Alan Teorisi

Yüzeysel yüke etki eden kuvvet

Orijinal not: Ders11.pdf

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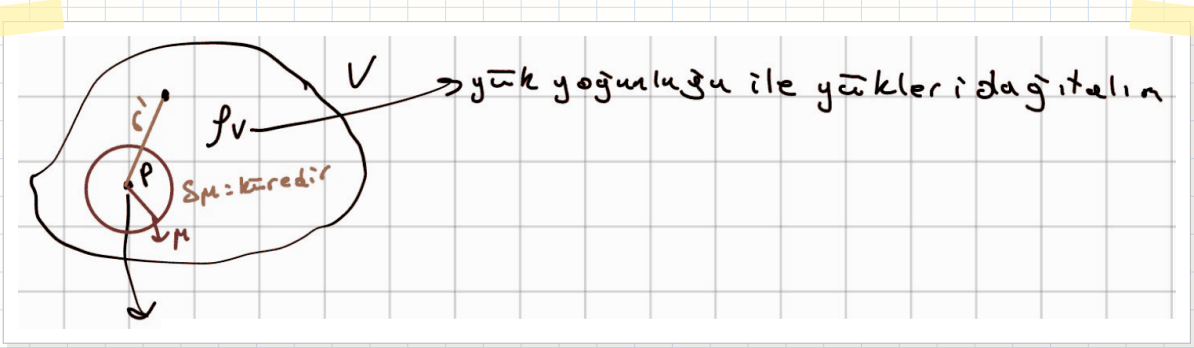
orj. s. 1

Yüzeysel yüke etki eden kuvvet

$q_1 \dots q_n$ tane yük olsun.

q_1 yüküne etki eden kuvveti:

$$\vec{F}_1 = \frac{q_1}{4\pi\varepsilon} \sum_{i=2}^{n} q_i \frac{\vec{r}_i}{r_i^3}$$

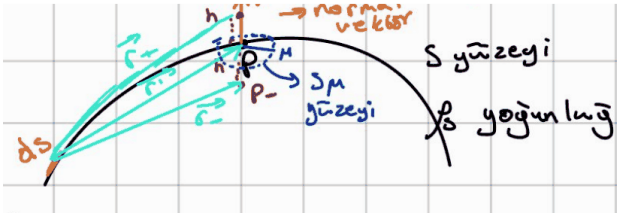


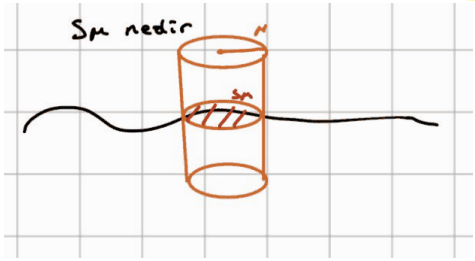
orijinal çizim, s. 1

P noktasına etki eden kuvveti hesaplayalım.

S_μ küresi dışında bulunan bütün yükleri içerideki birim yüke etki kuvvet (Elektrik alan). Bu kuvveti hesaplayıp, $\mu \to 0$ götürülürse P noktasındaki elektrik alanı buluruz.

$$\vec{E}(P) = \frac{1}{4\pi\varepsilon} \lim_{\mu \to 0} \int_{V - V_\mu} \rho_V \frac{\vec{r}'}{r'^3} \, dV$$





orijinal çizim, s. 1

P noktası üzerindeki elektrik alanı bulalım.

$$\vec{E}(P) = \frac{1}{4\pi\varepsilon} \lim_{\mu \to 0} \int_{S - S_\mu} \rho_s \frac{\vec{r}'}{r'^3}\, ds$$

Daha basit bir yol bulmaya çalışalım

$$\vec{E}(P_+) = \frac{1}{4\pi\varepsilon} \int_S \rho_s \frac{\vec{r}_+}{r_+^3}\, ds$$
$$\vec{E}(P_-) = \frac{1}{4\pi\varepsilon} \int_S \rho_s \frac{\vec{r}_-}{r_-^3}\, ds$$

orj. s. 2

$$\vec{E}(P_+) = \frac{1}{4\pi\varepsilon} \int_{S - S_\mu} \rho_s \frac{\vec{r}_+}{r_+^3}\, ds + \overbrace{\frac{1}{4\pi\varepsilon} \int_{S_\mu} \rho_s \frac{\vec{r}_+}{r_+^3}\, ds}^{e(h,\mu)\,\hat{n}}$$

$$\vec{E}(P_-) = \frac{1}{4\pi\varepsilon} \int_{S - S_\mu} \rho_s \frac{\vec{r}_-}{r_-^3}\, ds + \underbrace{\frac{1}{4\pi\varepsilon} \int_{S_\mu} \rho_s \frac{\vec{r}_-}{r_-^3}\, ds}_{-e(h,\mu)\,\hat{n}}$$

(yani $h \to 0$'a götürsek)

$$\lim_{P_+ \to P} \vec{E}(P_+) = \vec{E}(P) + e(0,\mu)\,\hat{n}$$
$$\lim_{P_- \to P} \vec{E}(P_-) = \vec{E}(P) - e(0,\mu)\,\hat{n}$$

$$\vec{E}^+(P) = \vec{E}(P) + e(0,\mu)\,\hat{n}$$
$$\vec{E}^-(P) = \vec{E}(P) - e(0,\mu)\,\hat{n}$$

$\mu \to 0$'a götürürsek

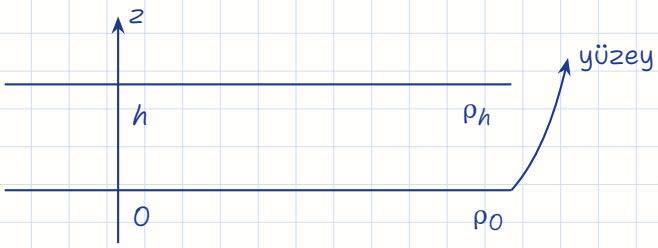
$$\begin{aligned} \vec{E}^+(P) &= \vec{E}(P) + e(0)\,\hat{n} \\ + \quad \vec{E}^-(P) &= \vec{E}(P) - e(0)\,\hat{n} \\ \hline \vec{E}(P) &= \tfrac{1}{2}\left[\vec{E}^+(P) + \vec{E}^-(P)\right] \end{aligned}$$

Herhangi bir $\rho_s\, ds$ yüzeysel yüküne etki eden kuvvet:

$$d\vec{F} = \frac{1}{2} \rho_s\, ds \left[\vec{E}^+ + \vec{E}^-\right]$$

Sayfa 55 problem 1

La la la laaa la la laaaa



a) $z = 0$'daki ve $z = h$'taki elektrik alanı doğrudan bulunuz.

sadece ρ_h'ın etkisi var diyelim

$$\vec{E}(0) = -\frac{\rho_h}{2\varepsilon}\vec{e}_z \qquad \vec{E}(h) = +\frac{\rho_0}{2\varepsilon}\vec{e}_z$$

b) $z > h$, $0 < z < h$, $z < 0$

$$\vec{E} = \frac{\rho_0 + \rho_h}{2\varepsilon}\vec{e}_z$$

orj. s. 3

$0 < z < h$

$$\vec{E} = \frac{(\rho_0 - \rho_h)}{2\varepsilon}\vec{e}_z$$

$z < 0$

$$\vec{E} = -\frac{(\rho_0 + \rho_h)}{2\varepsilon}\vec{e}_z$$

c) $z = 0$ ve $z = h$

$$\begin{aligned}
\vec{E}(0) &= \tfrac{1}{2}\left[\vec{E}^+(0) + \vec{E}^-(0)\right] \\
\vec{E}^+(0) &= \frac{(\rho_0 - \rho_h)}{2\varepsilon}\vec{e}_z \\
\vec{E}^-(0) &= -\frac{(\rho_0 + \rho_h)}{2\varepsilon}\vec{e}_z \\
\vec{E}(0) &= \frac{1}{2}\left[\frac{\rho_0 - \rho_h - \rho_0 - \rho_h}{2\varepsilon}\vec{e}_z\right] \\
&= -\frac{\rho_h}{2\varepsilon}\vec{e}_z
\end{aligned}$$

$$\begin{cases}
\vec{E}(h) = \frac{1}{2}\left[\vec{E}^+(h) + \vec{E}^-(h)\right] \\
\vec{E}^+(h) = \dfrac{\rho_0 + \rho_h}{2\varepsilon}\vec{e}_z \\
\vec{E}^-(h) = \dfrac{(\rho_0 - \rho_h)}{2\varepsilon}\vec{e}_z \\
\vec{E}(h) = \dfrac{1}{2}\left[\dfrac{\rho_0 + \rho_h + \rho_0 - \rho_h}{2\varepsilon}\right]\vec{e}_z \\
\vec{E}(h) = \dfrac{\rho_0}{2\varepsilon}\vec{e}_z
\end{cases}$$

d) $z = 0$ üzerinde S alan parçasına etki eden kuvvet

$$\begin{aligned}
\vec{F} &= \frac{1}{2}\rho_0 S\left[\vec{E}^+(0) + \vec{E}^-(0)\right] \\
&= -\frac{\rho_0\,\rho_h\,S}{2\varepsilon}\vec{e}_z
\end{aligned}$$

e) $\rho_h = \rho_0 \Rightarrow \vec{F} = -\dfrac{\rho_0^2}{2\varepsilon}\vec{e}_z$

$\rho_h = -\rho_0 \Rightarrow \vec{F} = \dfrac{\rho_0^2}{2\varepsilon}\vec{e}_z$