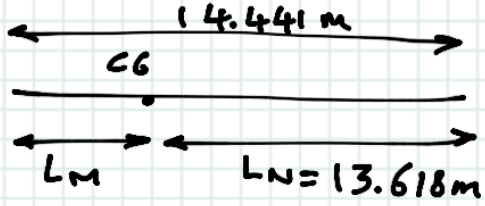
$$E_c = \frac{1}{2} M_N \dot{z}_N^2 + \frac{1}{2} 2M_M \dot{z}_M^2 + \frac{1}{2} M \dot{z}_A^2 + \frac{1}{2} I \dot{\theta}_A^2$$



$$M = diag(M_N, 2M_M, M, I)$$

$$E_p = \frac{1}{2} K_N (z_N - z_{AV})^2 + \frac{1}{2} 2K_M (z_M - z_{AR})^2 + \frac{1}{2} 2K_{A_1} (z_M - z_A + L_M \sin(\theta_A))^2 + \frac{1}{2} K_{A_2} (z_N - z_A - L_N \sin(\theta_A))^2$$

$$K = \begin{bmatrix} K_N + K_{A_2} & 0 & -K_{A_2} & -K_{A_2} L_N \\ 0 & 2K_M + 2K_{A_1} & -2K_{A_1} & 2K_{A_1} L_M \\ -K_{A_2} & -2K_{A_1} & 2K_{A_1} + K_{A_2} & -2K_{A_1} L_M + K_{A_2} L_N \\ -K_{A_2} L_N & 2K_{A_1} L_M & -2K_{A_1} L_M + K_{A_2} L_N & K_{A_2} L_N^2 + 2K_{A_1} L_M^2 \end{bmatrix}$$

$$D = \frac{1}{2} 2C_{A_1} (\dot{z}_M - \dot{z}_A + L_M \dot{\theta}_A)^2 + \frac{1}{2} C_{A_2} (\dot{z}_N - \dot{z}_A - L_N \dot{\theta}_A)^2$$

$$C = \begin{bmatrix} C_{A_2} & 0 & -C_{A_2} & -C_{A_2} L_N \\ 0 & 2C_{A_1} & -2C_{A_1} & 2C_{A_1} L_M \\ -C_{A_2} & -2C_{A_1} & 2C_{A_1} + C_{A_2} & -2C_{A_1} L_M + C_{A_2} L_N \\ -C_{A_2} L_N & 2C_{A_1} L_M & -2C_{A_1} L_M + C_{A_2} L_N & C_{A_2} L_N^2 + 2C_{A_1} L_M^2 \end{bmatrix}$$

$$T = \frac{\lambda}{c}, \quad \lambda = 1\text{m}, \quad c = 7.71\text{m/s}$$

$a = 0.01$ m

$z_{AV} = a e^{i\omega t}$

avec $\omega = \frac{2\pi}{T}$

$z_{AR} = a e^{i(\omega t + \phi)}$

$\phi = -2\pi \times 0.441$

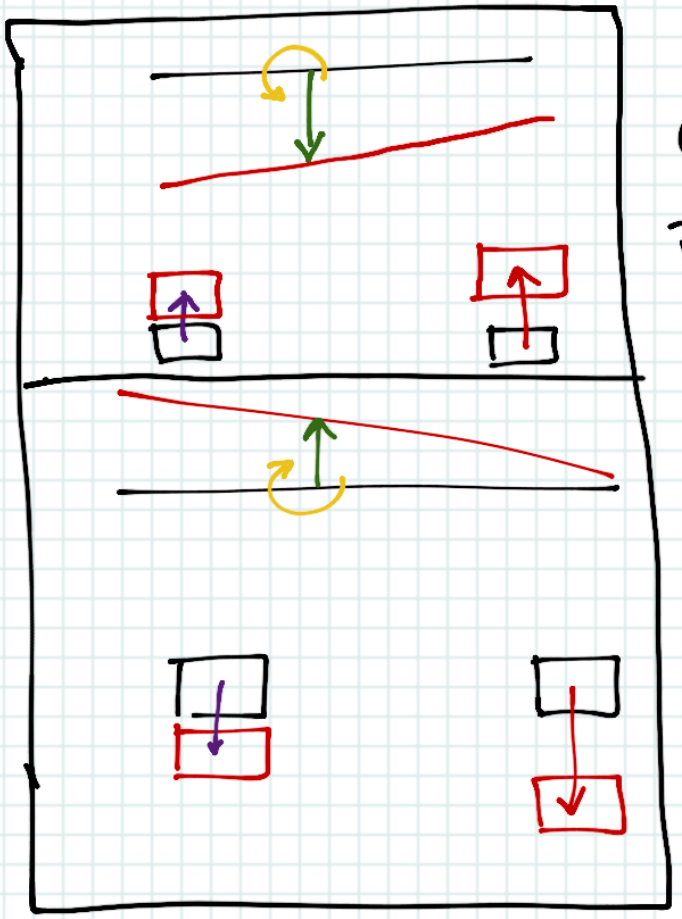
ou

$\phi = 2\pi \times 0.559$

—x—

Forçage : provient de l'E_p

$$F = \begin{Bmatrix} K_N a e^{i\omega t} \\ 2K_M a e^{i(\omega t + \phi)} \\ 0 \\ 0 \end{Bmatrix}$$



$$\Phi = [\vec{v}_1, \vec{v}_2, \vec{v}_3, \vec{v}_4], \quad \|\vec{v}_i\| = 1, \; i = 1,4$$

$$\vec{v}_1 = \begin{bmatrix} 1 \\ 0.5 \\ -1 \\ 0.25 \end{bmatrix}$$

$$M\ddot{x} + C\dot{x} + Kx = u$$

$$y = \dot{x}$$

$$M\dot{y} + Cy + Kx = u$$

$$M\dot{y} = -Cy - Kx + u$$

$$\boxed{\dot{y} = M^{-1}(-Cy - Kx + u)}$$

odeint résout

$$\frac{dy}{dt} = f(x, y, t)$$