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1. Medan Listrik oleh muatan distribusi analog dengan Medan Listrik oleh Muatan titik :

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}_0$$

Maka medan Listrik oleh muatan kontinue / kodistribusi dapat dihitung dengan dua cara. yaitu :

a. Hukum Coulumb

hukum coulumb dalam persiapanya menggunakan integral dari sistem koordinat kartisian, bola dan silinder

1). Untuk Integral garis

$$\vec{E} = \int_{line}\frac{1}{4\pi\varepsilon_0}\frac{dq}{r^2}\hat{r}_0 \rightarrow \text{dengan } dq = \lambda dl \text{ atau } \lambda dr$$

$$\text{Shs} : \vec{E} = \frac{1}{4\pi\varepsilon_0}\int\frac{\lambda dl}{r^2}\hat{r}_0$$

2). Untuk luas permukaan

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\iint\frac{\sigma\, ds}{r^2}\hat{r}_0$$

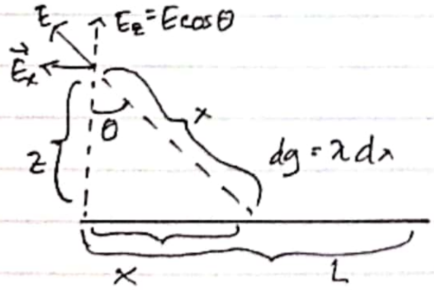
3). Untuk volume

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\iiint\frac{\rho\, dv}{r^2}\hat{r}_0$$

Contoh Penerapan hukum Columb untuk menghitung medan Listrik

Tugas Hal 53. NO 1

1.




$$\vec{E} = \vec{E}_z + \vec{E}_x$$

$$\vec{E}_z = \frac{1}{4\pi\varepsilon_0}\int_0^L d\vec{E}\cos\theta$$

$$\text{Ambil } \vec{E}_z = \frac{1}{4\pi\varepsilon_0}\int_0^L\frac{dq}{r^2} = \frac{1}{\square}\int_0^L\frac{\lambda dx}{r^2}\cos\theta$$

$$\Rightarrow \cos\theta = \frac{z}{r^2}$$

$$\vec{E}_z = \frac{1}{\square}\int_0^L \frac{z\lambda\,dx}{r^3} = \frac{1}{\square}\int_0^L \frac{z\lambda\,dx}{(z^2+x^2)^{3/2}}$$

$$= \frac{z\lambda}{4\pi\varepsilon_0}\int_0^L \frac{dx}{(z^2+x^2)^{3/2}}$$

Lihat di daftar Integral $\int_0^L \frac{dx}{(z^2+x^2)^{\frac{3}{2}}} = \frac{1}{z^2}\frac{x}{\sqrt{z^2+x^2}}\Big|_0^L$

$$= \frac{1}{4\pi\varepsilon_0}\lambda z\left[\frac{1}{z^2}\frac{x}{\sqrt{z^2+x^2}}\right|_0^L$$

$$\vec{E}_z = \frac{\lambda z}{4\pi\varepsilon_0}\frac{L}{z^2\sqrt{z^2+x^2}} = \frac{\lambda}{4\pi\varepsilon_0}\frac{L}{z\sqrt{z^2+x^2}}$$

$$\vec{E}_x = \mp\frac{1}{4\pi\varepsilon_0}\int_0^L \frac{\lambda\,dx}{r^2}\sin\theta = \frac{-\lambda}{4\pi\varepsilon_0}\int_0^L \frac{x\,dx}{(z^2+x^2)^{3/2}}$$

arah $\vec{E}_x$ kekiri $= \frac{-\lambda}{4\pi\varepsilon_0}\cdot\frac{1}{2}\int_0^L \frac{dx^2}{(z^2+x^2)^{3/2}}$

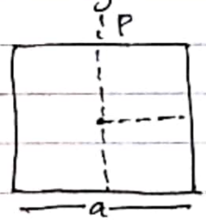
$$= \frac{-\lambda}{4\pi\varepsilon_0}\cdot\frac{1}{2}\cdot\left[-2\frac{1}{(z^2+x^2)^{1/2}}\right|_0^L$$

$$= \frac{-\lambda}{4\pi\varepsilon_0}\left[-\left(\frac{1}{\sqrt{z^2+x^2}} - \frac{1}{z}\right)\right]$$

$$\vec{E}_x = \frac{-\lambda}{4\pi\varepsilon_0}\left[\frac{1}{z} - \frac{1}{\sqrt{z^2+x^2}}\right]$$

Jadi, $\vec{E} = \vec{E}_z + \vec{E}_x$

Ulasan Tugas No 2 Hal 53

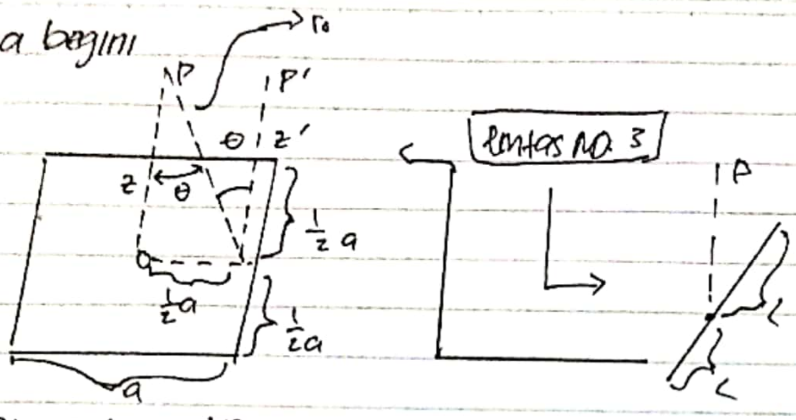



Solusi : Untuk menyelesaikan soal diatas gunakan no 3 yaitu kawat yang panjang $2L$ dengan $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda L}{z^2}$

$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda L}{z'^2}$ hasil contoh no 3

Konsepnya begini

Masalah ..




$P = P' \cos\theta$ ; karena ada 4 sisi maka

$P = 4P' \cos\theta$. Shs

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{2\lambda L}{z'^2} = 4 \cdot \frac{1}{4\pi\epsilon_0}\frac{2\lambda L}{z'^2}\cos\theta$$

Karena $L = \frac{1}{2}a$ dan $z' = r = \sqrt{z^2 + (\frac{1}{2}a)^2}$

dan $\cos\theta^2 = \frac{z}{\sqrt{z^2+(\frac{1}{2}a)^2}}$ maka

$$\vec{E} = 4 \cdot \frac{1}{4\pi\epsilon_0}\frac{2\lambda\frac{1}{2}a \cdot z}{(z^2+(\frac{1}{2}a)^2)\sqrt{z^2+(\frac{1}{2}a)^2}}$$

$$\therefore \vec{E} = \frac{1}{4\pi\epsilon_0}\frac{4\lambda a z}{\left(z^2+\frac{a^2}{4}\right)\sqrt{z^2+\frac{a^2}{4}}}\,\hat{z}$$