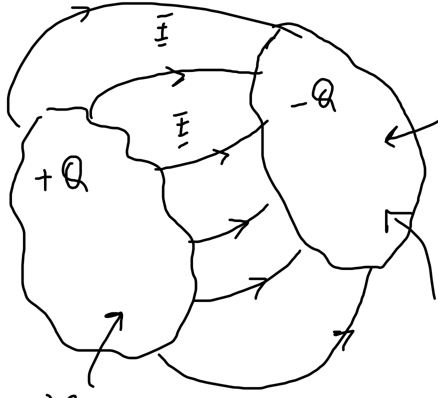
Condensatore



armatura del condensatore

Si vede che $Q \propto \Delta V$

V più piccolo

V più grande

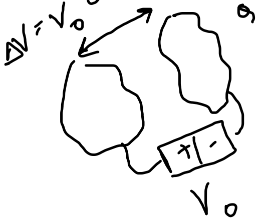
$$C = \frac{Q}{\Delta V}$$

capacità

C non dip. da Q o ΔV

ma dip. solo geometria (e materiali tra le armature)

Se fornisco ΔV al condensatore allora il = immagazzina la carica $Q = C\,\Delta V$



$$[C] = \frac{[Q]}{[\Delta V]} = \frac{C}{V} \overset{def}{=} \text{Faraday} \quad F$$

(mF) μF pF nF

Come si calcola la capacità di un condensatore? $C = \frac{Q}{\Delta V}$

1) Immagino di mettere una carica $+Q$ e $-Q$ sulle armature

2) Calcolo il $\underline{E}$ generato

($\underline{\text{th}}$ Gauss oppure metodo più complicato)

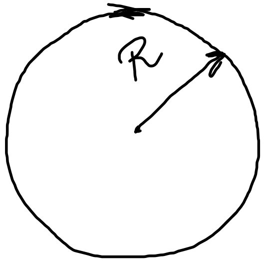
3) $\Delta V = -\int \underline{E} \cdot d\underline{l}$

qualunque percorso tra le armature

4) $C = \frac{Q}{\Delta V}$

1) Conduttore -

$$C = \frac{Q}{V}$$



(effetto punto) $V = \frac{Q}{4\pi\varepsilon_0 R}$

Per conduttore sferico: $C = \frac{\cancel{Q}}{\cancel{Q}} 4\pi\varepsilon_0 R = \underline{\underline{4\pi\varepsilon_0 R}}$

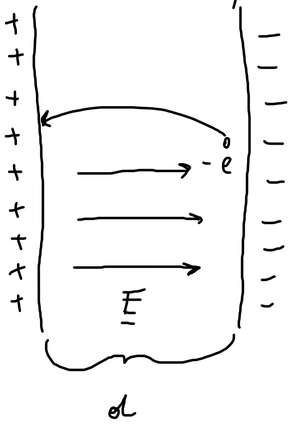
$\varepsilon_0 \approx \underline{8.85}\cdot 10^{-12} \frac{m^2}{NC^2}$ $\sim 10^{-11}$

$R \sim 10$ cm $\quad C \sim 10^{-11}\cdot 10^{-2} \sim 10^{-13}$ F

~ 0.1 pF

$R \sim 6{,}37\cdot 10^{6}$ m $\quad C \sim 10^{-11}\cdot 6\cdot 10^{6} \sim 10^{-4}$ F $\sim 0{,}1$ mF

2) Condensatore piano



Lato L delle armature $\quad L \gg d$

$$\underline{E} = ? \longrightarrow E = \frac{\sigma}{\varepsilon_0}$$

σ → dens. sup. carica su armature

$\Delta V = ?$

$$C = \frac{Q}{\Delta V}$$

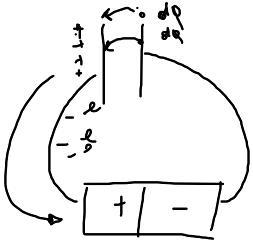
$$\Delta V = \underbrace{\frac{\sigma}{\varepsilon_0}}_{E} \cdot \underbrace{d}_{\text{distanza}}$$

$$C = \frac{\underbrace{\cancel{\sigma} \cdot \overbrace{L^2}^{\text{sup. armature}}}_{Q}}{\frac{\cancel{\sigma}\, d}{\varepsilon_0}} = \varepsilon_0 \, L^2/d$$

C alta: armature grandi e molto vicine

Il condensatore carico come serbatoio di energia

Per caricare un condensatore lo collego ad una batteria



$$C = \frac{Q}{\Delta V} \quad ; \quad Q = C\Delta V$$

$$\Delta V \rightsquigarrow V_0$$

Quanta energia è necessaria per caricare il condensatore?

$$dW = dq\,V$$

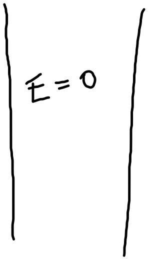
$$W = \underbrace{\Sigma\, dq\, V}_{\text{tutto il processo di carica}} = \underbrace{\int dq\, V(q)}_{\text{tutto il processo di carica}} = \int_0^Q \frac{dq \cdot q}{C} = \frac{1}{C}\int_0^Q dq\, q = \frac{1}{C}\frac{q^2}{2}\Big|_0^Q = \frac{Q^2}{2C}$$

$$C = \frac{q}{V(q)} \Rightarrow V(q) = \frac{C}{q}$$

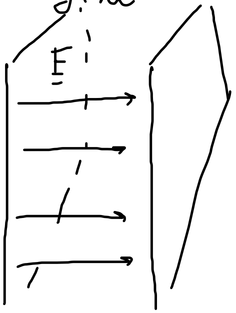
$$= \frac{C^2 V_0^2}{2C} = \frac{1}{2} C V_0^2$$

$$Q = C \cdot V_0$$

Inizio



Fine



$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 L^2}$$

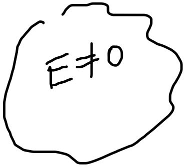
Condens. piano

$\underbrace{\frac{\text{energia}}{m^3}}$: densità volumetrica di energia

$$W = \frac{Q^2}{2C} = \frac{\varepsilon_0^{\cancel{2}}\, \cancel{L^4}^{\,2}\, E^2}{2\, \cancel{\varepsilon_0}\, \cancel{L^2}/d} = \left(\frac{1}{2}\varepsilon_0 E^2\right)\cdot \underbrace{\left(L^2 \cdot d\right)}_{\text{Volume della regione dove } E \neq 0}$$

$\varepsilon_0 L^2/d$

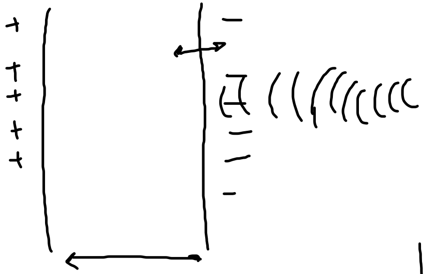
$Q = \varepsilon_0 L^2 E$



$$U = \int \underbrace{\frac{1}{2}\varepsilon_0 E^2}\, dV$$

u_E : densità di energia

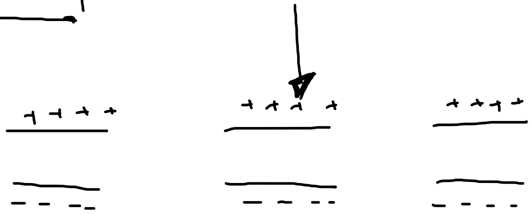
Dispositivi che fanno uso di condensatori



$$C = \varepsilon_0 \frac{Sup}{dist}$$

Q

$$V = \frac{Q}{C} \updownarrow$$



(tasto)

Ogni cond. ha Q

$C \uparrow$ quando premete un tasto

$V \downarrow$

Defibrillatore

$$P = \frac{W}{\Delta t}$$