Date

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Kelas : B

Kelistrikan dan kemagnetan

METODA PENENTUAN POTENSIAL LISTRIK

▷ persamaan Laplace

$\oint \vec{E} \cdot d\vec{l} = 0$, untuk $\vec{E}$ konservatif

$\oint \vec{E} d\vec{p} = \int \nabla \times \vec{E} \; d\vec{A} = 0$

$\nabla \times \vec{E} = 0$

$\nabla E = \rho / \varepsilon_0$

$E = -\nabla V$

$\nabla \vec{E} = -\nabla \nabla V$

$\frac{1}{\varepsilon_0} \rho = -\nabla^2 V$

$\vec{\nabla} V = -\nabla^2 V$

$\vec{\nabla} V = -\frac{1}{\varepsilon_0} \rho$ ⇒ Hukum poisson

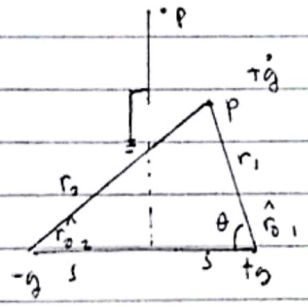
$\nabla^2 V = 0$ ⇒ persamaan Laplace

$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$

$\frac{\partial^2 V}{\partial^2 x^2} = 0$; $\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} = 0$; $\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$

▷ Metoda Bayangan

Muatan titik oleh batang konduktor



$V_p = \ldots ?$

$E_r = -\frac{\partial V}{\partial r}$; $E_\theta = -\frac{1}{r} \frac{\partial V}{\partial r}$

$V_p = \frac{1}{4\pi\varepsilon_0} + \frac{q}{r_1} + \frac{-q}{4\pi\varepsilon_0 r_2}$

$= \frac{q}{4\pi\varepsilon_0} \left(\frac{r_2 - r_1}{r_1 . r_2} \right)$.

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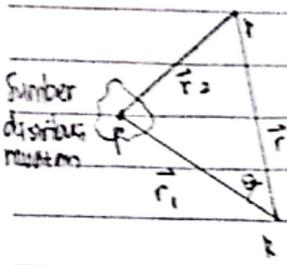
> Ekspansi multipol

• Monopol (kumb tunggal)



$$V_P = -\int_0^P \vec{E}\,dr \quad \cdots(1)$$

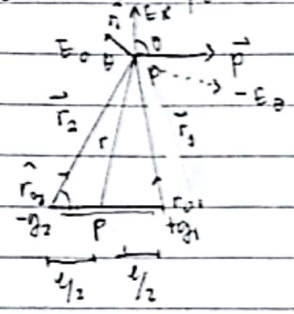
$$V_R = -\int_\infty^R \vec{E}\,dr \quad \cdots(2)$$

Dari (1) dan (2)

$$V_P - V_R = -\int_\infty^P \vec{E}\,dr + \int_\infty^R \vec{E}\,dr$$

$$V_{RP} = -\int_R^P \vec{E}\,dr = -\frac{1}{4\pi\varepsilon_0}\int_R^P \frac{\rho'\,d\tau}{R}$$

• potensial oleh dipol listrik



$$V_P = V(r,\theta) = \frac{q_1}{4\pi\varepsilon_0 r_1} - \frac{q_2}{4\pi\varepsilon_0 r_2}$$

dimana $q_1 = q_2 = q$

$$V(r,\theta) = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$r_1 = r - \frac{l}{2}\cos\theta$$

$$r_2 = r + \frac{l}{2}\cos\theta$$

$$V(r,\theta) = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r - \frac{l}{2}\cos\theta} - \frac{1}{r + \frac{l}{2}\cos\theta}\right]$$

$$= \frac{q}{4\pi\varepsilon_0}\left(\frac{l\cos\theta}{r^2 - \frac{l^2}{4}\cos^2\theta}\right)$$

Untuk $r \gg l$ maka

$$V(r,\theta) = \frac{q\,l\cos\theta}{4\pi\varepsilon_0 r^2}$$

$$V(r,\theta) = \frac{\vec{p}\cos\theta}{4\pi\varepsilon_0 r^2} = \frac{\vec{p}\cdot\hat{r}}{4\pi\varepsilon_0 r^2}$$