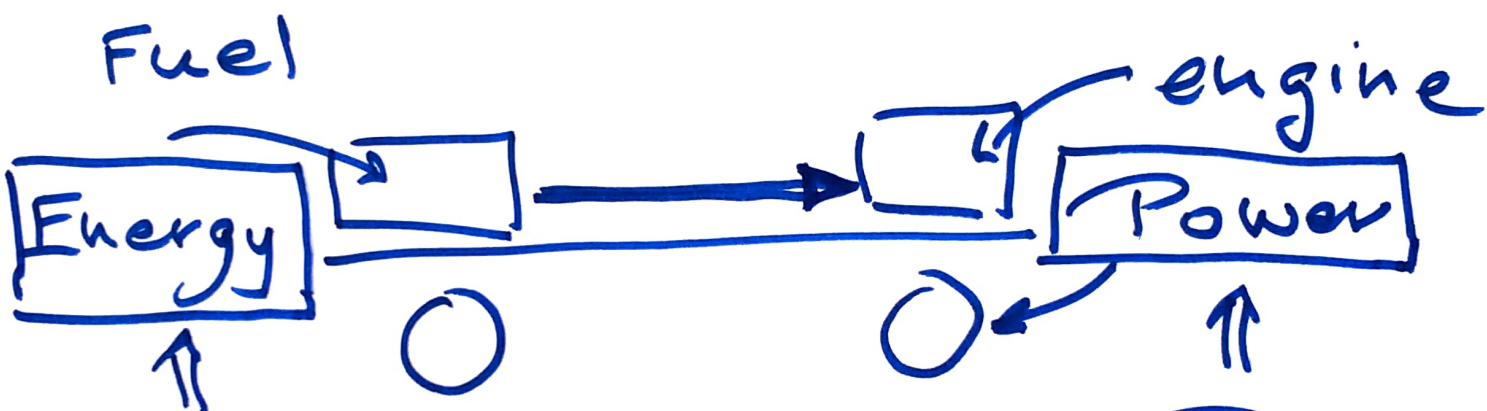


EECS 16A

Module 2, Lecture 3

- Energy & Power
- 2D resistive touch screen



$$P = \frac{\Delta E}{\Delta t} = \frac{dE}{dt}$$

$$E = P \cdot \Delta t = \int_0^{\Delta t} P(t) dt$$

Power P [W]

Energy E [J] = [W·s]

E.g. light bulb

(2)

10W, 1h

$$E = 10W \cdot 1h = \underline{10Wh}$$

$$= 10 \cdot W \cdot 3600s$$

$$= 36,000 \text{ W}\cdot\text{s}$$

$$= 36 \text{ kJ}$$

$$E = 10 \cdot 10h = \underline{100Wh}$$

Battery: stores energy

unit "energy" [Ah] = C_{bat}

AA cell $V_c = 1.5V$

Energy: $V_c \cdot C_{bat}$

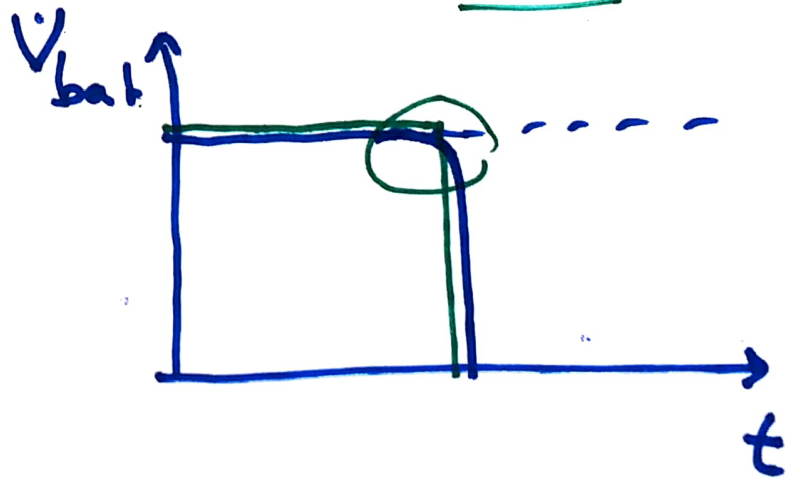
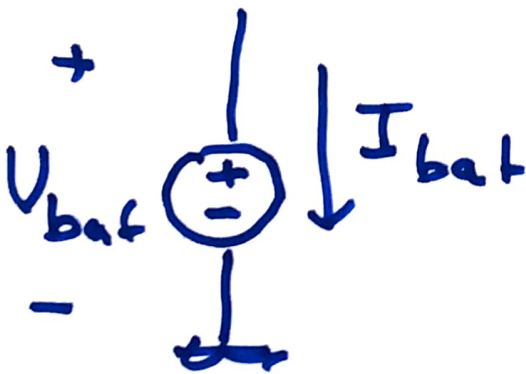
$$= 1.5V \cdot 1Ah = 1.5 \cdot W \cdot h$$

3

$$1.5 \text{ Wh} = 1.5 \cdot \text{W} \cdot 3600 \text{ s} \\ \approx 5000 \text{ Ws}$$

1 Ah ←
can deliver 1 A
for 1 hour.

or 0.1 A for 10 h



$$E, P \Rightarrow V, I$$

(4)

Definition:

$$V_{ab} = \frac{dE_{ab}}{dq} = [V]$$

Coulomb

Charge q electrons [C]

Current:

$$I = \frac{\Delta q}{\Delta t} = \frac{dq}{dt}$$
$$= [A]$$

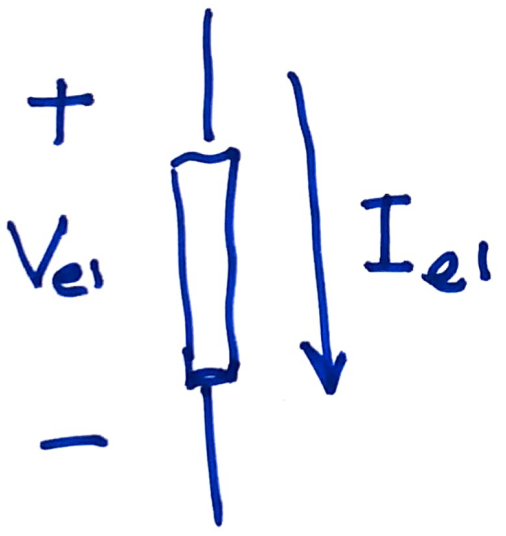
E.g. $1A = \frac{1C}{1s}$

$$1C \Rightarrow 6.2 \cdot 10^{18} \text{ electrons}$$

⑤

$$P = \frac{dE}{dt} = \underbrace{\frac{dE}{dq}}_V \cdot \underbrace{\frac{dq}{dt}}_I = V \cdot I$$

Passive sign convention:



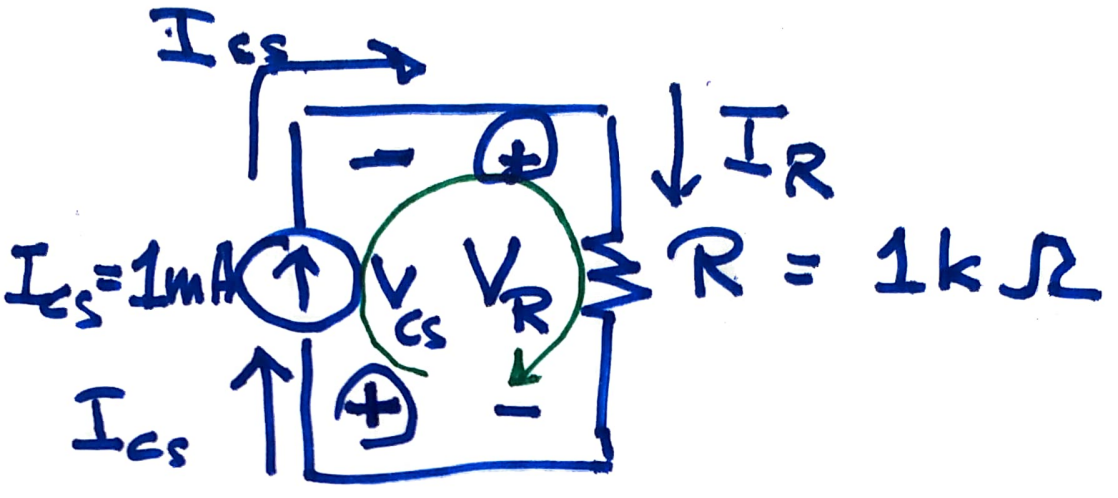
$$P_{diss} = V_{e1} \cdot I_{e1}$$

↑
Power dissipated

$$P_{diss} < 0$$

⇓
power delivered
to rest of
ckt

Example 1



$$I_R = I_{cs}$$

$$V_R = R \cdot I_R = 1\text{k}\Omega \cdot 1\text{mA} = 1\text{V}$$

power: $P_R = V_R \cdot I_R$
 $= 1\text{V} \cdot 1\text{mA} = 1\text{mW}$

dissipated!

7

KVL:

$$V_{CS} + V_R = \emptyset$$

$$V_{CS} = -V_R = -1V$$

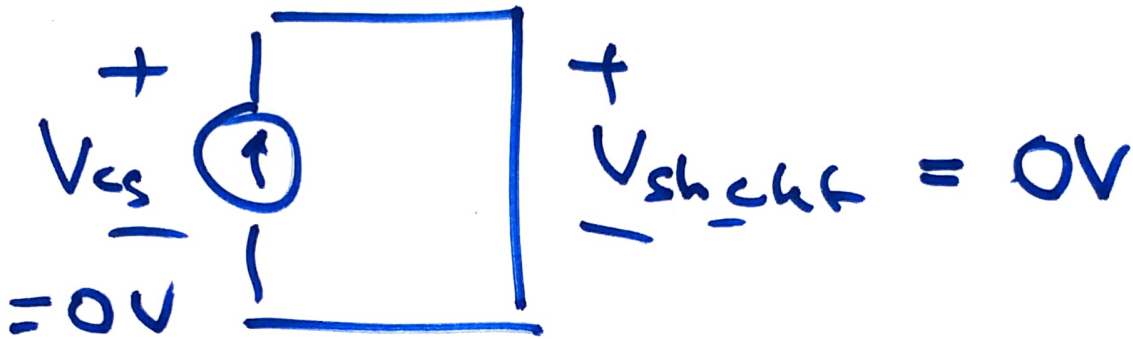
$$\begin{aligned} P_{CS} &= V_{CS} \cdot I_{CS} \\ &= -1V \cdot 1mA \\ &= -1mW \end{aligned}$$

delivers power
(to R)

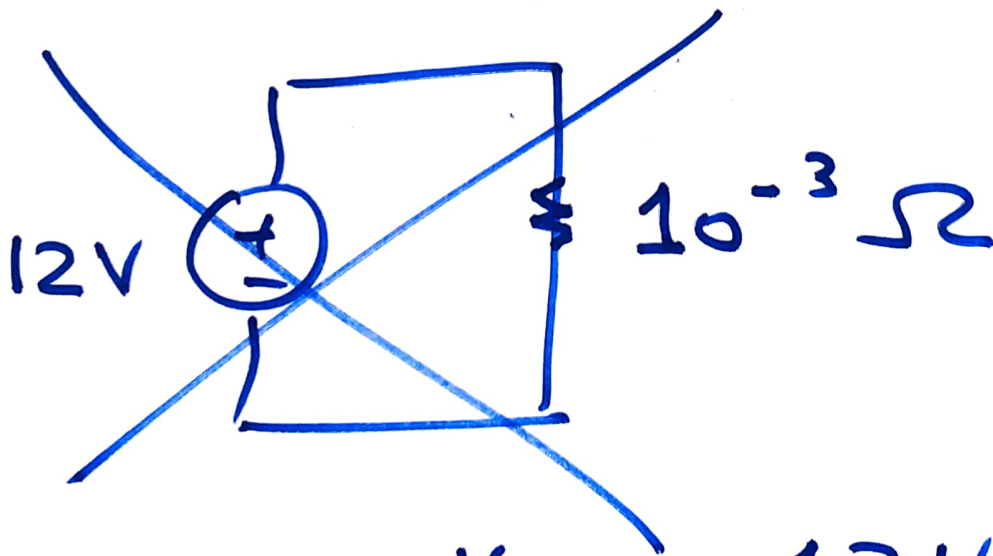
$$\begin{aligned} P_R + P_{CS} &= 1mW + (-1mW) \\ &= \emptyset \end{aligned}$$

②

Short ckt



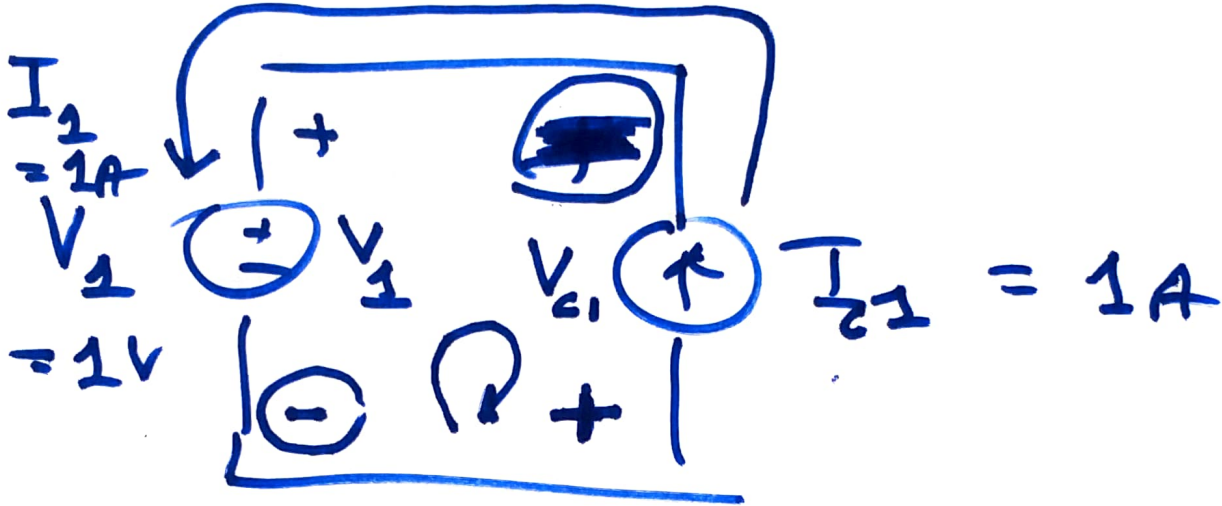
$$P_{cs} = V_{cs} \cdot I_{cs} = 0!$$



$$I = \frac{V}{R} = \frac{12V}{10^{-3} \Omega} = 12,000 A$$

9

Ex 2:



KVL:

$$-V_1 - V_{c1} = 0$$

$$\therefore V_{c1} = -V_1$$

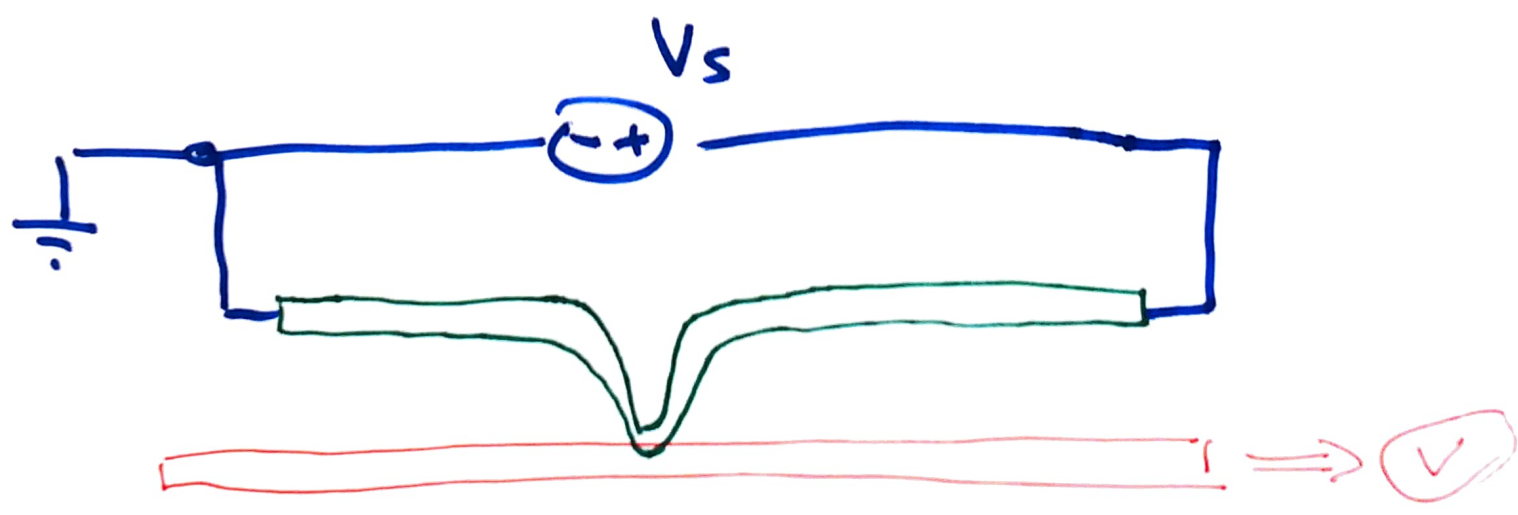
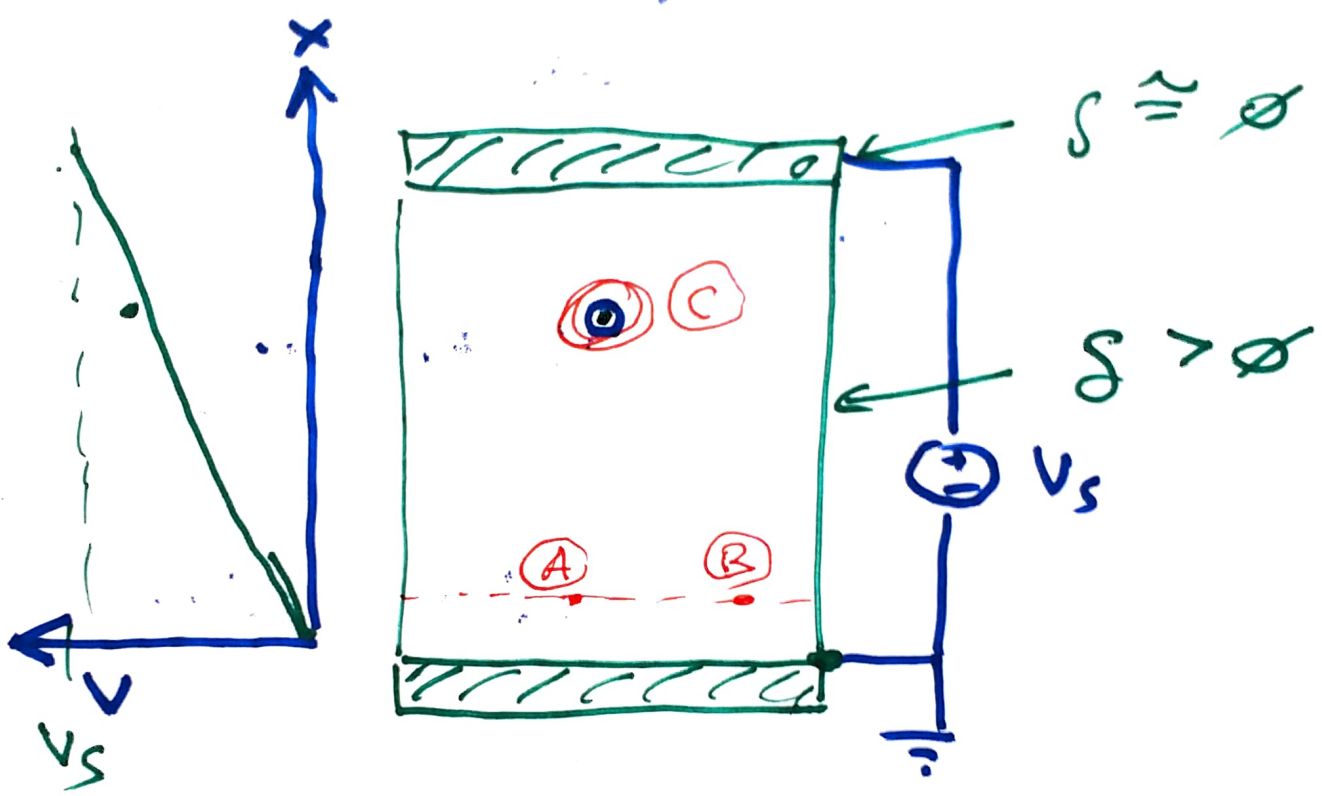
$$P_{cs} = -V_1 \cdot I_{c1} = -1V \cdot 1A = -1W$$

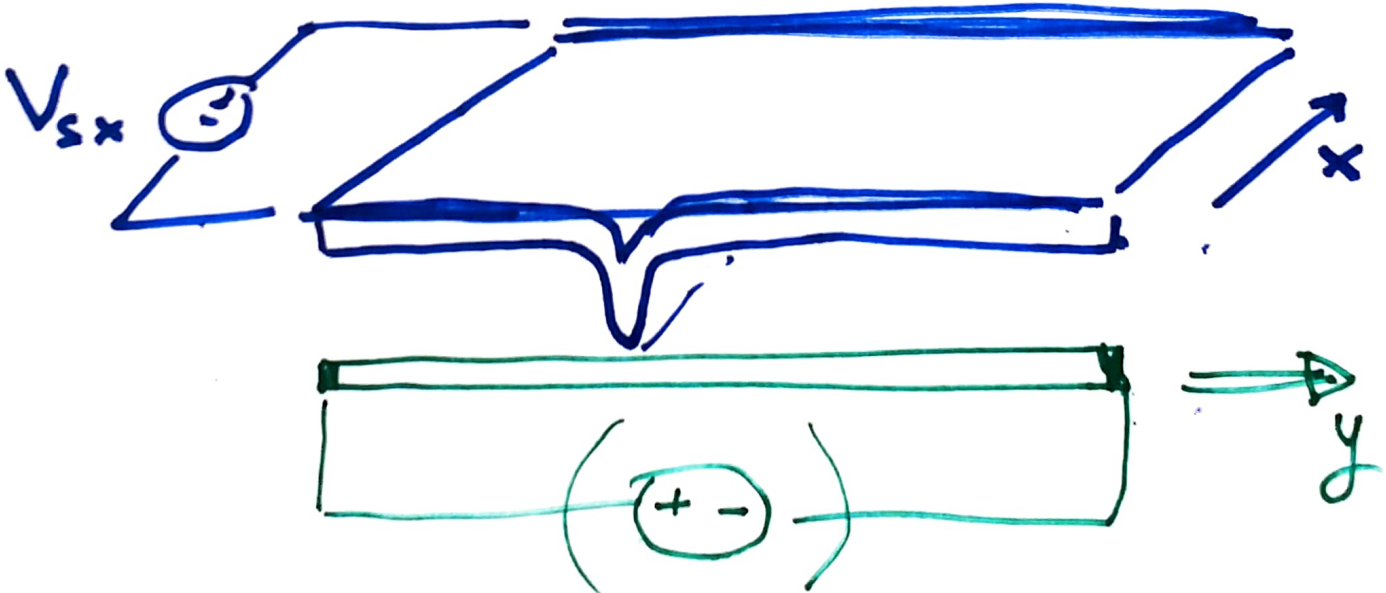
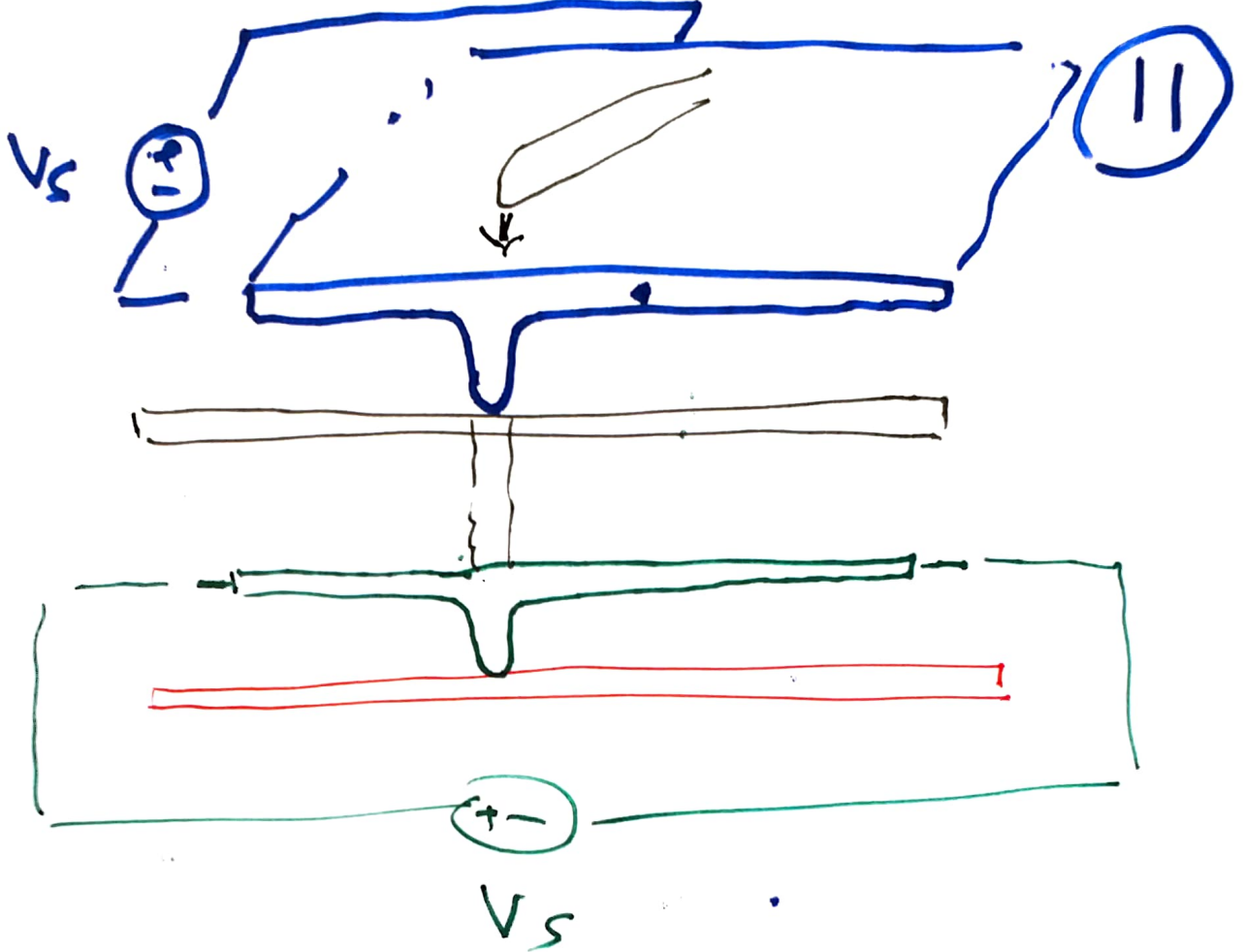
$$P_{vs} = V_1 \cdot I_{c1} = +1W$$

$$P = 0$$

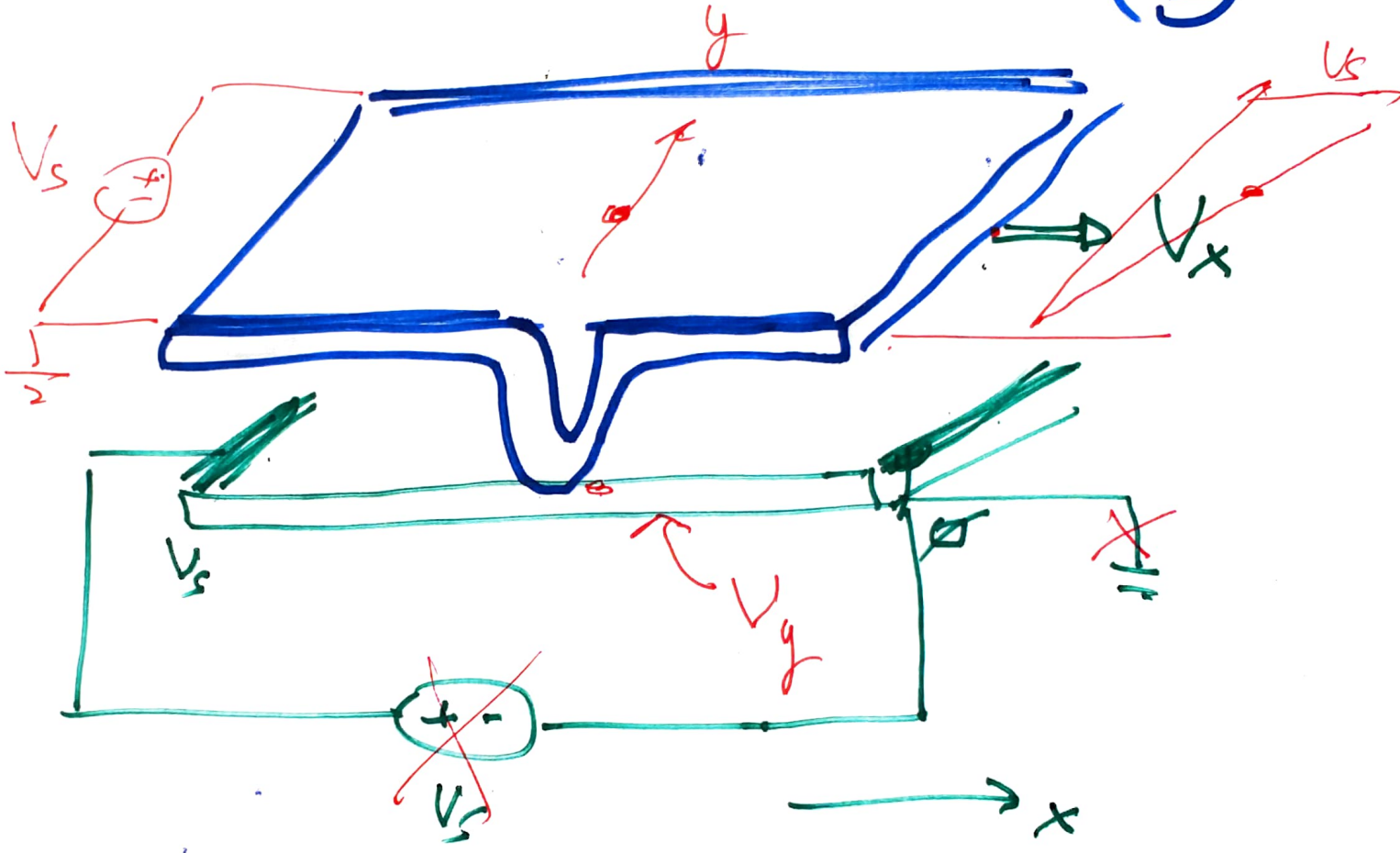
10

2D touch screen

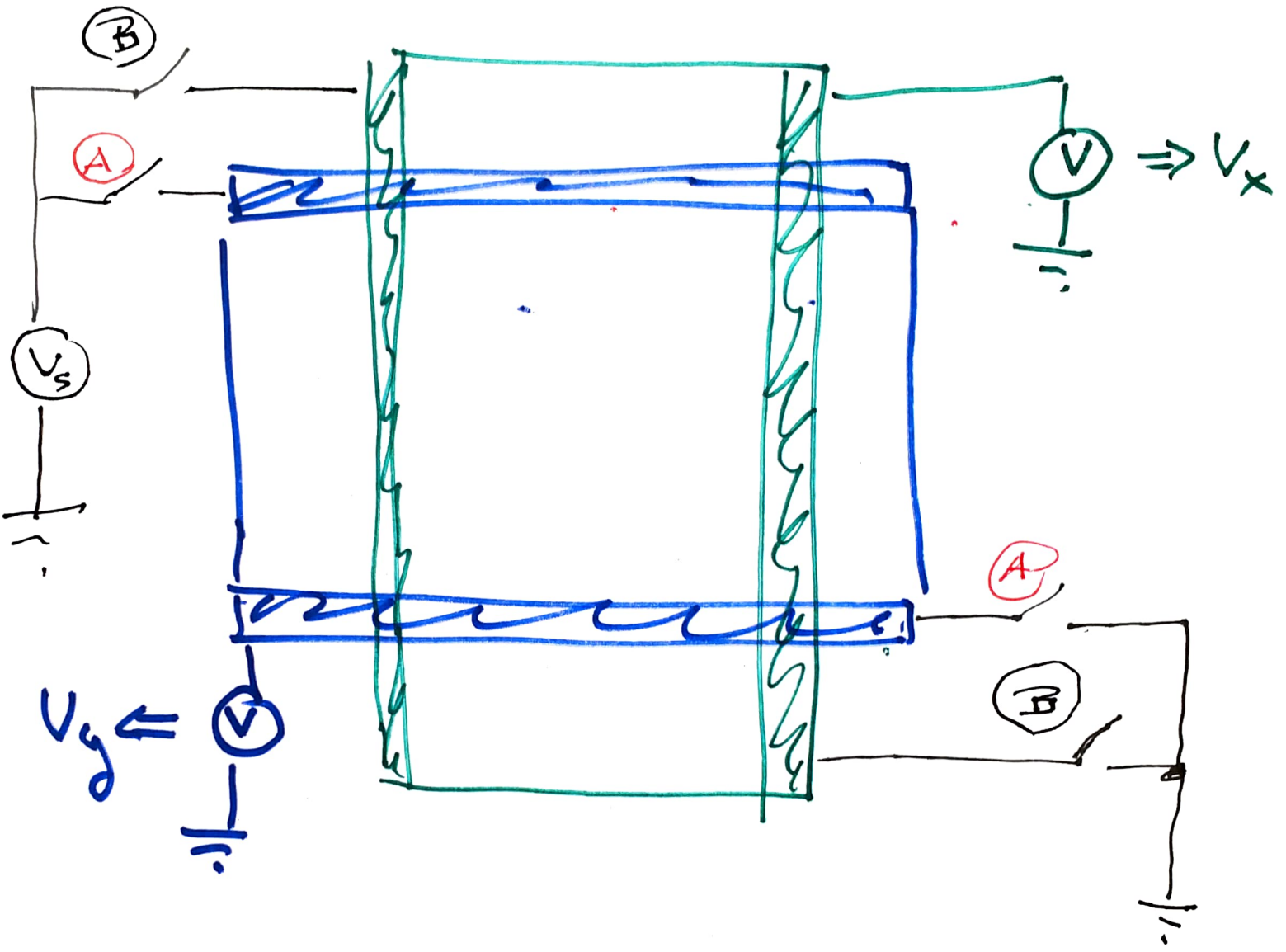




18



13



μC

14

