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Prodi : Pendidikan Fisika (B)

Tugas Mekanika

4.1). a. $V = Cxyz + C$

$\Rightarrow$ Jawab : $\vec{F} = -\vec{\nabla} V = -\hat{i}\frac{\partial V}{\partial x} - \hat{j}\frac{\partial V}{\partial y} - \hat{k}\frac{\partial V}{\partial z} = -C(\hat{i}yz + \hat{j}xz + \hat{k}xy)$

b. $V = \alpha x^2 + \beta y^2 + \gamma z^2 + C$

$\Rightarrow$ Jawab : $\vec{F} = -\vec{\nabla} V = -\hat{i}\,2\alpha x + \hat{j}\,2\beta y + \hat{k}\,2\gamma z$

c. $V = Ce^{-(\alpha x + \beta y + \gamma z)}$

$\Rightarrow$ Jawab : $\vec{F} = -\vec{\nabla} V = Ce^{-(\alpha x + \beta y + \gamma z)}(\hat{i}\alpha + \hat{j}\beta + \hat{k}\gamma)$

d. $V = Cr^n$ dalam koordinat bola

$\Rightarrow$ Jawab : $\vec{F} = -\vec{\nabla} V = -\hat{e}_r\frac{\partial V}{\partial r} - \hat{e}_\theta\frac{1}{r}\frac{\partial V}{\partial \theta} - \hat{e}_\phi\frac{1}{r\sin\theta}\frac{\partial V}{\partial \phi}$

4.2) a. $F = ix + jy + kz$

$\Rightarrow$ Jawab : $\vec{\nabla} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x & y & z \end{vmatrix} = 0 \rightarrow$ konservatif

b. $F = ix - jy + kz^2$

$\Rightarrow$ Jawab : $\vec{\nabla} + \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x & -y & z^2 \end{vmatrix} = \hat{k}(-1-1) \neq 0 \rightarrow$ tidak konservatif

c. $F = \hat{i}x + \hat{j}y + \hat{k}z^3$

$\Rightarrow$ Jawab : $\vec{\nabla} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x & y & z^3 \end{vmatrix} = \hat{k}(1-1) = 0 \rightarrow$ konservatif

d. $F = -kr^{-n}\,e_r$ dalam koordinat bola

$\Rightarrow$ Jawab : $\vec{\nabla} \times \vec{F} = \frac{1}{r^2\sin\theta}\begin{vmatrix} \hat{e}_r & \hat{e}_\theta r & \hat{e}_\phi r\sin\theta \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial \phi} \\ -kr & 0 & 0 \end{vmatrix} = 0 \rightarrow$ konservatif

4.3). a. $F = \hat{i}xy + \hat{j}cx^2 + \hat{k}z^3$

$\Rightarrow$ Jawab : $\vec{\nabla} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ xy & cx^2 & z^3 \end{vmatrix} = k(2(cx - x))$

$2cx - x = 0 \rightarrow c = 1/2$

b. $F = 1\ (z/y) + (j\ (xz/y^2) + k\ (x/y)$

=> Jawab. $\vec{\nabla} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ xy & cx^2 & z^3 \end{vmatrix} = k$

C. $F = 1\ (z/y) + sj\ (xz/y^2) + k\ (x/y)$

=> Jawab : $\vec{\nabla} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ \frac{z}{y} & \frac{cxz}{y^2} & \frac{x}{y} \end{vmatrix} = \hat{i}\left(\frac{-x}{y} - \frac{cx}{y^2}\right) + \hat{j}\left(\frac{1}{y} - \frac{1}{y}\right) + \hat{k}\left(\frac{cz}{y^2} + \frac{z}{y^2}\right)$

$\frac{-x}{y^2} - \frac{cx}{y^2} = 0 \rightarrow c = -1$ dan $\frac{cz}{y^2} + \frac{z}{y^2} = 0 \rightarrow c = -1$

4.4). a. $E = \text{konstan} = V(x, y, z) + 1/2\ mv^2$

diasalnya $E = 0 + 1/2\ mv'$

Pada $(1,1,1)$ $E = \alpha + \beta + y + 1/2\ mv^2 . 1/2\ mv^2$

b. $V_0 - 2/m\ (\alpha + \beta + y) = 0$

$$v_0 = \left[\frac{2}{m}(\alpha + \beta + y)\right]^{1/2}$$

c. $m\ddot{x} = F_x = -\partial V/\partial x$

$m\ddot{x} = -\alpha$

$m\ddot{y} = \frac{-\partial V}{\partial y} = -2\beta y$

$m\ddot{z} = \frac{-\partial V}{\partial z} = -3yz^2$

4.5). Pertimbangkan 2 fungsi gaya

(a). $F = \hat{i}x + \hat{i}y$

=> Jawab = $\vec{F} = \hat{i}x + \hat{j}y$

di $x = y$; $\vec{dr} = \hat{i}\,dx + \hat{j}\,dy$

$$\int_{(0,0)}^{(1,1)} \vec{F} \cdot \vec{dr} = \int_0^1 f_x dx + \int_0^1 f_y dy = \int_0^1 x\,dx + \int_0^1 y\,dy = -1$$

Pada lintasan sepanjang sumbu $x = \vec{dr} = \hat{i}dx$

dan pada garis $x = 1$ $\vec{dr} = j\,dy$

$$\int_{(0,0)}^{(1,1)} \vec{F} \cdot \vec{dr} = \int_0^1 F_x dx + \int_0^1 f_y dy = 1, \ \vec{F} = \text{konservatif}$$

(b). $\vec{F} = \hat{i}y - \hat{j}x$

di $x = y$: $\int_{(0,0)}^{(1,1)} \vec{F} \cdot \vec{dr} = \int_0^1 f_x dx + \int_0^1 f_y dy = \int_0^1 y\,dx - \int_0^1 x\,dy$

dan, dengan $x = y$ $\int_{(0,0)}^{(1,1)} \vec{F} \cdot d\vec{r} = \int_0^1 x\,dx - \int_0^1 y\,dy = 0$

Pada sumbu x = $\int_{(0,0)}^{(1,1)} \vec{F} \cdot d\vec{r} = \int_0^1 f x\,dx = \int_0^1 y\,dx$ ...

dan, dengan $y = 0$ Pada sumbu x $\int_{(0,0)}^{(1,0)} \vec{F} \cdot d\vec{r} = 0$

Pada garis $x = 1$ $\int_{(1,0)}^{(1,1)} \vec{F} \cdot d\vec{r} = \int_0^1 f y\,dy = \int_0^1 x\,dy$

dan, dengan $x = 1$ $\int_{(1,0)}^{(1,1)} \vec{F} \cdot d\vec{r} = \int_0^1 dy = 1$

Pada jalur ini $\int_{(0,0)}^{(1,1)} \vec{F} \cdot d\vec{r} = 0 + 1 = 1$, $\vec{F}$ = Tidak konservatif

4.6). Dari Contoh 2.3.2, $V(z) = -mg \dfrac{r_e^2}{(r_e+z)}$

$$V(z) = -mgr_e \left(1 + z/r_e\right)^{-1}$$

$$V(z) = -mgr_e \left(1 - z/r_e + z^2/r_e + \dots\right)$$

$$V(z) = -mgr_e + mgz - mgz/r_e^2 + \dots$$

dengan $-mgr_e$ sebuah konstan

$$V(z) \approx mgz\left(1 - z/r_e\right)$$

$$\vec{F} = -\vec{\nabla} V = -\hat{k}\, \partial/\partial z\; V(z)$$

$$= -\hat{k}\, mg\left[1 - z/r_e + z\left(1/r_e\right)\right]$$

$$\vec{F} = -\hat{k}\, mg\left(1 - 2z/r_e\right)$$

$$m\ddot{x} = F_x = 0$$

$$m\dot{z}\frac{dz}{dz} = -mg\left(1 - 2z/r_e\right)$$

$$\int_{v_z}^{0} \dot{z}\,dz = -g\int_0^h \left(1 - 2z/r_e\right) dz$$

$$-\frac{1}{2} v_{0z}^2 = -g\left(h - h^2/r_e\right)$$

$$h^2 - r_e h + r_e v^2{}_{z}/2g = 0$$

$$h - r_e h + r_e v^2{}_{0z}/2g = 0$$

$$h = r_e h - 1/2\sqrt{r_e^2 - \frac{2r_e v^2{}_{0t}}{gr_e}} \qquad (h, z << r_e)$$

$$h = \frac{r_e}{2} - \frac{r_e}{2}\sqrt{1 - \frac{2v^2{}_{0z}}{gr_e}}$$

$$(1+x)^{1/2} = 1 + x/2 - x^2/e + \dots$$

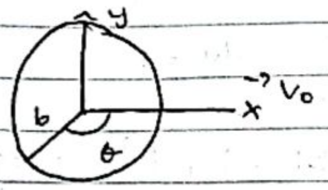
$$h = \frac{r_e}{2} - \frac{r_e}{2} + \frac{v^2{}_{0z}}{2g} + \frac{v^4{}_{0z}}{4gr_e} + \dots$$

$$h \simeq \frac{v^2_{0z}}{2g}\left(1+\frac{v^2_{0z}}{2gr_e}\right)$$

dari Contoh 2.3.2 $h = \frac{v_0^2}{2g}\left(1-\frac{v_0^2}{2gr_e}\right)^{-1}$

dan dengan $(1-x)^{-1} \simeq 1+x$, $h \simeq \frac{v_0^2}{2g}\left(1+\frac{v_0^2}{2gr_e}\right)$

4.7).



$\vec{r}' = \hat{i}\, b\cos\theta - \hat{j}\, b\sin\theta$

$\theta = \omega t = \frac{v_0 t}{b}$ = jadi, $\vec{r} = -\hat{i}\, v_0 \sin\theta - \hat{j}\, v_0\cos\theta$

Partikel keluar tepi $= y_0 = -b\sin\theta$ dan $v_{0y} = -v_0\cos\theta$

Jadi, $v_y = v_{0y} - gt = -v_0\cos\theta - gt$ dan $y = -b\sin\theta - v_0 t\cos\theta - 1/2\, gt^2$

tinggi maksimum $v_y = 0$

$$t = \frac{-v_0\cos\theta}{g}$$

$$h = -b\sin\theta - v_0\left(\frac{-v_0\cos\theta}{g}\right)\cos\theta - \frac{1}{2}g\left(\frac{-v_0\cos\theta}{g}\right)^2$$

$$h = -b\sin\theta = \frac{v_0^2\cos^2\theta}{2g}$$

h maksimum terjadi untuk $\frac{dh}{d\theta} = 0 = -b\cos\theta - \frac{2v_0^2\cos\theta\sin\theta}{2g}$

$$\sin\theta = \frac{-gb}{v_0^2}$$

$$\cos^2\theta = 1-\sin^2\theta = \frac{v_0^4 - g^2b^2}{v_0^4}$$

$$h_{max} = \frac{gb^2}{v_0^2} + \frac{v_0^4 g^2 b^2}{2gv_0^2} = \frac{gb^2}{2v_0^2} + \frac{v_0^2}{2g}$$

lumpur meninggalkan roda di $\theta = \sin^{-1}\left(-\frac{gb}{v_0^2}\right)$

4.8). $x = R\cos\varphi$ dan $x = v_{0x}t = (v_0\cos\alpha)t$

Jadi, $t = \frac{R\cos\varphi}{v\cos\alpha}$

$y = R\sin\varphi$ dan $y = v_y t = -\frac{1}{2}gt^2 = (v_0\sin\alpha)t - gt^2$

$$R\sin\varphi = (v_0\sin\alpha)\frac{R\cos\varphi}{v_0\cos\alpha} - \frac{1}{2}g\left(\frac{R\cos\varphi}{v_0\cos\alpha}\right)^2$$

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$$\sin \varphi = \tan \alpha \cos \varphi - \frac{gR\cos^2 \alpha}{2 V_0^2 \cos^2}$$

$$R = \frac{2 V_0^2 \cos^2 \alpha}{g\cos\varphi}(\tan\alpha \cos\varphi - \sin\varphi) = \frac{2V_0^2 \cos\alpha}{g\cos^2\varphi}(\sin\alpha\cos\varphi - \cos\alpha\sin\varphi)$$

$$\sin(\theta + \varphi) = \sin\theta\cos\varphi + \cos\theta\sin\varphi$$

$$R = \frac{2V_0^2 \cos\alpha}{g\cos^2\varphi}\sin(\alpha - \varphi)$$

R maks. untuk $\frac{dR}{dx} = 0 = \frac{2V_0^2}{g\cos^2\varphi}\left[-\sin\alpha\sin(\alpha-\varphi) + \cos\alpha\cos(\alpha-\varphi)\right]$

$\cos(\theta+\varphi) = \cos\theta\cos\varphi - \sin\theta\sin\varphi$ jadi $\cos(2\alpha - \varphi) = 0$

$$2\alpha - \varphi = \pi/2 \qquad \alpha = \pi/4 + \varphi/2$$

$$R_{max} = \frac{2V_0^2}{g\cos\varphi}\cos\left(\frac{\pi}{4} + \frac{\varphi}{2}\right)\sin\left(\frac{\pi}{4} - \frac{\varphi}{2}\right)$$

$$\sin\left(\frac{\pi}{4} - \frac{\varphi}{2}\right) = \cos\left[\frac{\pi}{2} - \left(\frac{\pi}{4} - \frac{\varphi}{2}\right)\right] = \cos\left(\frac{\pi}{4} + \frac{\varphi}{2}\right)$$

$$R_{max} = \frac{2V_0^2}{g\cos^2\varphi}\cos^2\left(\frac{\pi}{4} + \frac{\varphi}{2}\right)$$

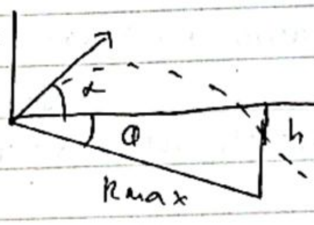
$$R_{max} = \frac{2V_0^2}{g\cos^2\varphi}\left[\frac{1}{2}\cos\left(\frac{\pi}{2} + \varphi\right) + \frac{1}{2}\right] = \frac{V_0^2}{g\cos^2\varphi}\left[\cos\left(\frac{\pi}{2} + \varphi\right) + 1\right]$$

menggunakan $\cos\left(\frac{\pi}{2} + \theta\right) = -\sin\theta$

$$R_{max} = \frac{V_0^2}{g(1-\sin\varphi)}(1-\sin\varphi)$$

$$= \frac{V_0^2}{g(1+\sin\varphi)}$$

4.9) a.



$$R = \frac{2V_0^2}{g}\frac{\cos\alpha\sin(\alpha+\varphi)}{\cos^2\varphi}$$

$-\varphi = \ldots R_{max} = V_0^2(1+\sin\varphi)$ dan ...

$$2\alpha = \pi/2 = \alpha$$

$$R_{max} = \frac{h}{\sin\varphi} = \frac{V_0^2}{g}\frac{(1+\sin\alpha)}{\cos^2\varphi} = \frac{V_0^2}{g(1-\sin\varphi)}$$

$$\sin\varphi = \frac{gh}{V_0^2} \Big/ \left(1 + \frac{gh}{V_0^2}\right)$$

$$\sin\varphi = \sin(\pi/2 - 2\alpha) = \cos 2\alpha = 1 - 2\sin^2\alpha$$

$$1 - 2\sin^2\alpha = \frac{gh}{V_0^2} \Big/ \left(1 + \frac{gh}{V_0^2}\right)$$

$$2\sin^2\alpha = \frac{2}{\csc^2\alpha} = 1 - \frac{gh}{V_0^2} \Big/ \left(1 + \frac{gh}{V_0^2}\right) = \frac{1}{1 + \frac{gh}{V_0^2}}$$

akhirnya $= \csc^2\alpha = 2\left(1 + gh/V_0^2\right)$

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b). $R_{max} = \frac{h}{\sin y} = \frac{h}{1-2\sin^2 x} = \frac{h}{1-2/\csc^2 x}$

$$R_{max} = \frac{V_0^2}{g}\left(1 + \frac{gh}{V_0^2}\right)$$

4.12) a. x dan z adalah posisi bola

$x = V_0 t \cos \frac{1}{2}\theta_0$, $z = V_0 t \cos \frac{1}{2}\theta_0 \sin\theta_0 - \frac{1}{2}gt^2$

sejak $V_x = V_0 \cos \frac{1}{2}\theta$,

$R = \frac{V_0^2}{g} \cos^2 \frac{1}{2}\theta_0 \sin 2\theta_0$

maks $\frac{dR}{d\theta} = 0$

$\frac{dR}{d\theta} = \frac{V_0^2}{g}\left(2\cos^2 \frac{1}{2}\theta_0 \cos 2\theta_0 - \cos\frac{1}{2}\theta_0\right.$

$\left.\sin\frac{1}{2}\theta \sin 2\theta_0\right) = 0$

$2\cos^2\frac{1}{2}\theta_0 \cos 2\theta_0 = \cos\frac{1}{2}\theta_0 \sin\frac{1}{2}\theta_0 \sin 2\theta_0$

$2\cos^2\theta_0 = 1 + \cos 2\theta_0$ dan $\sin 2\theta = 2\sin\theta_0 \sin 2\theta_0$

didapat : $(1+\cos\theta_0)(2\cos^2\theta_0 - 1) = \sin\theta_0 \sin\theta_0$

$\cos\theta_0 = (1-\cos^2\theta \cos\theta.$

atau $(1+\cos\theta_0)(3\cos^2\theta_0 - \cos\theta_0 - 1) = 0$

hanya akar positif yang berlaku adalah $\theta.\ 0 \le \theta \le \pi/2$

$\cos\theta_0 = 1/6\,(1+\sqrt{13}) = 0,7676 \qquad \theta_0 = 39°51'$

b. Untuk $V_0 = 25\ m/s \quad R_{max} = 55,4\ m \quad \theta_0 = 39°51'$

maks $\frac{dz}{dt} = 0$

$V_0 \cos\frac{1}{2}\theta_0 \sin\theta_0 = gT$ atau $T = \frac{V_0 \cos\frac{1}{2}\theta_0 \sin\theta_0}{g}$

atau $H = \frac{V_0^2}{2g}\cos^2\frac{1}{2}\theta_0 \sin^2\theta$, maks. tetap di θ,

maks. pada ketinggian tetap terjadi $\frac{dH}{dt} = 0$

$\frac{dH}{dt} = \frac{V_0^2}{2g}\left(2\cos^2\frac{1}{2}\theta_0 \sin\theta_0 \cos\theta_0 \, dt - \cos\frac{1}{2}\theta_0 \sin\frac{1}{2}\theta_0\right.$

$\left.\sin^2\theta\right) = 0$

$(1+\cos\theta_0)\sin\theta_0\cos\theta_0 = \frac{1}{2}\sin\theta_0 \sin^2\theta_0 =$

$\frac{1}{2}\sin\theta_0(1-\cos^2\theta_0)./\ \sin\theta_0(1+\cos\theta_0)(3\cos\theta_0 - 1) = 0$

$\sin\theta_0 = 0 \qquad \cos\theta_0 = -1$

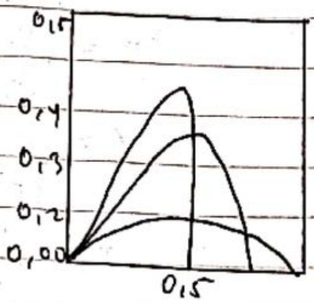
Jadi $H_{max} = 18,9\ m \quad \theta_0 = \cos^{-1}\frac{1}{3} = 70,32°$

4.13). r menggantikan x

$$z = \frac{\dot{z}_0}{\dot{r}_0} r - \frac{g}{2\dot{r}_0^2} r^2$$ dimana $\dot{r}_0 = V_0 \cos\theta_0 \quad \dot{z}_0 = V_0 \sin\theta_0$

$$z = r \tan\theta_0 - \frac{gr^2}{2V_0^2} \sec^2\theta$$ sejak $\sec^2\theta_0 = 1 + \tan^2\theta$

$$\frac{gr^2}{2V_0^2} \tan^2\theta_0 - r\tan\theta_0 + z + \frac{gr^2}{2V_0^2} = 0$$



(r, z) titik koordinat

$$\tan\theta_0 = \frac{1}{gr}\left[V_0^2 \pm (V_0^4 - gzV_0^2 - g^2r^2)^{1/2}\right]$$

$$V_0^4 - 2gzV_0^2 - g^2r^2 \geq 0$$

Permukaan kritis oleh karena itu $V_0^4 - 2gz - g^2r^2 = 0$

4.17). $$m\ddot{x} = f_x = -\frac{\partial V}{\partial x} = -kx = -\pi^2 mx$$

$$x = A\cos\left(\sqrt{\frac{k}{m}} + t\alpha\right) = A\cos(\pi t + \alpha)$$

$$m\ddot{y} = -\frac{\partial V}{\partial y} = 4\pi^2 m\alpha$$

$$y = B\cos(2\pi t + \beta)$$

$$m\ddot{z} = -\frac{\partial V}{\partial z} = -9\pi^2 mz$$

$$z = C\cos(3\pi t + \gamma)$$

sejak $x = y = z = 0$ Pada $t = 0$ $\alpha = \beta = \gamma = -\pi/2$

$$x = A\cos(\pi t \cdot \pi/2) = A\sin\pi t$$

$$\dot{x}_0 = A\pi\cos\pi t$$

$$V_0^2 = \ddot{x}_0^2 + \ddot{y}_0^2 + \ddot{z}_0^2$$ dan $\ddot{x}_0 = \ddot{y}_0 = \ddot{z}_0$

$$\dot{x}_0 = \frac{V_0}{\sqrt{3}} = A\pi$$

$$A = \frac{V_0}{\pi\sqrt{3}}$$

$$x = \frac{V_0}{\pi\sqrt{3}} \quad 3\sin\pi t$$

$$y = B\sin 2\pi t, \quad y = 2B\pi\cos 2\pi t$$

$$y_0 = \frac{V_0}{\sqrt{3}} = 2\pi$$

$$B = \frac{V_0}{2\pi\sqrt{3}}$$

$$y = \frac{V_0}{2\pi\sqrt{3}} \sin 2\pi t$$

$$z = C \sin 3\pi t$$

$$\dot{z}_0 = \frac{V_0}{\sqrt{3}} = 3\pi t \qquad \dot{z} = 3C\pi \cos 3\pi t$$

$$\dot{z}_0 = \frac{V_0}{\sqrt{3}} = 3C\pi$$

$$C = \frac{V_0}{3\pi\sqrt{3}}$$

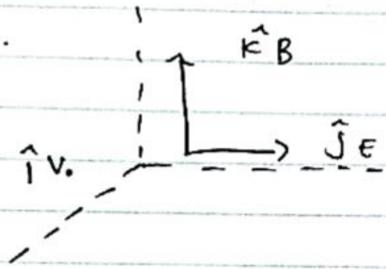
$$z = \frac{V_0}{3\pi\sqrt{3}} \sin 3\pi t$$

sejak $\omega_x = \pi.$ $\omega_y = 2\pi$ dan $\omega_z = 3\pi$, maka

$$t_{min} = \frac{2\pi n}{\omega_x} = \frac{2\pi n_2}{\omega_y} = \frac{2\pi n_3}{\omega_z}$$

waktu maks pada $n_1 = 1$, $n_2 = 2$, $n_3 = 3$ $\quad t_{min} = \frac{2\pi}{\pi} = 2$

4.20).



$$\vec{F} = q(\vec{E} + \vec{V} + \vec{B})$$

$$\vec{V} \times \vec{B} = (\hat{i}\dot{x} + \hat{j}\dot{y} + \hat{k}\dot{z}) \times kB = \hat{i}\dot{y}B - \hat{j}\dot{x}B$$

$$\vec{F} = \hat{i} q\dot{y}B + \hat{j} q (E - \dot{x}B)$$

$$m\ddot{x} = F_x = q\dot{y}B$$

$$\dot{x} - \dot{x}_0 = \frac{qB}{m} y$$

$$m\ddot{y} = F_y = qE - q\dot{x}B = qE - qB(\dot{x}_0 + qB/m\, y)$$

$$\ddot{y} = qE/m - qB\dot{x}/m - (qB/m)^2 y = eE/m + EB\dot{x}/m - [eB/m]^2$$

$$\ddot{y} + \omega^2 y = -eE + \omega\dot{x}_0 ..$$

$$y = \frac{1}{\omega^2}\left(-\frac{eE}{m} + \omega x\right) + A\cos(\omega t + \theta_0)$$

$$\dot{y} = -A\omega \sin(\omega t + \theta)$$

$$\dot{y}_0 = 0, \text{ Jadi } \theta_0 = 0, \; A = \frac{-1}{\omega^2}\left(-\frac{eE}{m} + \omega\dot{x}_0\right)$$

$$y = a(1 - \cos \omega t), \quad a = 1/\omega^2 (-eE/m + \omega\dot{x}_0)$$

$$\dot{x} = \dot{x}_0 = \frac{qB}{m} y : \dot{x} - \omega y = \dot{x}_0 - \omega a (1 - \cos \omega t)$$

$$x = (\dot{x}_0 - \omega a)t + a \sin \omega t$$

$$x = a \sin \omega t + bt, \qquad b = \dot{x}_0 - \omega a$$

$$m\ddot{z} = F_z = 0 \qquad z = \dot{z}_0 t + z_0 = 0$$