Alan Teorisi

Dielektrik ortam

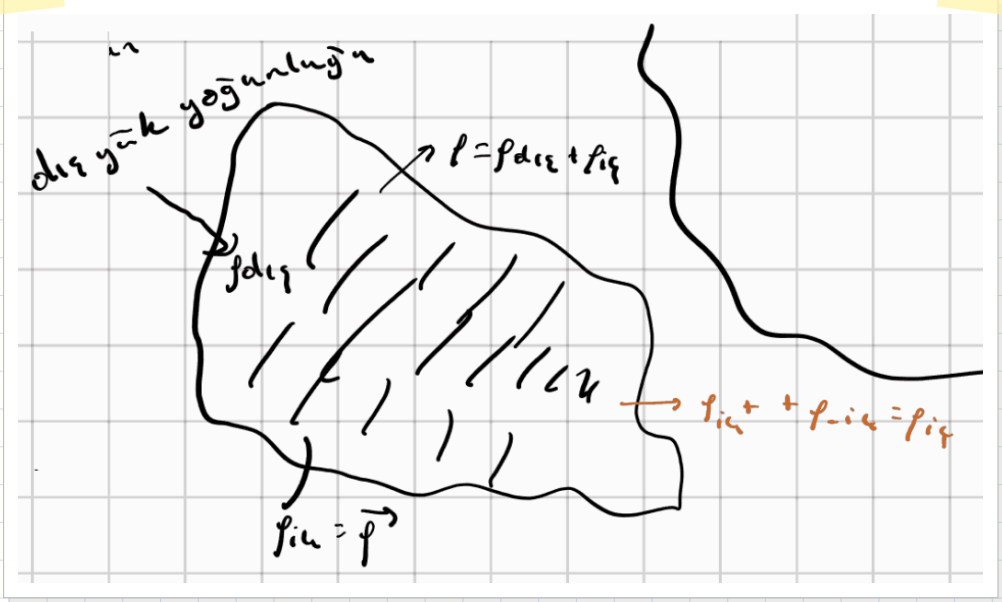
Orijinal not: Ders13.pdf

UYARI Bu belge, el yazısı ders notlarından Claude (Anthropic) yardımıyla dijitale aktarılmıştır. Yardımcı kaynak olarak hazırlanmıştır; hata veya eksik içerebilir. Lütfen orijinal notları ve ders kaynaklarını esas alın.

NOTICE *This document was transcribed from handwritten lecture notes with the help of Claude (Anthropic). It is meant as a supplementary resource and may contain errors or omissions. Always check against the original notes and official course material.*

orj. s. 1

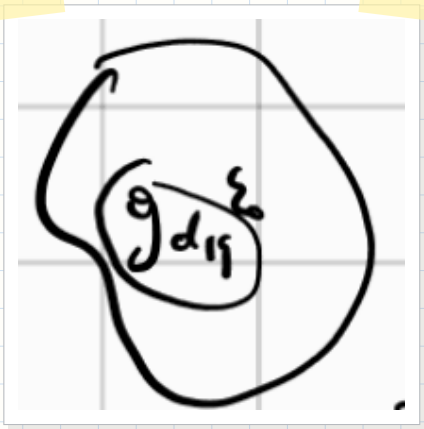
Boş olmayan ortam



orijinal çizim, s. 1

Belli bir zaman sonra dengeye erişip bir iç yük oluşturacak

Boş uzayda



orijinal çizim, s. 1

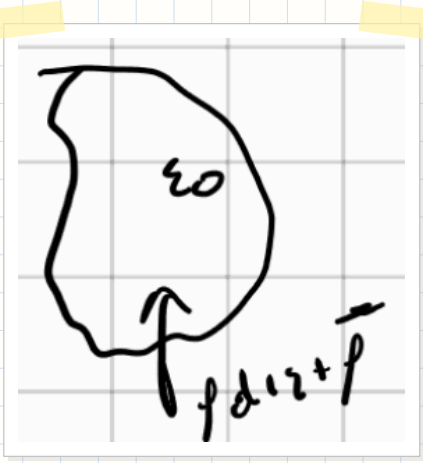
$$\vec{E} = -\text{grad}\, V \qquad \vec{D} = \varepsilon_0 \vec{E} \qquad \vec{D} \parallel \vec{E}$$

$$\Delta V = -\frac{\rho}{\varepsilon_0} = \frac{-\rho_{dış}}{\varepsilon_0}$$

$$\text{div}\, \vec{D} = \text{div}(\varepsilon_0 \vec{E}) = \rho = \rho_{dış}$$

(Ortamın fiziksel varlığından ötürü dış yük tarafından yaratılan $\vec{E}$'nin etkisiyle oluşan yüklerin yoğunluğu)

$\rho = \rho_{dış} + \bar{\rho}$ artık ortamı boş gibi düşünebiliriz



orijinal çizim, s. 1

$$\text{div}(\varepsilon_0 \vec{E}) = \rho = \rho_{dış} + \bar{\rho}$$

? kapa katsayısı ortamın duyarlılığıdır

$$\bar{\rho} = -\text{div}\left(\varepsilon_0 \overbrace{\chi(\vec{E})}\, \vec{E}\right)$$

$$\text{div}(\varepsilon_0 \vec{E}) - \bar{\rho} = \rho_{dış}$$

div lineerdir

$$\text{div}(\varepsilon_0 \vec{E}) + \text{div}(\varepsilon_0 \chi(\vec{E})\, \vec{E}) = \rho_{dış}$$

$$\text{div}\left(\varepsilon_0 \underbrace{(1 + \chi(\vec{E}))}_{\varepsilon_r > 1} \cdot \vec{E}\right) = \rho_{dış}$$

İçinde bir takım dipollerin oluştuğu ortama dielektrik ortam denir. Böyle bir ortamda $\vec{P} = \varepsilon_0 \chi(\vec{E}) \cdot \vec{E}$, $\vec{E}$ ile aynı yöndedir, dolayısıyla da

$$\underbrace{\vec{P} \parallel \vec{E}}_{\text{aynı yönde ve paraleldir.}} \quad \Rightarrow \chi(\vec{E}) > 0$$

$$\text{div}\left(\underbrace{\varepsilon_0 \varepsilon_r}_{\varepsilon} \cdot \vec{E}\right) = \rho_{dış} \Rightarrow \text{div}(\varepsilon \cdot \vec{E}) = \rho_{dış}$$

$$\vec{D} = \varepsilon \vec{E}$$

$$\operatorname{div}\vec{D} = \rho_{dış}$$

ortam basitse kapa elektrik alana bağımlı değil sabittir.

Basit ortamda $\varepsilon = \varepsilon_0 \cdot \varepsilon_r \Rightarrow \varepsilon > \varepsilon_0$ $\quad \varepsilon_r = \dfrac{\varepsilon}{\varepsilon_0} > 1$ bağıl dielektrik sabiti

$\Delta V = -\dfrac{\rho_{dış}}{\varepsilon}$ ortam basitse

Boşluk: $\operatorname{div}\vec{D} = \rho_{dış}$ $\quad (\vec{D} \to \varepsilon_0\vec{E})$

$\operatorname{div}\vec{E} = -\rho_{dış}/\varepsilon_0$ $\quad \operatorname{div}(\vec{D}) = \rho_{dış}$ $\quad (\vec{D} \to \varepsilon\vec{E})$

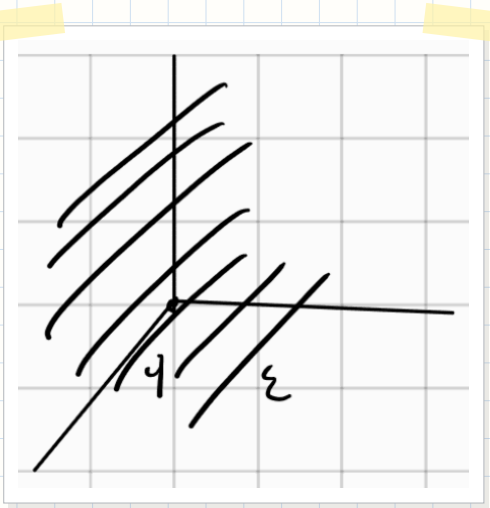
$\Delta V = -\rho_{dış}/\varepsilon_0 \longrightarrow V = \dfrac{q}{4\pi\varepsilon_0 r}$

$\operatorname{rot}\vec{E} = 0$

$\operatorname{div}\vec{D} = \rho_{dış} \Rightarrow \operatorname{div}(\varepsilon\vec{E}) = \rho_{dış}$

$\vec{F} = q\vec{E}$ $\quad \operatorname{div}\vec{E} = \dfrac{\rho_{dış}}{\varepsilon}$

orj. s. 2

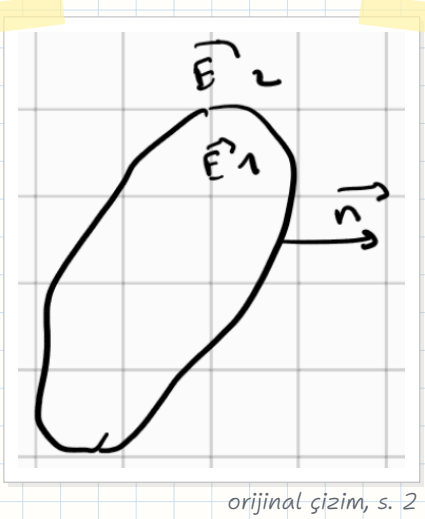


orijinal çizim, s. 2

$q = 1$ ise $\quad V = \dfrac{1}{4\pi\varepsilon \cdot r}$

$$V = \frac{1}{4\pi\varepsilon}\int \frac{\rho}{r'}\,dv$$

$\vec{E} = -\operatorname{grad} V$ $\quad \vec{D} = \varepsilon\vec{E}$ $\quad \operatorname{rot}\vec{E} = 0$



orijinal çizim, s. 2

$$\vec{n} = \frac{d\vec{S}}{dS}$$

$$\operatorname{rot}\vec{E} = 0 \;\Rightarrow\; \{\operatorname{rot}\vec{E}\} + \vec{n} \times (\vec{E}_2 - \vec{E}_1)\big|_S\, \delta(s) = \{0\} + 0 \cdot \delta(s)$$

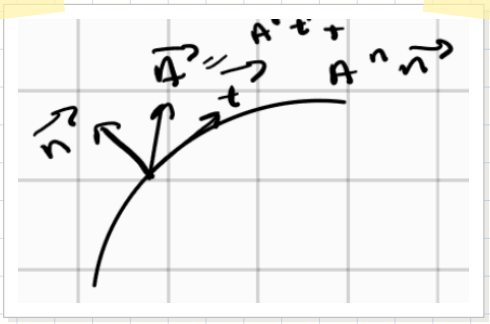
$$\left\{ \begin{array}{l} \operatorname{rot}\vec{E}_1 : v_1 \\ \operatorname{rot}\vec{E}_2 : v_2 \end{array} \right\} + \vec{n} \times \left(\vec{E}_2\big|_S - \vec{E}_1\big|_S\right) \delta(s)$$

$$\underline{\qquad\qquad\qquad\qquad\qquad\qquad 0}$$

$$= \left\{ \begin{array}{ll} 0 & v_1 \\ 0 & v_2 \end{array} \right\} + 0 \cdot \delta(s)$$

$$\vec{n} \times \left(\vec{E}_2\big|_S - \vec{E}_1\big|_S\right) = 0$$

$$\Rightarrow \vec{n} \times \vec{E}_2\big|_S = \vec{n} \times \vec{E}_1\big|_S \;\Rightarrow\; \vec{E}_1^{\,t}\big|_S = \vec{E}_2^{\,t}\big|_S$$



orijinal çizim, s. 2

$$\vec{n} \times \vec{A} = \vec{n} \times \left(A^t \vec{t} + A^n \vec{n}\right)$$
$$= A^t \underbrace{(\vec{n} \times \vec{t})}_{\vec{t}'} + A^n \underbrace{\vec{n} \times \vec{n}}_{0}$$
$$\vec{n} \cdot \vec{A} = \vec{n} \cdot \left(A^t \vec{t} + A^n \vec{n}\right)$$
$$= A^t \vec{n} \cdot \vec{t} + A^n \vec{n} \cdot \vec{n} = A^n$$

orj. s. 3

$$\operatorname{div}\vec{D} = \rho$$

$$\left\{ \begin{array}{l} \operatorname{div}\vec{D}_1 : v_1 \\ \operatorname{div}\vec{D}_2 : v_2 \end{array} \right\} + \vec{n}\left(\vec{D}_2 - \vec{D}_1\right)\big|_S \overset{1}{=} \left\{ \begin{array}{l} \rho_1 ; v_1 \\ \rho_2 ; v_2 \end{array} \right\} + \rho_s\, \delta(s)$$

$$\operatorname{div}\vec{D}_1 = \rho_1 \qquad\qquad \vec{n}\left(\vec{D}_2 - \vec{D}_1\right)\big|_S = \rho_s$$
$$\operatorname{div}\vec{D}_2 = \rho_2 \qquad\qquad \Rightarrow\; \vec{n}\,\vec{D}_2\big|_S - \vec{n}\,\vec{D}_1\big|_S = \rho_s$$

[1] Claude notu: muhtemelen sol tarafta da $\delta(s)$ çarpanı yazılmalıydı.

$$D_2^n|_S - D_1^n|_S = \rho_s \;=\; -\varepsilon_2 \frac{\partial V_2}{\partial n}\Big|_S + \varepsilon_1 \frac{\partial V_1}{\partial n}\Big|_S = \rho_s$$

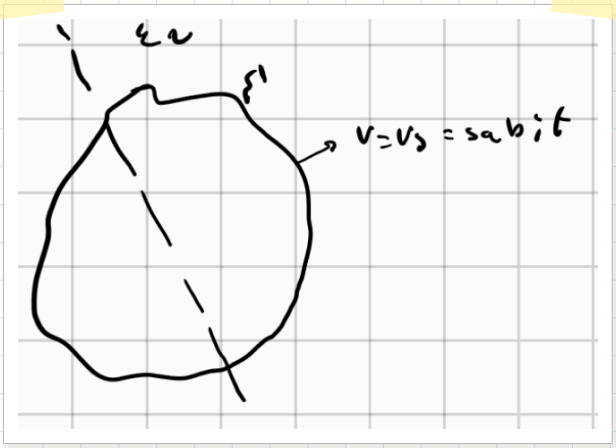
$$\Rightarrow \; +\varepsilon_2 \frac{\partial V_2}{\partial n}\Big|_S - \varepsilon_1 \frac{\partial V_1}{\partial n}\Big|_S = -\rho_s$$

$$\vec{E} = -\text{grad}\, V = \left\{ \begin{array}{l} -\text{grad}\, V_1 : v_1^{\text{iç}} \\ -\text{grad}\, V_2 : v_2^{\text{dış}} \end{array} \right\} + \overbrace{\vec{n}\,(V_2 - V_1)|_S}^{0}\, \delta(s)$$

$$V_1|_S = V_2|_S$$

$\Delta V_1 = -\frac{\rho_1}{\varepsilon_1}$ v_1'de

$\Delta V_2 = -\frac{\rho_2}{\varepsilon_2}$ v_2'de



orijinal çizim, s. 3

$$\vec{E} = -\text{grad}\, V = -\text{grad}\, V_s = 0$$

$$\vec{D} = \varepsilon \vec{E} = 0$$

$$\text{div}\, \vec{D} = \rho = 0$$

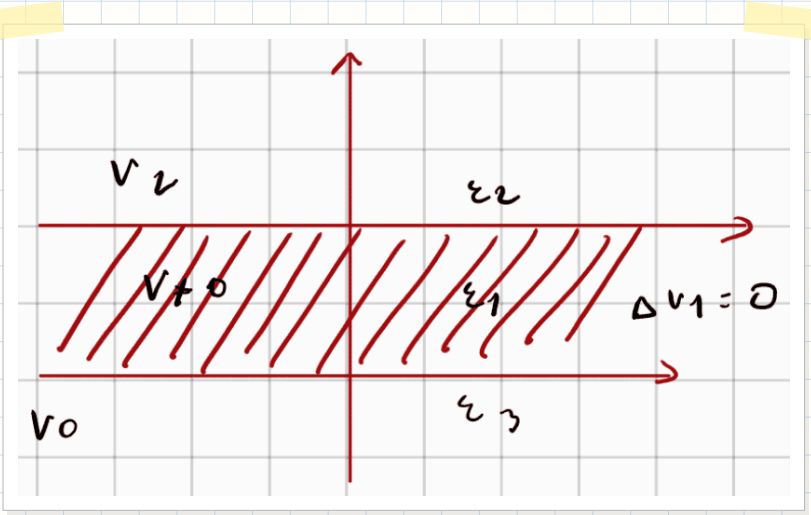
$$\varepsilon_2 \frac{\partial V_2}{\partial n} = -\rho_s$$

$$V_1|_S = V_s|_S = V_s = \text{sabit}$$

$$V_1|_S = V_s|_S = V_s = \text{sabit}$$
$$V_2|_{s=\infty} < \infty$$

orj. s. 4

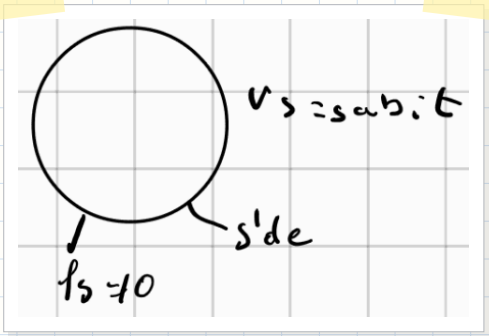
Yüzey üzerinde potansiyel sabitse ve içeride yük yoksa iç bölgede potansiyel sabittir, elektrik alan de sabittir, ve içerde $\rho = 0$ //



orijinal çizim, s. 4

$$V_2 = V_d = \text{sabit}$$
$$\vec{D}_2 = 0$$
$$\rho_2 = 0$$

$$\operatorname{div}\vec{D} = \rho \Rightarrow \Delta V_1 = \frac{\partial^2 V_1}{\partial x^2} + \frac{\partial^2 V_{12}}{\partial x^2} + \frac{\partial^2 V_1}{\partial z^2} = 0$$



orijinal çizim, s. 4

$$\frac{d^2 V_1}{dx^2} = 0 \Rightarrow V_1 = Ax + B$$
$$V_1\Big|_{x=0} = A \cdot 0 + B = V_0 \Rightarrow B = V_0$$
$$V_1\Big|_{x=d} = Ad + V_0 = V_d$$

$$\rho_{s1} = \vec{e}_x\left(\vec{D}_2\Big|_{x=d}^{0} - \vec{D}_1\Big|_{x=d}\right)$$
$$\rho_{s1} = -\vec{D}_1\Big|_{x=d}\vec{e}_x = -\varepsilon_1\vec{E}_1\Big|\vec{e}_x \qquad x > d$$
$$\rho_s^0 = -\rho_s^d$$

[2] Claude notu: muhtemelen ikinci terim $\partial^2 V_1/\partial y^2$ olmalı.