No. 1

Date : 19-09-2025
Jum'at

Pert. 4

MEDAN ELEKTROMAGNETIK

HUKUM GAUSS

Non Distrik

Note:

$$\oiint \vec{E}\, ds = \iiint \nabla \vec{E}\, d\tau \qquad E = \frac{q}{4\pi\varepsilon_0 r^2}$$

$$\oint \vec{E}\, d\vec{s} = \int \nabla \vec{E}\, d\tau$$

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

$$= \frac{1}{4\pi\varepsilon_0}(2\pi)\int_0^{\pi} Q \sin\theta\, d\theta = \frac{q(2\pi)}{4\pi\varepsilon_0}\left[-\cos\theta \Big|_0^{\pi}\right]$$

$$= \frac{4\pi q}{4\pi\varepsilon_0} = \frac{q}{\varepsilon_0}$$

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

Note:

$\int_V \rho\, d\tau = 1$

$q = \lambda l$

$q = \sigma a \rightarrow$ luas

$q = \rho V \rightarrow$ volume

$$\nabla. \iiint \nabla \vec{E}\, \tau \qquad \vec{E} \rightarrow \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

Note: $\boxed{q = \rho\, d\tau}$

$$= \frac{1}{4\pi\varepsilon_0} \iiint \nabla \left(\frac{r^2}{r^2}\right) \rho\, d\tau$$

$$= \frac{1}{4\pi\varepsilon_0} \int_V \nabla \left(\frac{\hat{r}^2}{r^2}\right) d\tau = \frac{\rho}{4\pi\varepsilon_0}\left[\int 4\pi\delta\, d\tau\right]$$

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$$= \frac{4\pi\rho}{4\pi\epsilon_0} \rightarrow \boxed{\nabla \cdot \vec{E} = \frac{\rho}{\epsilon_0}}$$

Operator

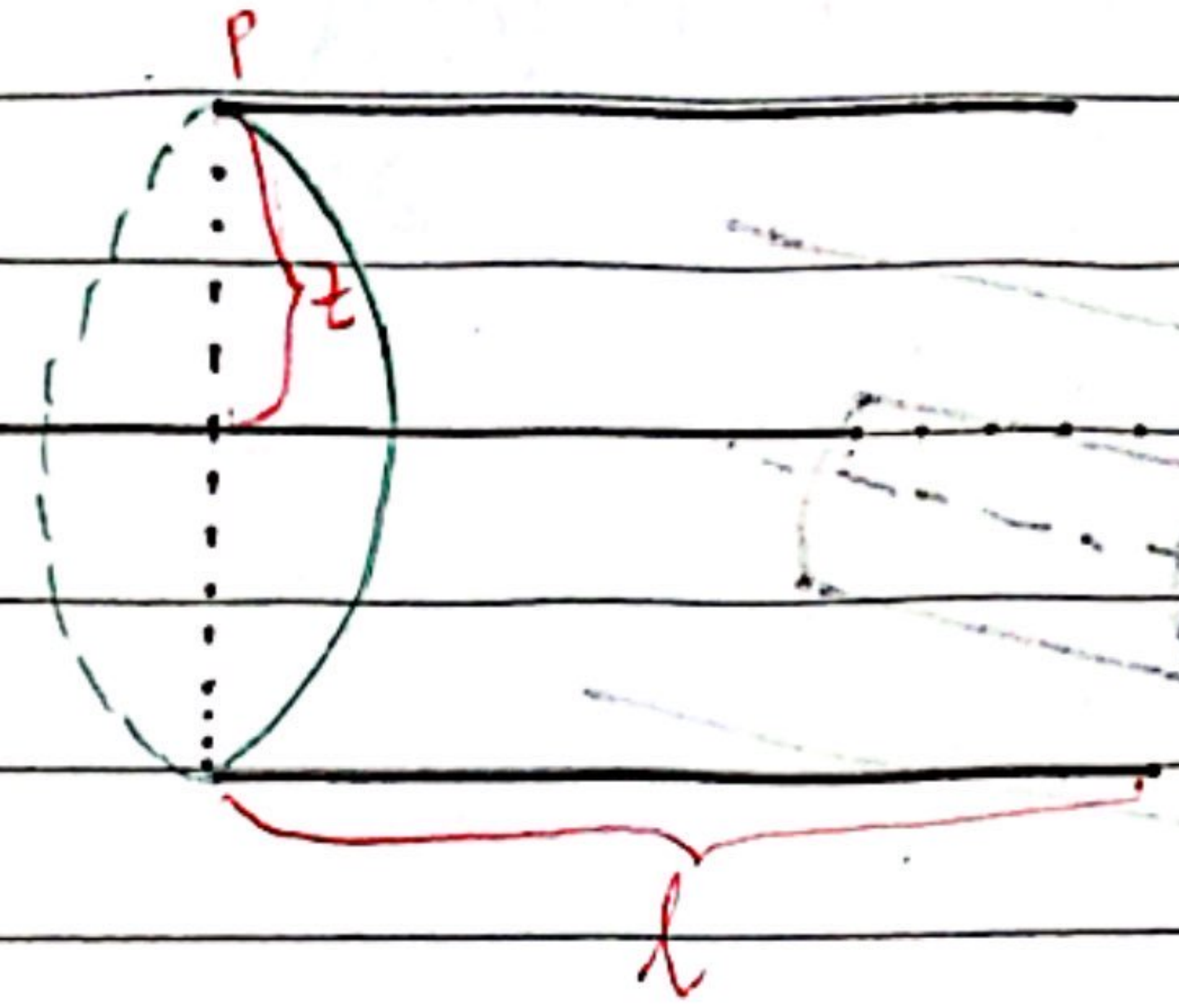
Medan yang sumbernya non logam

Medan elektromagnetik

↳ Medan yang dihasilkan oleh sumber muatan / arus listrik.

Contoh:

1. Hitung medan listrik pada kawat lurus panjang sejauh z



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

$$\oint \vec{E}\, d\vec{S} = \frac{q}{\varepsilon_0}$$

$$ES = \frac{\lambda l}{\varepsilon_0}$$

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

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

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

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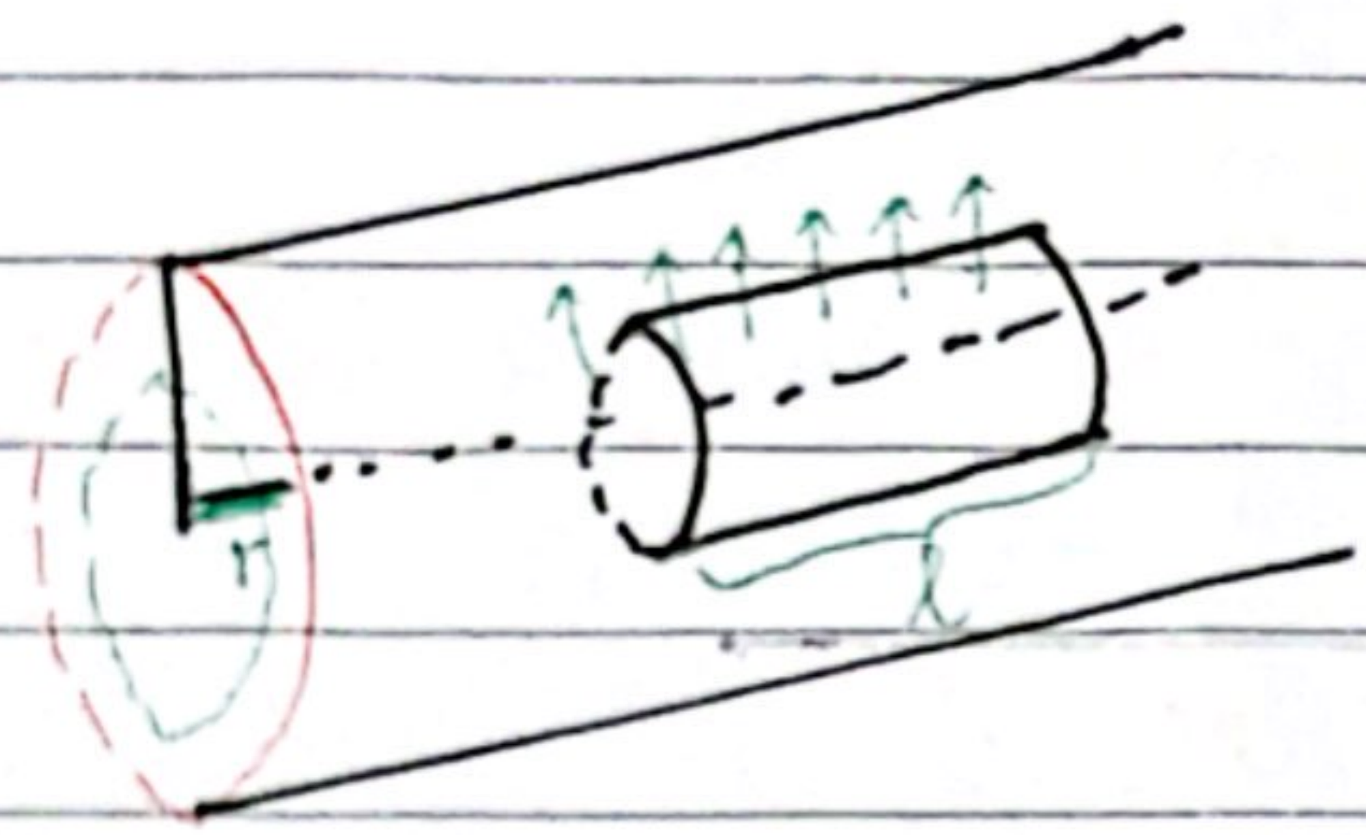
2. Pada silinder dengan jari-jari r.

Hitung medan magnet yang di dalam!

Bergantung pada rapat massa per volume (ρ)



$$\oint E\,ds = \frac{q}{\varepsilon_0}$$

$$= \frac{1}{\varepsilon_0}\iiint \rho\, d\tau$$

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

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

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

$$= \frac{2\pi\rho l}{\varepsilon_0}\left[\frac{1}{2}\, 0\right]$$

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

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$$E(2\pi r l) = \frac{\cancel{\pi} \rho \cancel{l} r^2}{\varepsilon_0}$$

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

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