$\boxed{1}$

$$dF = \underbrace{\frac{\rho \pi D^2}{4} \overset{C_M}{2}}_{C_1} \underbrace{\dot{u}\, dz}_{F_1} + \underbrace{\frac{1}{2}\rho \overset{C_D}{0.7} D_m}_{C_2} \underbrace{u|u|\, dz}_{F_2}$$

Distance = 100 m, $H = 50$ m, $D = 7$ m

$T = 15$ s, $\zeta_a = 2{,}5$ m

[$\omega^2 = kg \tanh(kh)$ ← Løser med numerisk python script.]

$k = 0.02223$

a) $\lambda = 282{,}64$ meter

$\boxed{1B.1}$ $dF = C_1F_1 + C_2F_2$

$$\int_{-h}^{0} \cosh(k(h+z))\,dz = \left[\frac{\sinh(k(h+z))}{(h+z)}\right]_{z=-h}^{z=0}$$

$$\cancel{\frac{\sinh(kh)}{h} + \frac{\sinh(k\,0)}{0}}$$

$$= \frac{\sinh(h \cdot k)}{k} \rightarrow \Big|_{h=50}^{k=0.02223} \rightarrow \approx \underline{60{,}95}$$

$\boxed{1B.2}$ $C_1 \cdot F_1 = \frac{\rho \pi D^2}{4} C_m \cancel{\omega} \frac{g\zeta_a k}{\cancel{k}} \cancel{\frac{\sinh(kh)}{\cosh(kh)}} \cancel{\sin} \cos(kx - \omega t)$

$\xrightarrow{\tanh(kh)}$

$$F_2 = \left(\frac{kg\,\zeta_a}{\omega\cosh(kh)}\right)^2 |\sin(\cancel{kx}\omega t)|\, \sin(kx-\omega t) \int_{-h}^{0} \cosh^2(kh+kz)\,dz$$

$\cancel{F_2}$ $\sinh(2kh) = 2\cosh(kh).\sinh(kh)$

$$\int_{-h}^{0} dz = \frac{1}{4k}\left(2\cosh(kh)\sinh(kh) + 2kh\right)$$

$$\cancel{F_2 = \left(\frac{kg\,\zeta_a}{\omega\cosh(kh)}\right)^2 \frac{k}{2}}$$

$$F_2 = \cancel{\left(\frac{\omega\zeta_a}{\cosh(kh)}\right)^2} = \underbrace{\left(\frac{\omega\ \ \zeta_a}{\tanh(kh)\ \cosh(kh)}\right)^2}_{\circ} \frac{1}{2k}(2\cosh()\ldots)\ |\sin()|\sin()$$

$$\zeta_a^2 \frac{kg\tanh(kh)}{\tanh^2()\cosh^2()} = \frac{\zeta_a^2 kg\cosh()}{\sinh()\cosh^2()} = \frac{\zeta_a^2 kg}{\sinh()\cosh()}$$

$$\cancel{F_2 = \zeta_a^2 g} \ \cancel{(k\sinh(kh))}$$

$$F_2 = \zeta_a^2 g\left(\frac{1}{2} + \frac{kh}{\sinh(kh)}\right) |\sin(\cancel{kx}x-\omega t)|\,\sin(kx-\omega t)$$

$$C_2 = -\frac{1}{2}\rho C_D D$$

$\boxed{1B_3}$ $\boxed{\omega = \frac{2\pi}{15}} \approx 0.419$

$$F = \rho \frac{\pi D^2}{4} C_m g \zeta_a \tanh(kh) \cos(kx - \omega t)$$

$$- \frac{1}{2} \rho C_D D \zeta_a^2 g \left(\frac{1}{2} + \frac{kh}{\sinh(2kh)} \right) |\sin(kx - \omega t)| \sin(kx - \omega t)$$

Cyl 1 $x = 0$, $C_m = 2$, ... osv. $\rho = 1025$

$$F_{cyl1} = 1{,}56 \cdot 10^6 \cos(\underset{0.419t}{\omega t}) + 1{,}14 \cdot 10^5 |\sin(0{,}419t)| \sin(0.419t)$$

$$kL = 0.02223 \cdot \cancel{282{,}64}^{100} = \underline{2{,}223}$$

$$F_{cyl2} = -\,||\,- \cos(0.419t - 2{,}223)$$
$$+ \;-||-\; |\sin(0{,}419t - 2{,}223)| \sin(\quad)$$

phase shifted, Same Amp.

$\boxed{1C}$ Neglect dragforces.

$$F = 1{,}55 \cdot 10^6 \underbrace{\left[\cos(\omega t) + \cos(\omega t - kL)\right]}_{= \underline{a}},$$

Must find $\underline{a = 0}$.

$$a = \cos(\omega t) + \cos(\omega t)\cos(kL) + \sin(\omega t)\sin(kL) = 0$$

$$\cos(kL) + \tan(\omega t)\sin(kL) = -1 \quad \text{I}$$

$\tan(\omega t) \to \infty$ when $\omega t \to \frac{2n+1}{2}\pi$

Thus I will only ~~make~~ make sense for

$\sin(kL) = 0$ and $\cos(kL) = -1$.

$$kL = (2n+1)\pi \quad , \quad n = 0, 1, 2, \ldots$$

$F = 0$ for $kL = (2n+1)\pi$. here $\underline{L = 100 \text{ meter}}$

$k = \frac{2\pi}{\lambda}$

$$\frac{200\cancel{\pi}}{\lambda} = (2n+1)\cancel{\pi}$$

$$\lambda = \frac{200}{(2n+1)}$$

$\lambda_1 = 200\,m$	$T_1 = 11{,}8\,s$
$\lambda_2 = 66{,}7\,m$	$T_2 = 6{,}6\,s$
$\lambda_3 = 40\,m$	$\underline{T_3 = 5{,}1\,s}$
$\lambda_4 = 28{,}6\,m$	