No.
Date 14-maret 2022

Nama : Mita Safira
NPM : 2013022044
Prodi : Pendidikan Fisika
Kelas : B

Distribusi Muatan

1. Medan listrik oleh muatan terdistribusi Analog dengan i medan listrik oleh muatan titik.

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r}_0$$

maka medan listrik oleh kontinue / terdistribusi dapat dihitung dengan 2 cara, yaitu :

a. Hukum Coulomb

Hukum Coulomb dalam penerapannya menggunakan integral dalam sistem koordinat kartisian, bola dan selinder

1.) Untuk Integral garis

$$\vec{E} = \int_{line} \frac{1}{4\pi\epsilon_0} \frac{dq}{r^2} \hat{r}_0 \rightarrow \text{dengan} = \lambda dl \text{ atau } \lambda dr$$

sehingga : $\vec{E} = \frac{1}{4\pi\epsilon_0} \int \frac{\lambda dl}{r^2} \hat{r}_0$

2.) Untuk luas permukaan

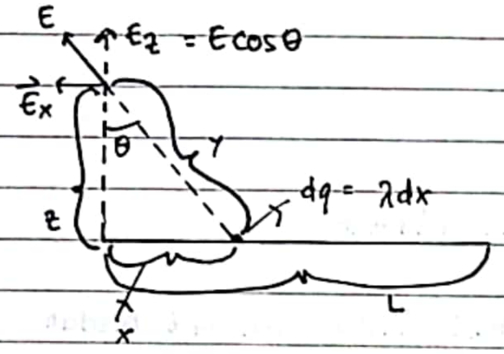
$$\vec{E} = \frac{1}{4\pi\epsilon_0} \iint \frac{\sigma d\vec{s}}{r^2} \hat{r}_0$$

3.) Untuk volume.

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \iiint \frac{\rho d\tau}{r^2} \hat{r}_0$$

Tugas Hal 53 no. 1

1.



$$\boxed{\vec{E} = \vec{E_z} + \vec{E_x}}$$

$$\vec{E_z} = \frac{1}{4\pi\epsilon_0}\int_0^L d\vec{E}\cos\theta$$

Ambil $\vec{E_z} = \frac{1}{4\pi\epsilon_0}\int_0^L \frac{dq}{r^2} = \frac{1}{\square}\int_0^L \frac{\lambda dx}{r^2}\cos\theta$

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

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

$$= \frac{z\lambda}{4\pi\epsilon_0}\int_0^L \frac{dx}{(z^2+x^2)^{3/2}}$$

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

$$= \frac{1}{4\pi\epsilon_0}\lambda z\left[\frac{1}{z^2}\frac{x}{\sqrt{z^2+x^2}}\right|_0^L$$

$$\vec{E_z} = \frac{\lambda z}{4\pi\epsilon_0}\frac{L}{z^2\sqrt{z^2+x^2}} = \frac{x}{4\pi\epsilon_0}\frac{L}{z\sqrt{z^2+x^2}}$$

$$\vec{E_x} = -\frac{1}{4\pi\epsilon_0}\int_0^L \frac{\lambda dx}{r^2}\sin\theta = -\frac{x}{4\pi\epsilon_0}\int_0^L \frac{x\,dx}{(z^2+x^2)^{3/2}}$$

ubah $\vec{E_x}$ kekiri

$$= -\frac{\lambda}{4\pi\epsilon_0}\cdot\frac{1}{2}\int_0^L \frac{dx^2}{(z^2+x^2)^{3/2}}$$

$$= -\frac{\lambda}{4\pi\epsilon_0}\cdot\frac{1}{2}\left[-2\,\frac{1}{(z^2+x^2)^{\frac{1}{2}}}\right|_0^L$$

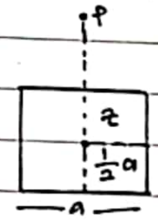
$$= -\frac{\lambda}{4\pi\epsilon_0}\left[-\left(\frac{1}{\sqrt{z^2+x^2}} - \frac{1}{z}\right)\right]$$

$$\vec{E_x} = -\frac{\lambda}{4\pi\epsilon_0}\left[\frac{1}{z} - \frac{1}{\sqrt{z^2+x^2}}\right]$$

Jadi, $\vec{E} = \vec{E_z} + E_x$

No.
Date

(2.)

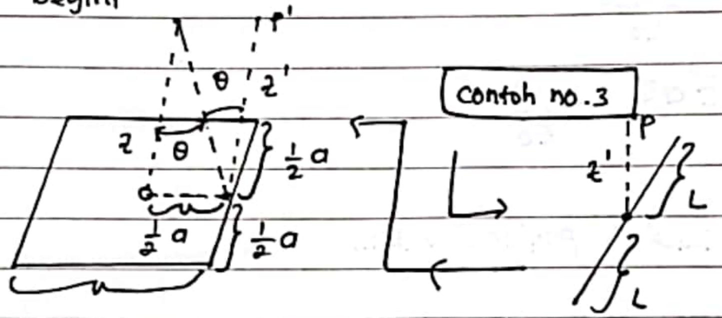


Solusi : Untuk menyelesaikan soal di atas gunakan contoh nomor 3, yaitu kawat yang panjangnya $2L$, dengan $\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{2\lambda L}{z'^2}$

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

Konsepnya begini

masalah



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

$P = 4P' \cos\theta$; sehingga

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

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

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

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

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

No.
Date

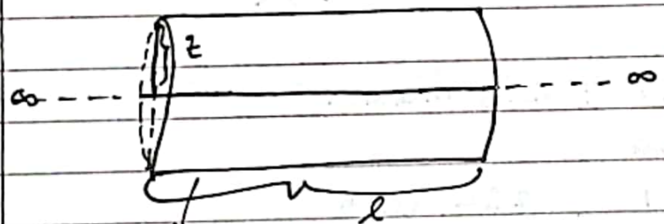
muatan kontinue.

{ 1. medan listrik
2. potensial listrik
3. Energi listrik

Pembahasan : medan listrik
medan listrik pada benda-benda simetri tinggi dihitung dengan menggunakan "Hukum Gauss"

1. $\vec{E} = \frac{\rho}{\epsilon_0}$
2. $\oint\!\!\oint \vec{E}\, d\vec{a} = \frac{\Phi}{\epsilon_0}$

a.) Pada kawat panjang sekali



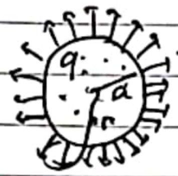
$\oint\!\!\oint \vec{E}\, d\vec{a} = \frac{\Phi}{\epsilon_0}$, $\Phi = \lambda l$

$\vec{E} \cdot a = \frac{\lambda , l}{\epsilon_0}$

$\vec{E}\,(2\pi z l) = \frac{\lambda \cdot l}{\epsilon_0}$

$$\boxed{\vec{E} = \frac{\lambda}{2\pi \epsilon_0 z}\,\hat{k}}$$

Bola pejal (penuh muatan) jari-jarinya a mempunyai muatan sebesar q. Hitung medan listrik di luar bola sejauh r (r > a)



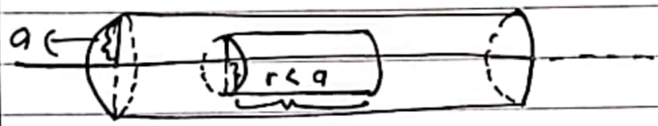
→ Permukaan Gauss

$$\oint \vec{E}\, d\vec{a} = \frac{Q}{\epsilon_0}$$

$$\vec{E}(4\pi r^2) = \frac{q}{\epsilon_0}$$

$$\vec{E} = \frac{q}{4\pi\epsilon_0 r^2}\hat{r}$$

c.) Silinder panjang ~~membentuk~~ membawa rapat muatan volume $\rho = kr$. Hitung medan listrik di dalam silindir dengan di luar silinder, jika jari-jari silinder a



$$\oint \vec{E}\, d\vec{a} = \frac{Q_{mc}}{\epsilon_0} \rightarrow \rho_v = q$$

Di dalam → $$\vec{E}(2\pi r . l) = \frac{1}{\epsilon_0}\int_v \rho\, d\tau$$

$$= \frac{1}{\epsilon_0}\int_0^{r}\int_0^{2\pi}\int_0^{l} (k\rho)\,\rho\, d\rho\, d\phi\, dz$$

$$= \frac{2\pi l k}{\epsilon_0}\int_0^{r} r^2\, d\rho$$

$$\vec{E}(2\pi\rho l) = \frac{2}{3}\,\frac{\pi l k}{\epsilon_0}\,\rho^3$$

$$\vec{E} = \frac{k\rho^2}{3\epsilon_0}\hat{r}, \quad \rho > a$$

Di luar $$\vec{E}(2\pi\rho l) = \frac{1}{\epsilon_0}\int_0^{a}\int_0^{2\pi}\int_0^{l} (k\rho)\, r\, d\rho\, d\phi\, dz$$

$$\boxed{\vec{E} = \frac{ka^3}{3\epsilon_0\rho}} = \frac{2\pi k l}{\epsilon_0}\int_0^{a}\rho\, dr = \frac{2}{3}\,\frac{\pi k l}{\epsilon_0}\,a^3$$