

P3-2012

1.a) $x = R\varphi$

b) $\tau = \tau_d - \tau_e$ $\tau_d = -k(x - (-a))R = -k(x+a)R$
 $\tau_e = -k(x - (-a))R = -k(x+a)R$

$\tau = \cancel{k}kR(+x \cancel{+} a + x + a) = -2kRx = -2kR^2\varphi$

c) $I_z \frac{d^2\varphi}{dt^2} = \tau = -2kR^2\varphi$ $I_z = I$

$\frac{d^2\varphi}{dt^2} + \frac{2kR^2}{I}\varphi = 0$ $\omega = \sqrt{\frac{2kR^2}{I}} = \frac{2\pi}{T}$

$\frac{2kR^2}{\frac{1}{2}MR^2} = \left(\frac{2\pi}{T}\right)^2 = \frac{4k}{M}$ $M = \left(\frac{I}{2\pi}\right)^2 4k$

$M = \left(\frac{3,14}{2 \times 3,14}\right)^2 \times 4 \times 10 = 10 \text{ kg}$

d) $\varphi(t) = A \cos(\omega_0 t + \delta)$ $t=0 \Rightarrow \varphi=0$
 $\cos \delta = 0$ $\delta = \frac{\pi}{2} + n\pi$ 

$\frac{d\varphi}{dt} = -A\omega_0 \sin(\omega_0 t + \delta) = -A\omega_0 \sin(\omega_0 t + \delta)$

$\frac{d\varphi}{dt} < 0 \Rightarrow \sin(\omega_0 t) > 0 \Rightarrow 0 \leq \delta \leq \pi \Rightarrow n=0$
 $\delta = \frac{\pi}{2}$



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$$e) \quad E_c = \frac{1}{2} \frac{1}{2} M R^2 \left(\frac{d\varphi}{dt} \right)_{\max}^2 = \frac{5}{8} J = \frac{M R^2}{4} (A \omega_0)^2$$

$$\omega_0 = \frac{2\pi}{T} = 2 \text{ rad/s}$$

$$\sqrt{\frac{4 E_c}{M R^2 \omega_0^2}} = A$$

$$A = \sqrt{\frac{4 \times 5/8 \pi^2}{10 \times 4}} = \frac{\pi}{4}$$

$$2. a) \quad (A + B(0))e^{-0} = A = 0$$

$A = 0$

$$b) \quad \frac{d\varphi}{dt} = 0 \quad \varphi_{\max} \quad \varphi = B t e^{-\frac{\gamma}{2} t}$$

$$\frac{d\varphi}{dt} = B e^{-\frac{\gamma}{2} t} - B t \frac{\gamma}{2} e^{-\frac{\gamma}{2} t} = B(1 - \frac{\gamma}{2} t) e^{-\frac{\gamma}{2} t}$$

$$\frac{d\varphi}{dt} = 0 \Rightarrow 1 - \frac{\gamma}{2} t_1 = 0 \quad t_1 = \frac{2}{\gamma} = \frac{2e}{3}$$

$$c) \quad \varphi_{\max} = B t_1 e^{-\frac{\gamma}{2} t_1} = B \frac{2e}{3} e^{-\frac{3}{2e} \cdot \frac{2e}{3}} = \frac{2e}{3} B e^{-1}$$

$$B = \frac{\pi}{3} \cdot \frac{3}{2} = \frac{\pi}{2}$$

$$d) \quad \varphi(t_2) = B 4e \times e^{-\frac{3}{2} \cdot \frac{4e}{2}} = 4 \frac{\pi}{2} e e^{-6}$$

$$\varphi(t_2) = 2\pi e^{-6} = 2\pi \times 0,002 = 0,014 \pi$$

$$e) \quad \omega_0 = B = \frac{\pi}{2} \text{ rad/s} \quad f) \quad \omega = \frac{\gamma}{2} = \frac{3}{2e}$$

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