Elektrik Potansiyel

$\vec{\nabla} \times \vec{E} = 0$ $\qquad \vec{E} = \vec{\nabla} f \qquad \partial_x \partial_y = \partial_y \partial_x$

$$\vec{\nabla}_j \times (\vec{\nabla} f) = \overbrace{\epsilon_{ijk}}^{A_i} \partial_j \partial_k f$$

$$\epsilon_{123} = -\epsilon_{132}$$

$$\int \vec{\nabla} \times \vec{E} = 0 \qquad \epsilon_{123}\, \partial_2 \partial_3 = \underbrace{\epsilon_{132}}_{-\epsilon_{123}}\, \partial_3 \partial_2$$

Stokes $\qquad\qquad \partial_2 \partial_3$

$$\oint \vec{E} \cdot d\vec{l} = 0 \qquad 0 = -0 \text{ ancak}$$

$$V(\vec{r}) \equiv - \int_{\mathcal{O}}^{\vec{r}} \vec{E} \cdot d\vec{l}$$

$\mathcal{O}$ = referans noktası

Ancak 2 nokta arasında potansiyel tanımlıdır.

$$V(\vec{b}) - V(\vec{a}) = - \int_{\mathcal{O}}^{\vec{b}} \vec{E} \cdot d\vec{l} - \left[- \int_{\mathcal{O}}^{\vec{a}} \vec{E} \cdot d\vec{l} \right]$$

$$-\left[\int_{\vec a}^{\vartheta} \vec E\cdot d\vec l + \int_{\vartheta}^{\vec b}\vec E\cdot d\vec l\right]$$

$$-\left[\int_{\vec a}^{\vec b}\vec E\cdot d\vec l\right] = V_{\vec a\vec b}$$

$$V(\vec b)-V(\vec a) = \int_{\vec a}^{\vec b}(\vec\nabla V)\cdot d\vec l$$

$$\Rightarrow \vec E = -\vec\nabla V$$

Poisson ve Laplace Denklemi

$$\vec\nabla\cdot\vec E = \rho/\epsilon_0 \qquad \vec\nabla\times\vec E = 0$$

$$E = -\vec\nabla V \qquad 0 = 0$$

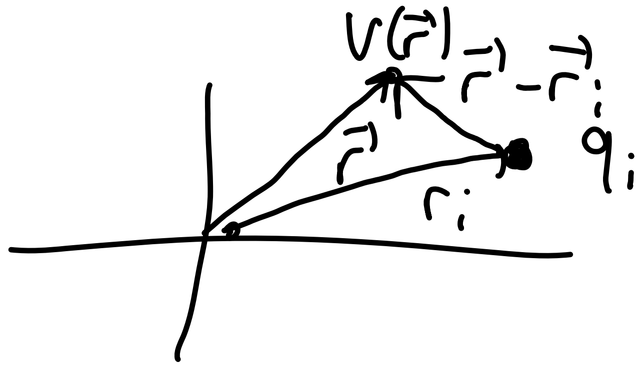
$$-\nabla^2 V = \rho/\epsilon_0 \Rightarrow \nabla^2 V = -\rho/\epsilon_0$$

Poisson

$$\nabla^2 V = 0 \Rightarrow \text{Laplace}$$

Lokal yük dağılımında

$$V_i(\vec r) = \frac{1}{4\pi\epsilon_0}\,\frac{q}{|\vec{\mathscr{r}}_i|} \qquad \vec{\mathscr{r}}_i = \vec r - \vec r_i$$



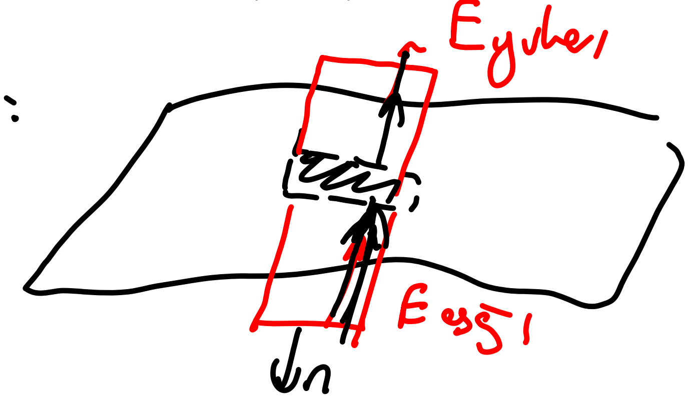
$$V(\vec r) = \frac{1}{4\pi\epsilon}\sum \frac{q_i}{|\vec{\mathscr{r}}_i|}$$

← 1-dim

$$V(\vec r) = \frac{1}{4\pi\epsilon_0}\int \frac{\lambda(\vec r\,')}{|\vec{\mathscr{r}}|}\,dl'$$

$$V(\vec r) = \frac{1}{4\pi\epsilon}\int \frac{\rho(\vec r\,')}{|\vec{\mathscr{r}}|}\,dV$$

<u>Sınır Şartları:</u>



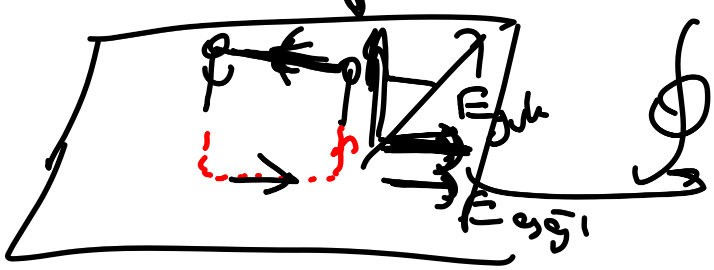
$$\oint \underbrace{\vec{E}\cdot d\vec{A}} = \frac{q_{enc}}{\epsilon_0} = \frac{\sigma\cancel{A}}{\epsilon_0} =$$

$E_{yukarı}$

$$\left(E_{yukarı}A - E_{aşağı}A\right) = \left(E_{yukarı} - E_{aşağı}\right)\cancel{A}$$

$E^{\perp} \Rightarrow$ yüzeyde discontinous (süreksiz)

$$E^{\perp}_{yukarı} = E^{\perp}_{aşağı} + \frac{\sigma}{\epsilon_0}$$



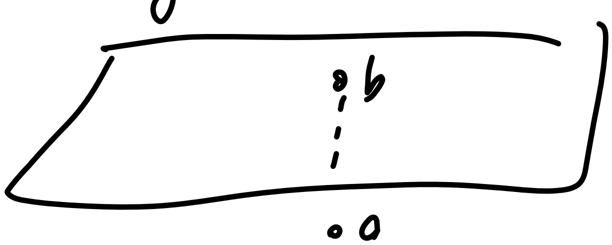
$$\oint \vec{E}\cdot d\vec{l} = 0$$

$$-E^{\parallel}_{yukarı}\, l + E^{\parallel}_{aş}\, l = 0$$

$$\cancel{l}\left[-E^{\parallel}_{yuk} + E^{\parallel}_{aşağı}\right] = 0$$

$$E^{\parallel}_{yukarı} = E^{\parallel}_{aşağı}$$

$$\vec{E}_{yukarı} = \vec{E}_{aşağı} + \frac{\sigma}{\epsilon_0}\hat{n}$$



$$V_b - V_a = -\int_a^b \vec{E}\cdot d\vec{l} = 0$$

$$\vec{E} = -\vec{\nabla} V$$

$$\vec{E}_{yukarı} - \vec{E}_{aşağı} = \frac{\sigma}{\varepsilon_0}\hat{n}$$

$$\vec{\nabla} V_{yukarı} - \vec{\nabla} V_{aşağı} = -\frac{\sigma}{\varepsilon_0}\hat{n}$$

$$\frac{\partial V_{yukarı}}{\partial n} - \frac{\partial V_{aşağı}}{\partial n} = -\frac{1}{\varepsilon_0}\sigma$$

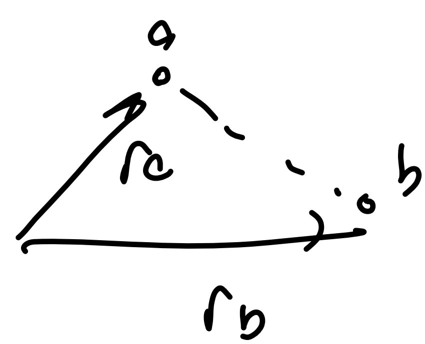
$$\frac{\partial V}{\partial n} = \vec{\nabla} V \cdot \hat{n}$$

Potensiyel Enerji

$$\overset{\vec{r}}{V(\vec{b})} - \overset{\infty}{V(\vec{a})} = \frac{W}{Q}$$

$$\vec{b} = \vec{r}$$

$$\vec{a} = \infty$$



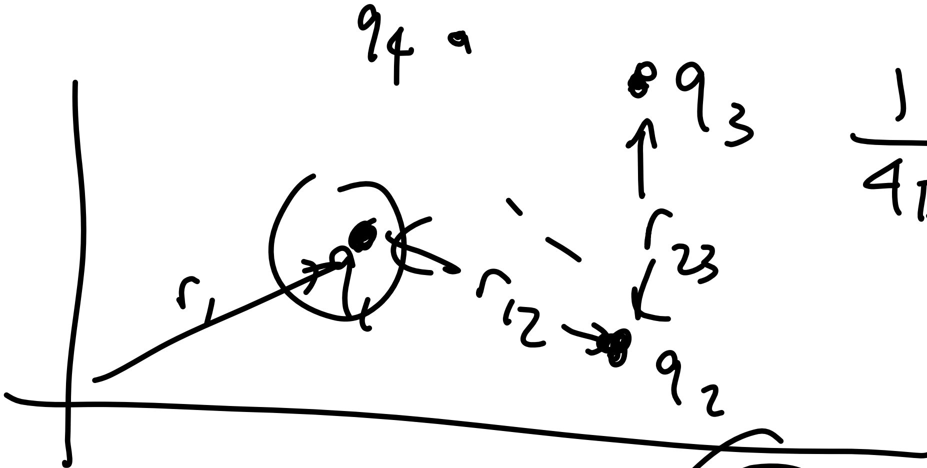
$$V(\infty) = 0$$

$$\boxed{V(\vec{r}) = \frac{W}{Q}}$$

$$V(\infty) = 0$$

$$W_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$$

$$V_{q_1}(\vec{r}_{12}) = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_{12}}$$



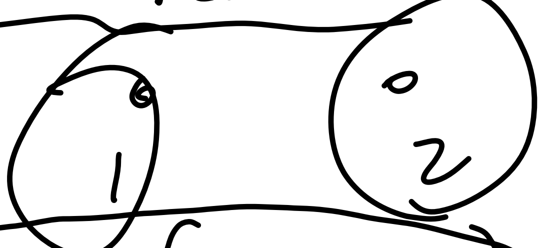
$$\frac{1}{4\pi\epsilon_0}\left(\frac{q_1q_2}{r_{12}} + \frac{q_2q_3}{r_{23}} + \frac{q_1q_3}{r_{13}} + \frac{q_1q_4}{r_{14}} + \frac{q_2q_4}{r_{24}} + \frac{q_3q_4}{r_{34}}\right)$$

$$W = \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{n}\sum_{j>i}^{n}\frac{q_iq_j}{r_{ij}}$$

$$W = \frac{1}{4\pi\epsilon_0}\,\frac{1}{2}\sum_{i=1}^{n}\sum_{j\neq i}^{n}\frac{q_iq_j}{r_{ij}}$$

$$W = \frac{1}{2}\sum_{i=1}^{n} q_i\left(\sum_{j\neq i}^{n}\frac{1}{4\pi\epsilon_0}\frac{q_j}{r_{ij}}\right)$$

$$W = \frac{1}{2}\sum_{i=1}^{n} q_i V(\vec{r}_i)$$



$1\to 2$	$2\to 1$
$1\to 3$	$2\to 3$
$1\to 4$	$2\to 4$
$3\to 1$	$4\to 1$
$3\to 2$	$4\to 2$
$3\to 4$	$4\to 3$

Sürekli

$$W = \frac{1}{2}\int \rho V \, d\tau$$

Kartezyen dxdydz

$$\vec{\nabla}\cdot\vec{E} = \rho/\epsilon_0$$

$$W = \frac{1}{2}\int \epsilon_0(\vec{\nabla}\cdot\vec{E})\, V\, d\tau$$

i.b.p.

$$\nabla(A\cdot B) = A\nabla B + B\nabla A$$

$$W = \frac{\epsilon_0}{2}\left[\int \underbrace{\vec{\nabla}\cdot(\vec{E}V)}_{\text{Div. teor.}}\, d\tau - \int \vec{E}\cdot\underbrace{\vec{\nabla}V}_{-\vec{E}}\, d\tau\right]$$

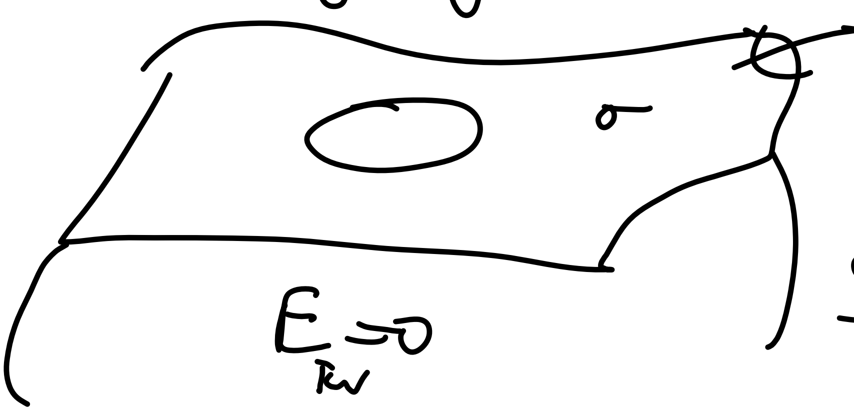
$$= \frac{\epsilon_0}{2}\left[\cancel{\oint_S V\vec{E}\cdot d\vec{a}} + \int_{V\to\infty} E^2\, d\tau\right]$$

$$W = \frac{1}{2}\int_V \rho V\, d\tau$$

$$= \frac{1}{2}\epsilon_0\int E^2\, d\tau$$

$V \to$ tüm uzay

iletken yüzey



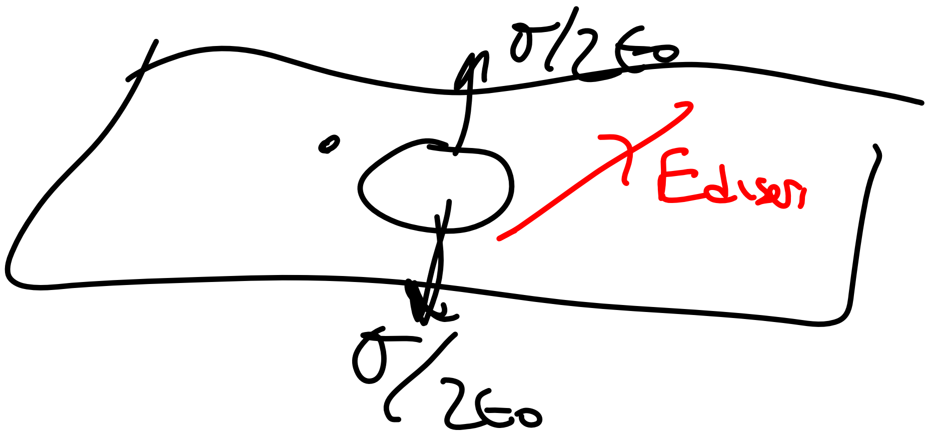
yük yoğunluğu

$$\delta S = 0$$

$$\frac{\sigma}{\epsilon_0}\hat{n}$$

İletken

$$\vec{E}_{dışarı} = \frac{\sigma}{\epsilon_0}\hat{n}$$



$$\vec{E}_{yukarı} = \vec{E}_{dışarı} + \frac{\sigma}{2\epsilon_0}$$

$$\vec{E}_{aşağı} = \vec{E}_{dışarı} - \frac{\sigma}{2\epsilon_0}$$

$$\left(\vec{E}_{yukarı} + \vec{E}_{aşağı}\right) = 2\,\vec{E}_{dışarı}$$

$$\vec{E}_{dışarı} = \underbrace{\frac{1}{2}\left(\vec{E}_{aşağı} + \vec{E}_{yukarı}\right)}$$

Birimalana düşen

Elektrik kuvvet

$$\vec{f} = \sigma\,\vec{E}_{ortalama}$$

$$f = \frac{F}{A} = \frac{q}{A}E \Rightarrow \text{pressure}$$

$$E = \frac{\sigma}{2\epsilon_0}$$

$$P = \underbrace{\sigma}\,\underbrace{E_{ort}} \Rightarrow \sigma \cdot \frac{\sigma}{2\epsilon_0} = \boxed{\frac{\sigma^2}{2\epsilon_0}}$$

$$\boxed{P = \frac{\epsilon_0}{2} E^2}$$

<u>Kapasitans</u> =

$$C = \frac{q}{V} \to \frac{2Q}{2V}$$

$$\int dw = \int_0^Q \underbrace{\left(\frac{q}{c}\right)}_{V} dq$$

$$w = \frac{Q^2}{2c} = \frac{1}{2} CV^2$$