Jumat

Date : 19 - Sep - 2025

Hukum Gauss

$$\oiint \vec{E}\, dS = \iiint \nabla \vec{E}\, d\vec{b}$$

$$\oint_S \vec{E}\, d\vec{s} = \int_V \nabla \cdot \vec{E}\, d\vec{b}$$

$$\oint \vec{E}\, d\vec{s} = \frac{1}{4\pi\varepsilon_0} \int_0^{2\pi}\int_0^{\pi} r^2 \sin\theta\, d\theta$$

$$= \frac{1}{4\pi\varepsilon_0} (2\pi) \int_0^{\pi} Q \sin\theta\, d\theta$$

$$= \frac{Q\,(2\pi)}{4\pi\,\varepsilon_0} \left[-\cos\theta \Big|_0^{\pi} \right]$$

$$= \frac{4\pi\, Q}{4\pi\, \varepsilon_0} = \frac{Q}{\varepsilon_0}$$

$$\oint \vec{E}\, d\vec{s} = \frac{Q}{\varepsilon_0}$$

$$\iiint \nabla \vec{E}\, d\vec{b} \qquad \frac{1}{4\pi\varepsilon_0} \quad \frac{Q}{r^2} \qquad Q = P\, db$$

$$\nabla \vec{E} = \frac{1}{4\pi\varepsilon_0} \iiint \nabla \left(\frac{\hat{r}}{r^2} \right) P\, d\vec{b}$$

$$Q = P\, d\vec{b}$$

$$= \frac{1}{4\pi\varepsilon_0} P \int_V \nabla \left(\frac{\hat{r}}{r^2} \right) d\vec{b} \longrightarrow \int_V \delta\, db = 1$$

$$= \frac{P}{4\pi\varepsilon_0} \left[4\pi (\delta\, db) \right]$$

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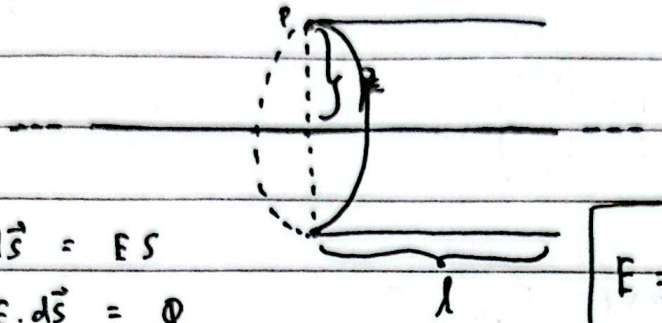
$= \frac{4\pi\rho}{4\pi\varepsilon_0} \longleftrightarrow \nabla\vec{E} = \frac{\rho}{\varepsilon_0}$ → Operator

Contoh :

1. Hitung medan listrik pada kawat lurus panjang segaih z



$Q = \lambda l$

$Q = \sigma A$

$Q = \rho V$

$E \oint d\vec{s} = ES$

$\oint_S E.d\vec{s} = \frac{Q}{\varepsilon_0}$

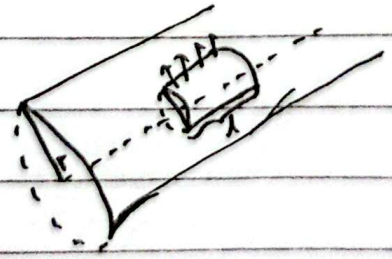
$E.S = \frac{\lambda l}{\varepsilon_0}$

$E.2\pi z l = \frac{\lambda l}{\varepsilon_0}$

$E = \frac{\lambda}{2\pi\varepsilon_0 z}$

$E = \frac{\lambda}{2\pi\varepsilon_0 z}$

2. Sebuah silinder pejal panjang sekali. dengan jari-jari silinder R, rapat muatan q. hitung medan listrik didalam silinder



$\oint E ds = \frac{Q}{\varepsilon_0}$ → $\rho d\vec{E}$

$= \frac{1}{\varepsilon_0} \iiint \rho d\vec{b}$

lanjutan dibelakang

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$$= \frac{\rho}{\varepsilon_0} \int_0^{\lambda} \int_0^{\rho} \int_0^{2\pi} r\, d\phi\, dr\, dz$$

$$= \frac{2\pi\lambda}{\varepsilon_0} \int_0^{\lambda} \int_0^{r} r\, dr\, dz$$

$$= \frac{2\pi\rho z}{\varepsilon_0} \int_0^{\lambda} r\, dr$$

$$= \frac{2\pi\rho\lambda}{\varepsilon_0} \left[\frac{1}{2} r^2 \Big|_0^r \right]$$

E . S =

$$E\,(2\pi r\lambda) = \frac{2\pi\rho\lambda}{2\varepsilon_0} \left[r^2 - 0 \right]$$

$$E\,(2\pi r\lambda) = \frac{\pi\rho\lambda r^2}{\varepsilon_0}$$

$$E = \frac{\rho r^2}{2r\varepsilon_0} = \frac{\rho r}{2\varepsilon_0}$$

$$\boxed{E = \frac{\rho r}{2\varepsilon_0}}$$

jadi, medan listrik didalam silinder dengan jari-jari r bergantung pada rapat dan tempatnya.