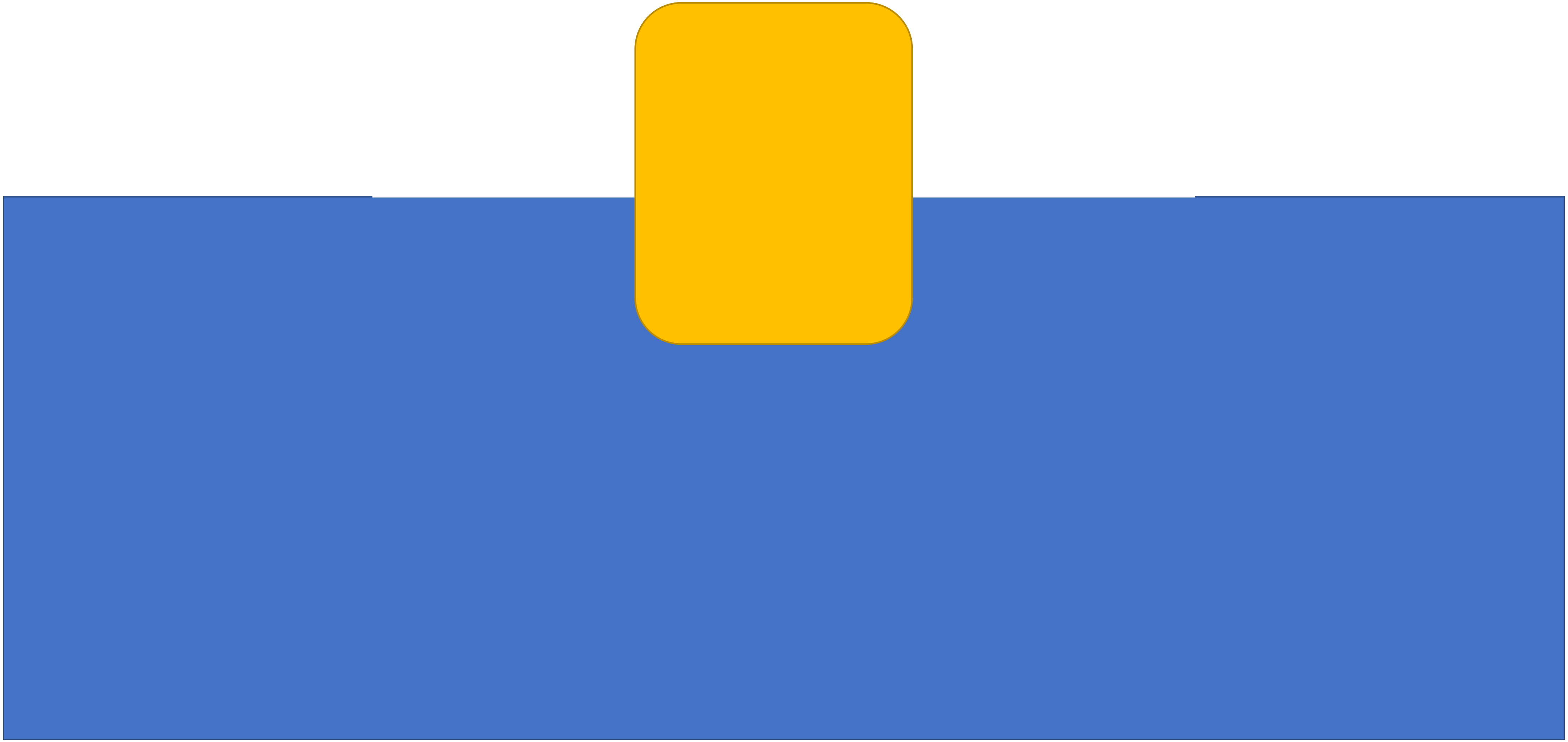
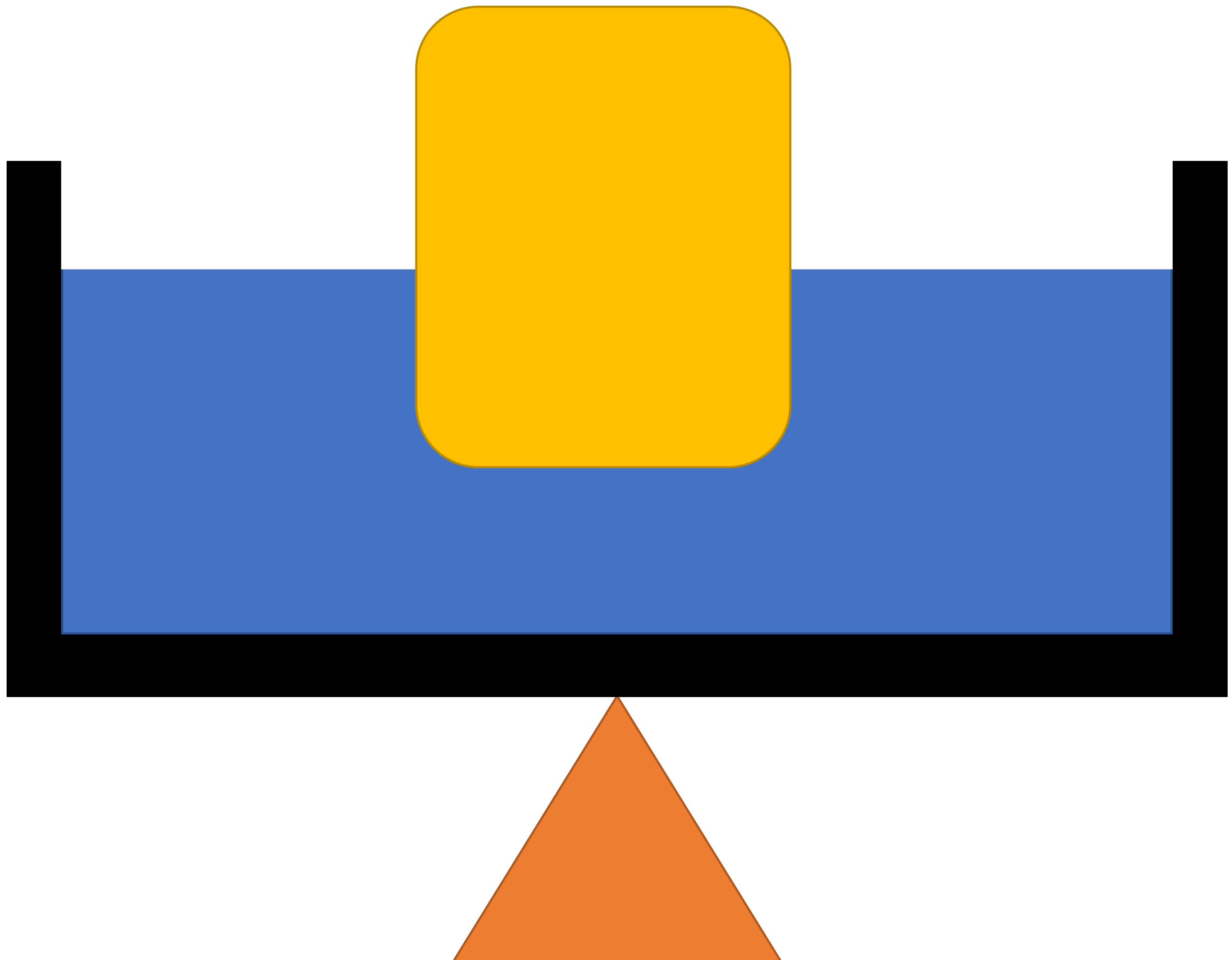
Dinâmica de Sistemas Navais e Oceânicos

PNV3314 Dinâmica de Sistemas

Aula 4



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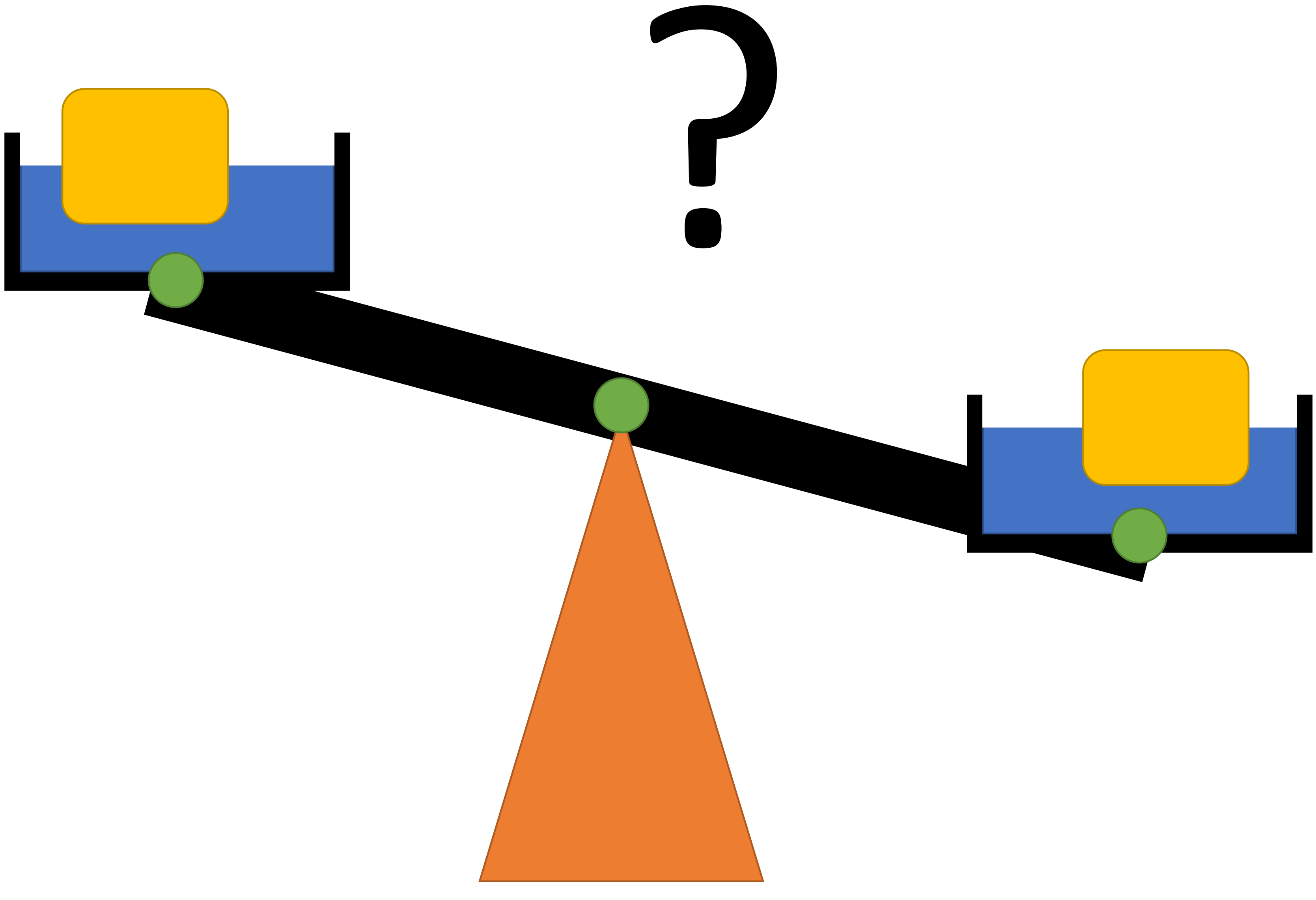
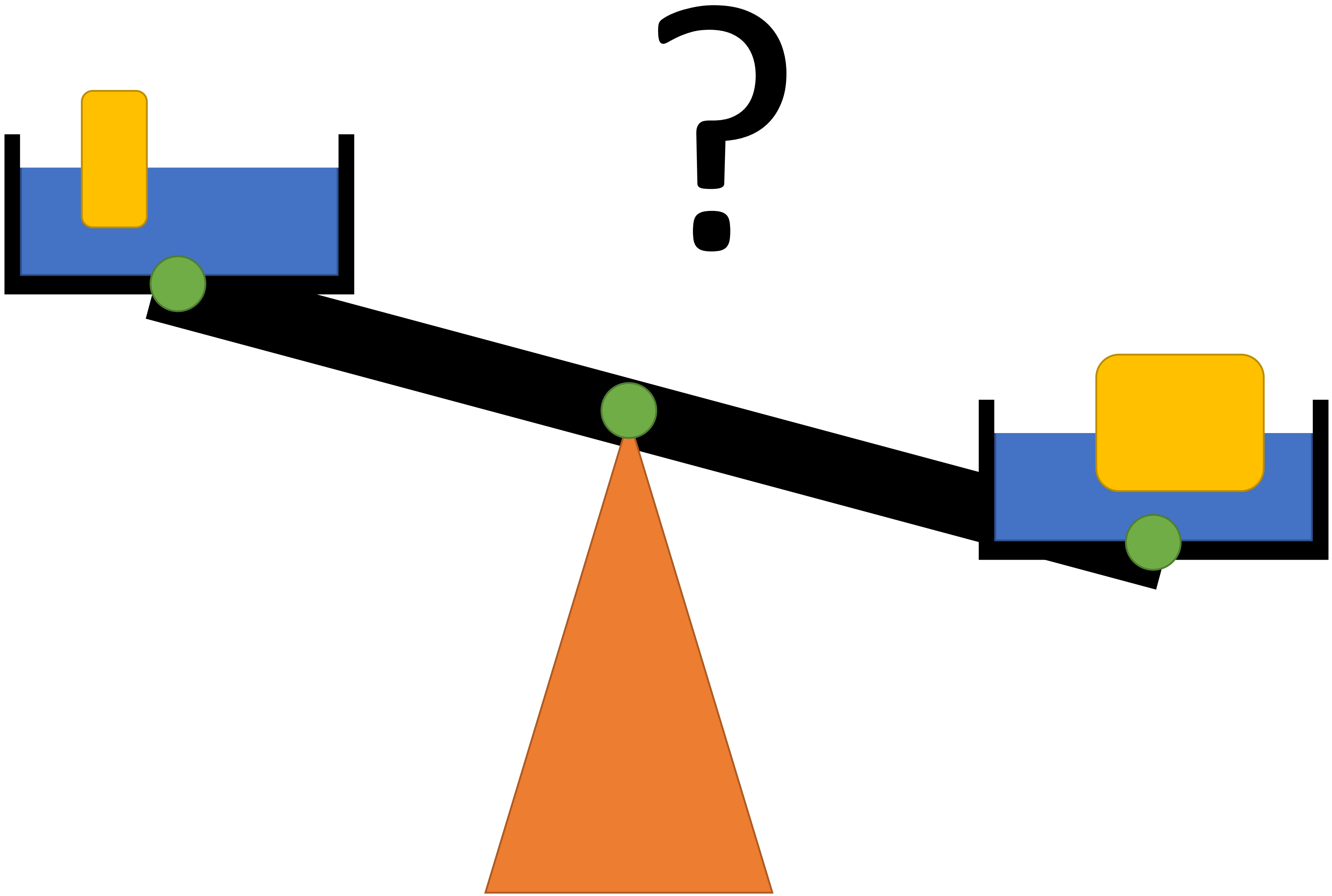
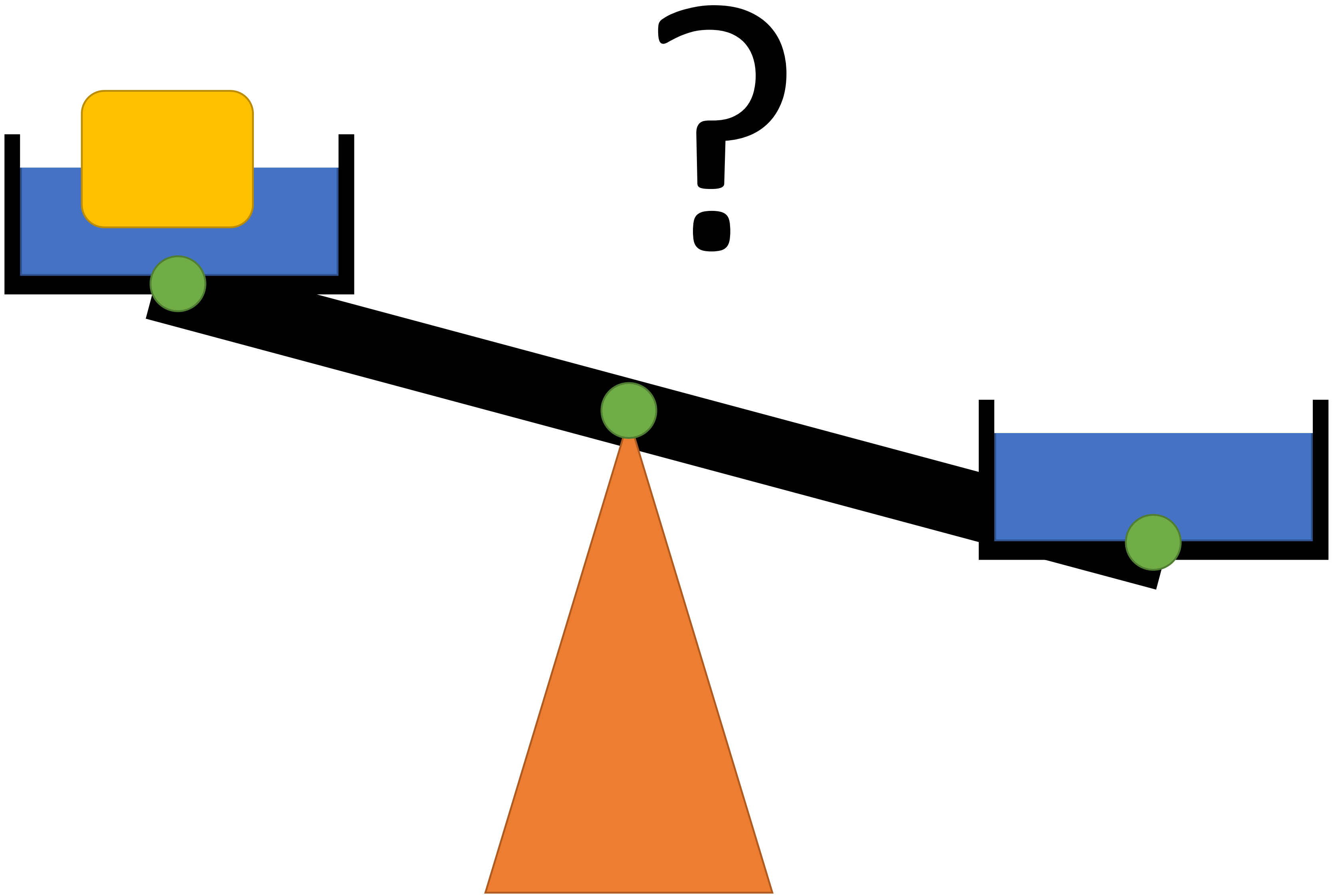
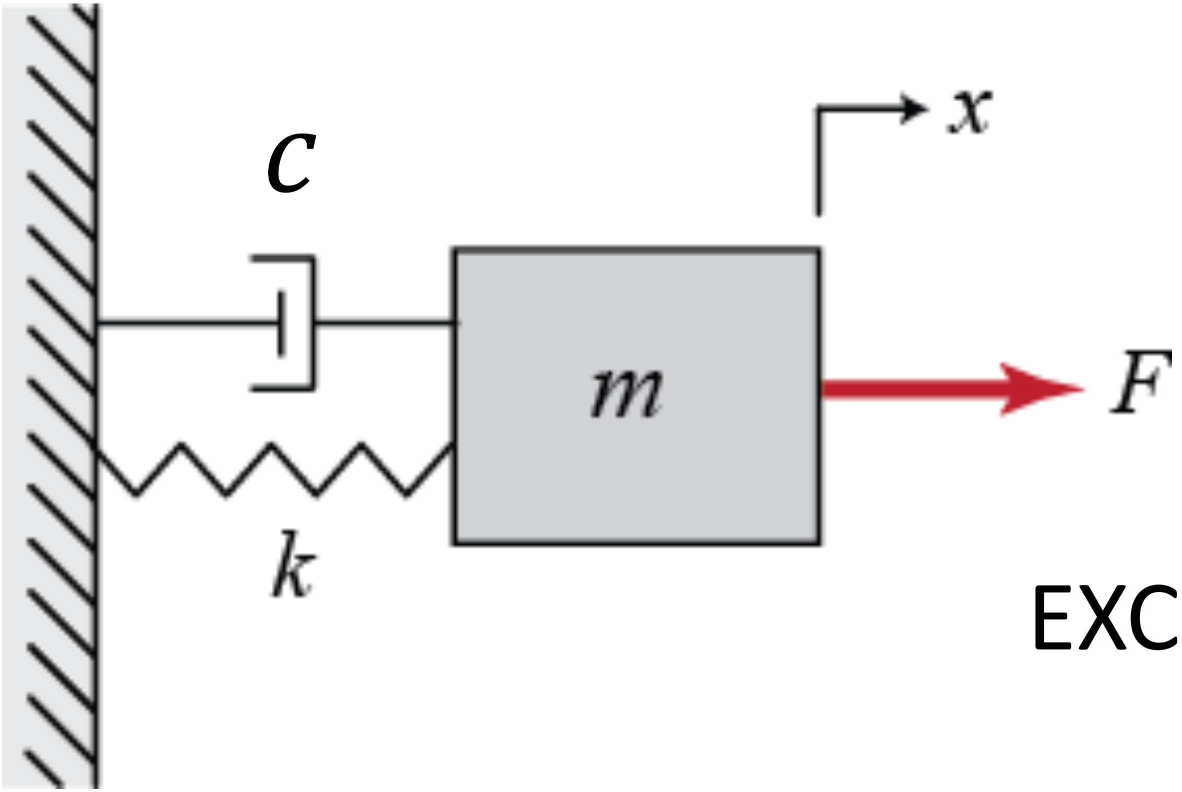








EXCITAÇÃO EXTERNA
INÉRCIA
RIGIDEZ
AMORTECIMENTO

Equação do movimento:
eq. diferencial ordinária linear de segunda ordem

$x = x(t)$

Derivadas de uma única função (x) de uma variável independente (t)

Sem produtos entre x, $\dot{x}$ e $\ddot{x}$

$\ddot{x}$(t)

$$m\ddot{x} + c\dot{x} + kx = F(t)$$

INERCIAL

AMORTECIMENTO (DISSIPAÇÃO)

RIGIDEZ (RESTAURAÇÃO)

FORÇA EXTERNA (EXCITAÇÃO)

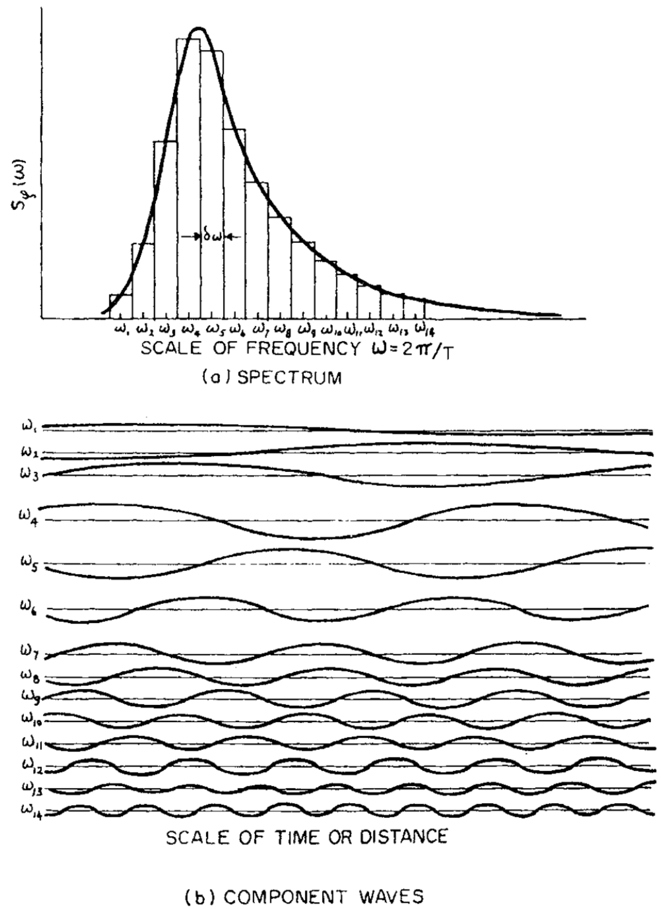


Fig. 8 Typical variance spectrum of waves, showing approximation by a finite sum of components

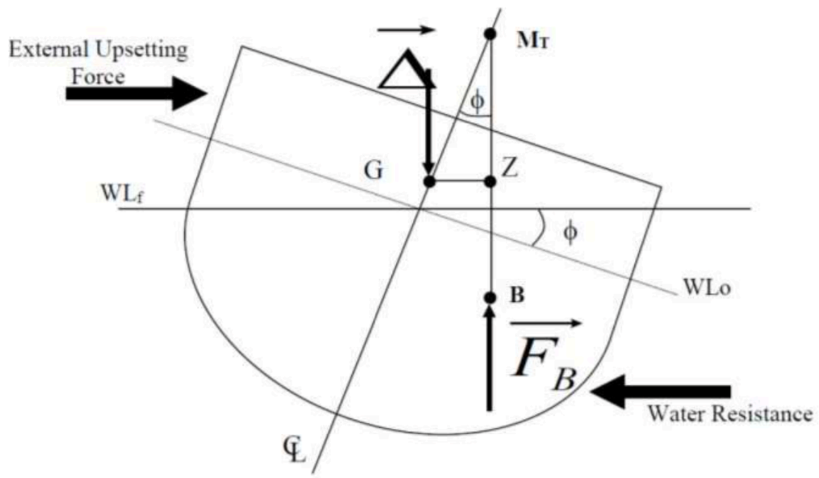


Figure 2.1: Heeled Ship due to an external moment

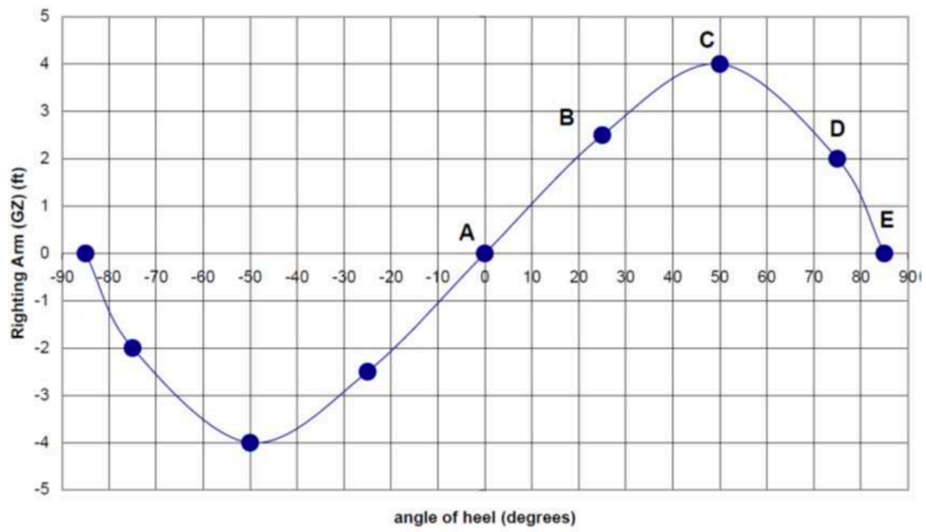
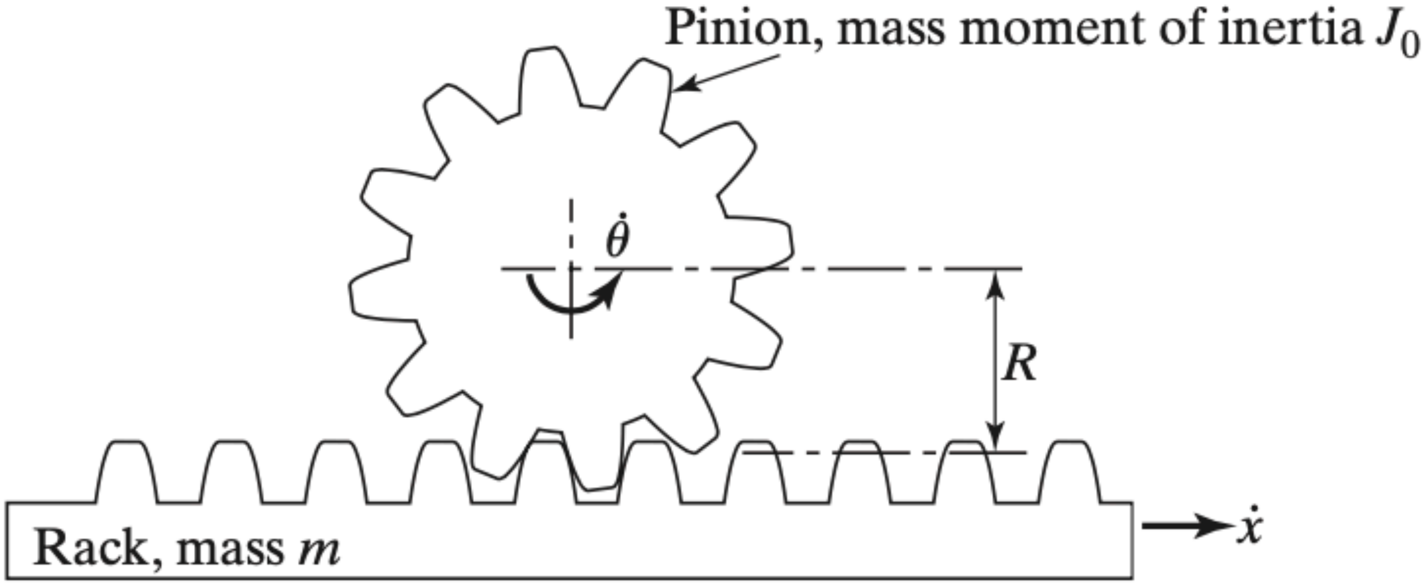
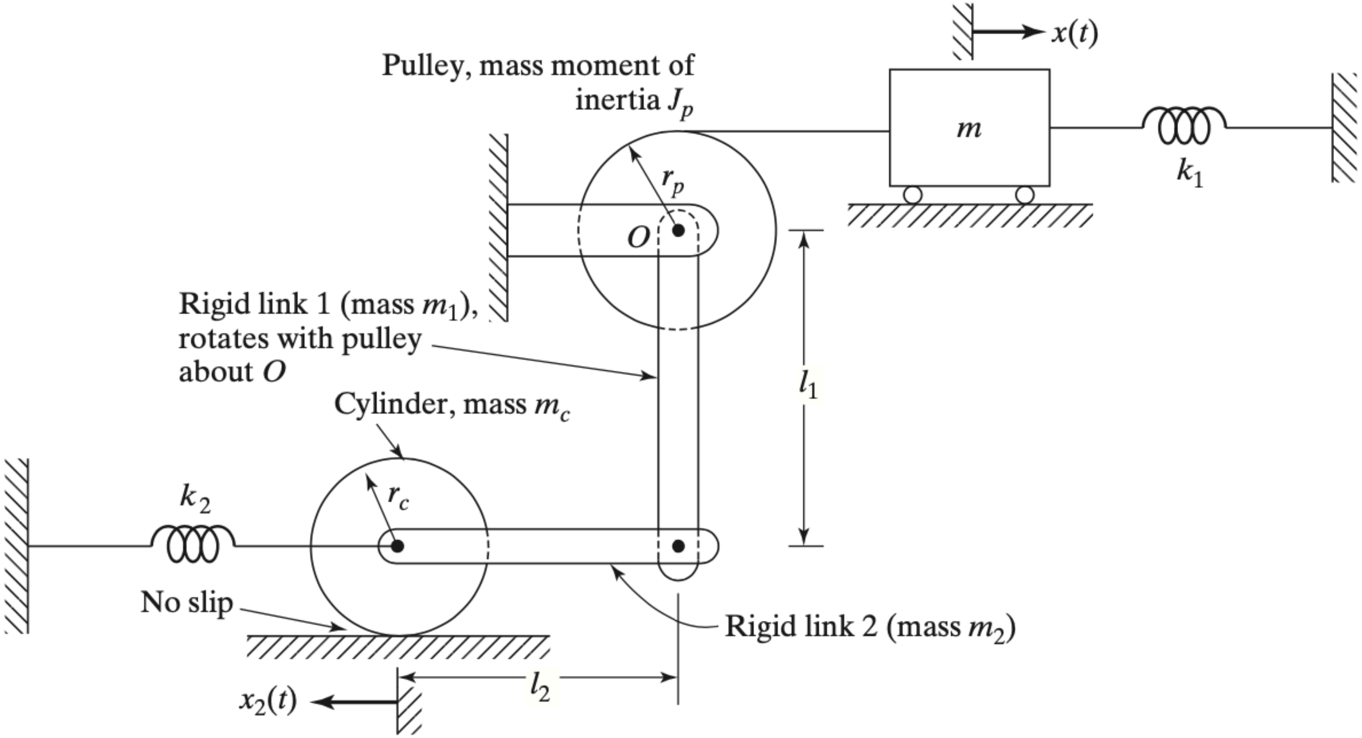


Figure 2.2: Curve of Intact Statical Stability

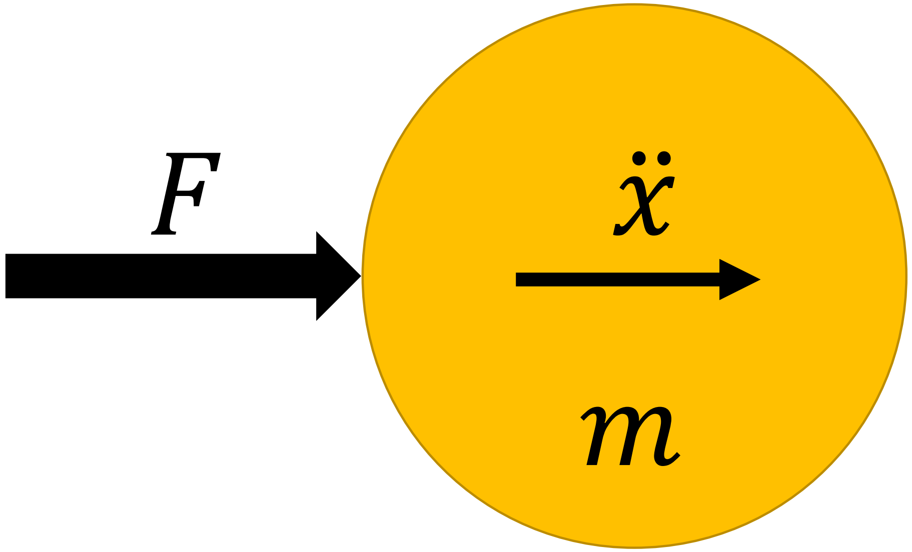
Inércia equivalente



Inércia equivalente



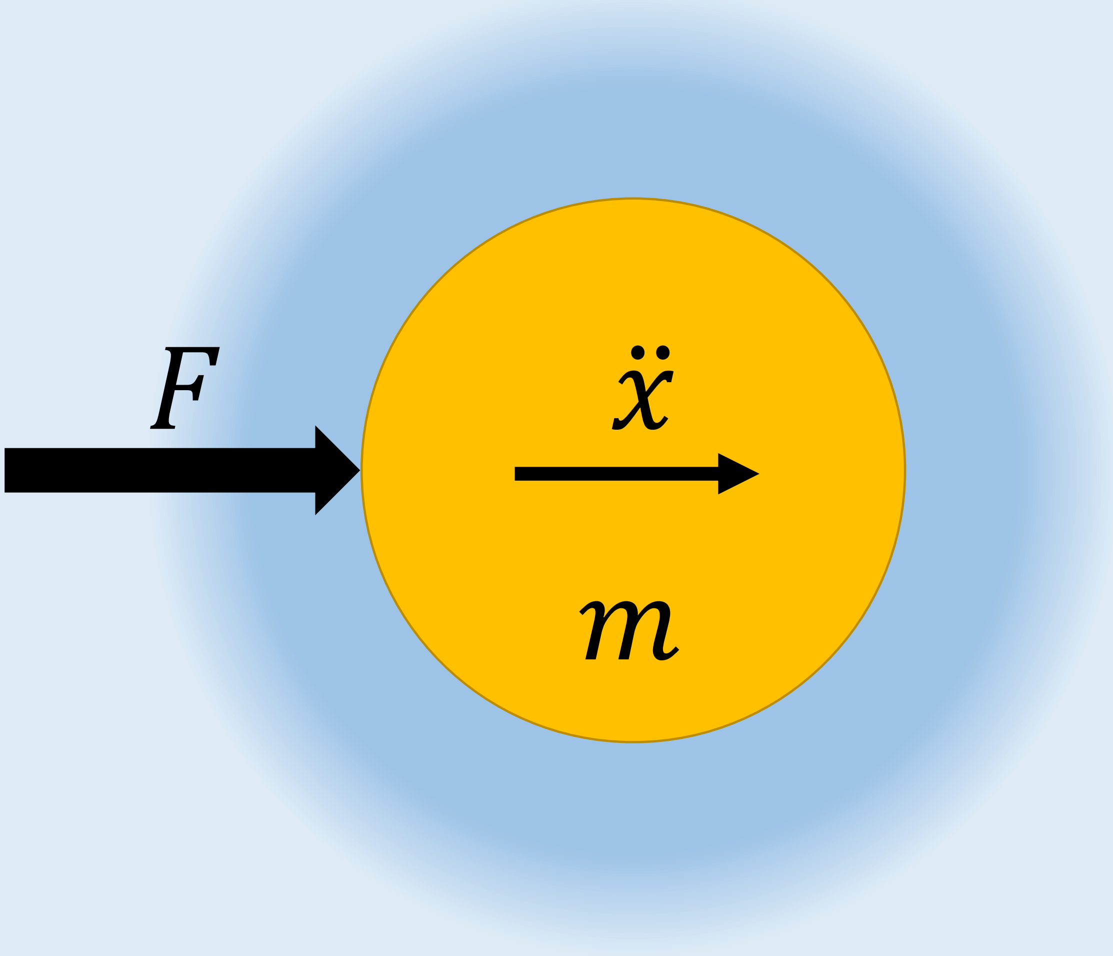
Inércia adicional



$$F = m\ddot{x}$$

NO VÁCUO

Inércia adicional



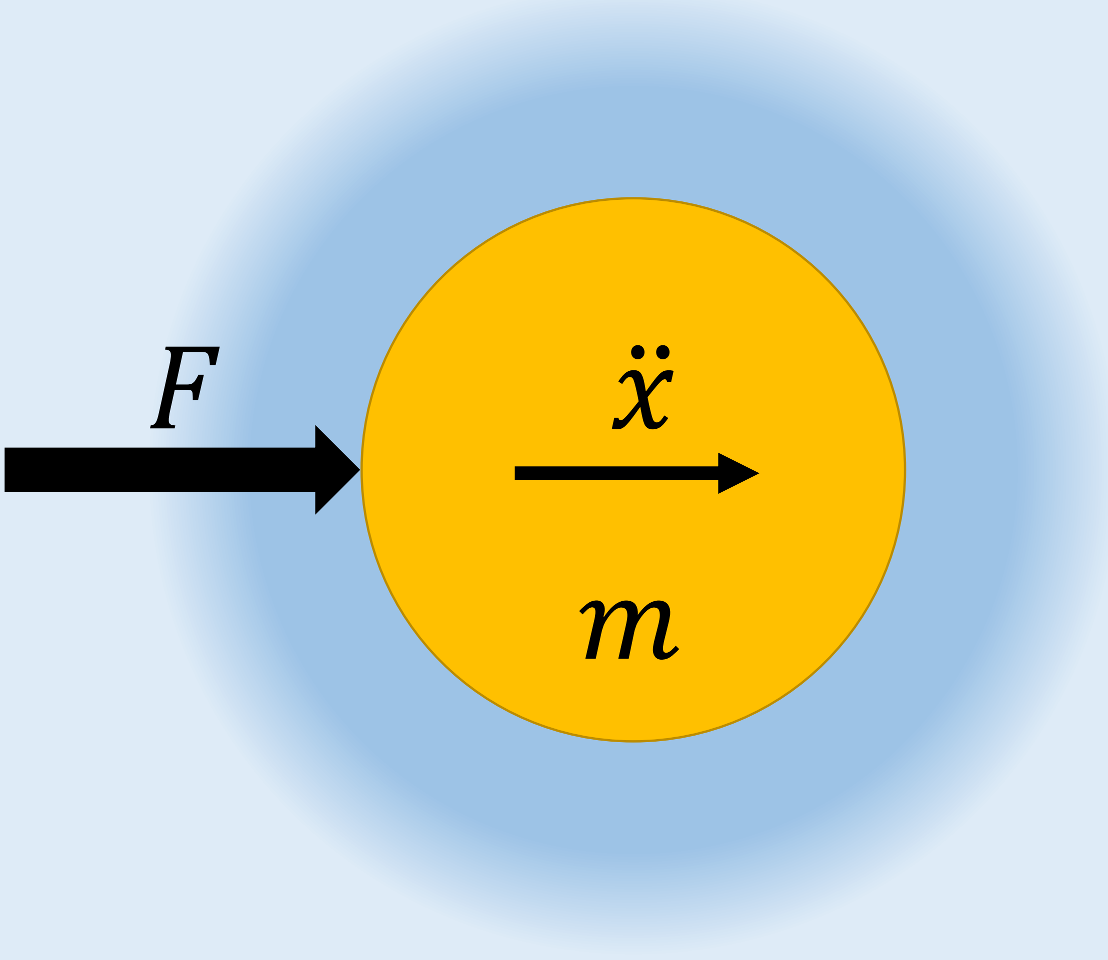
$$F = m\ddot{x} + m_a\ddot{x}$$

$$F = (m + m_a)\ddot{x}$$

massa adicional

NA ÁGUA

Inércia adicional



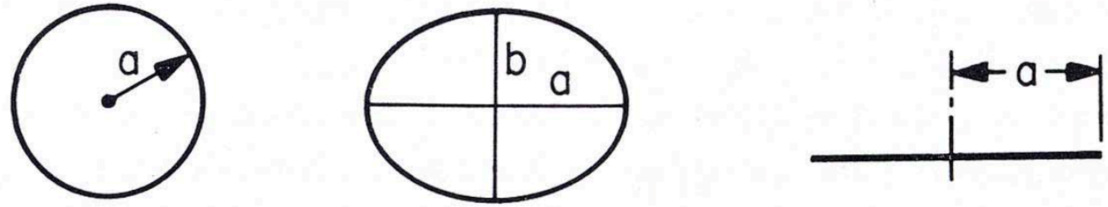
$$F = (m + m_a)\ddot{x}$$

$$\frac{m_a}{\rho \forall} = C_a$$

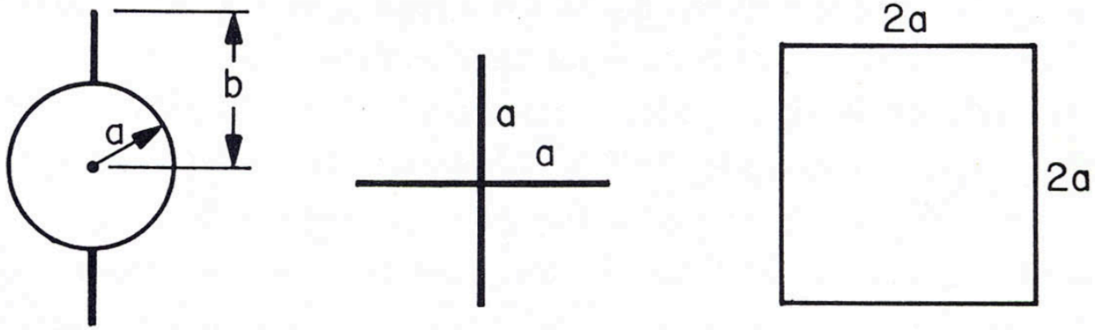
Depende da geometria do corpo e do movimento

Coeficiente de massa adicional

Table 4.3
Added-Mass Coefficients for Various Two-Dimensional Bodies.

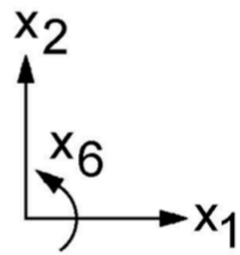


m_{11}:	$\pi \rho a^2$	$\pi \rho b^2$	0
m_{22}:	$\pi \rho a^2$	$\pi \rho a^2$	$\pi \rho a^2$
m_{66}:	0	$\frac{1}{8}\pi \rho (a^2 - b^2)^2$	$\frac{1}{8}\pi \rho a^4$



m_{11}:	$\pi \rho [a^2 + (b^2 - a^2)^2/b^2]$	$\pi \rho a^2$	$4.754\ \rho a^2$
m_{22}:	$\pi \rho a^2$	$\pi \rho a^2$	$4.754\ \rho a^2$
m_{66}:	*	$\frac{2}{\pi} \rho a^4$	$0.725\ \rho a^4$

*For the finned circle the added moment of inertia is given by the formula



[Newman, 1977]

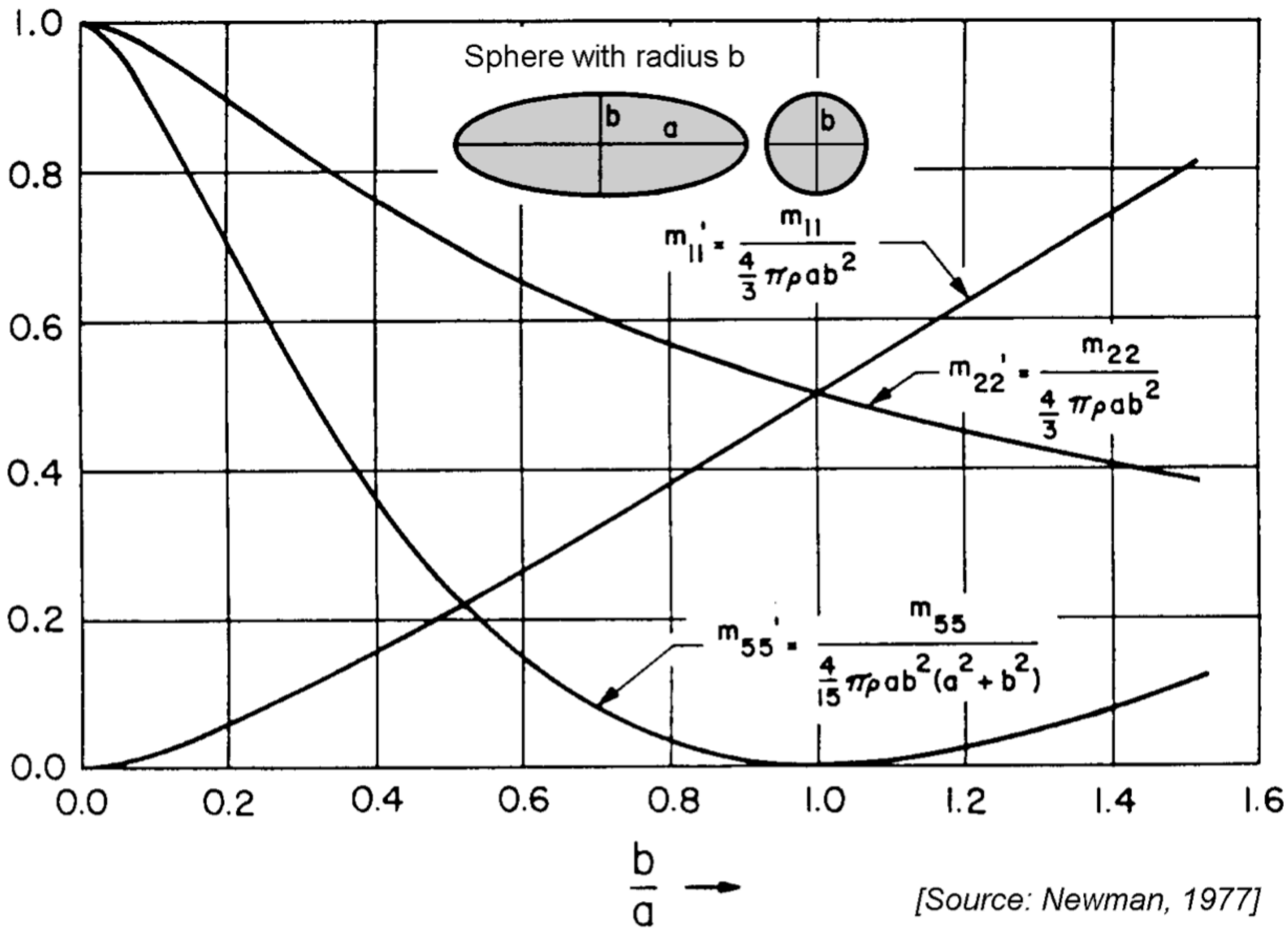


Figure 6.10: Added Mass Coefficients of Ellipsoids

Matriz de massa adicional

$$m_a = \rho \forall C_a = \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} & m_{15} & m_{16} \\ m_{21} & m_{22} & m_{23} & m_{24} & m_{25} & m_{26} \\ m_{31} & m_{32} & m_{33} & m_{34} & m_{35} & m_{36} \\ m_{41} & m_{42} & m_{43} & m_{44} & m_{45} & m_{46} \\ m_{51} & m_{52} & m_{53} & m_{54} & m_{55} & m_{56} \\ m_{61} & m_{62} & m_{63} & m_{64} & m_{65} & m_{66} \end{bmatrix}$$

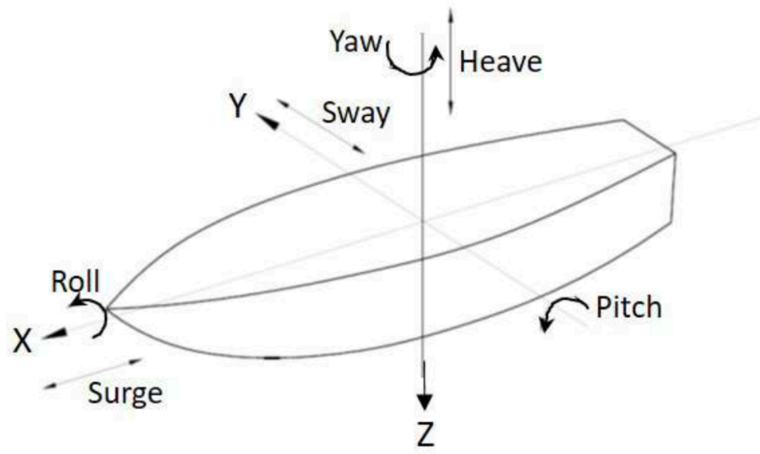
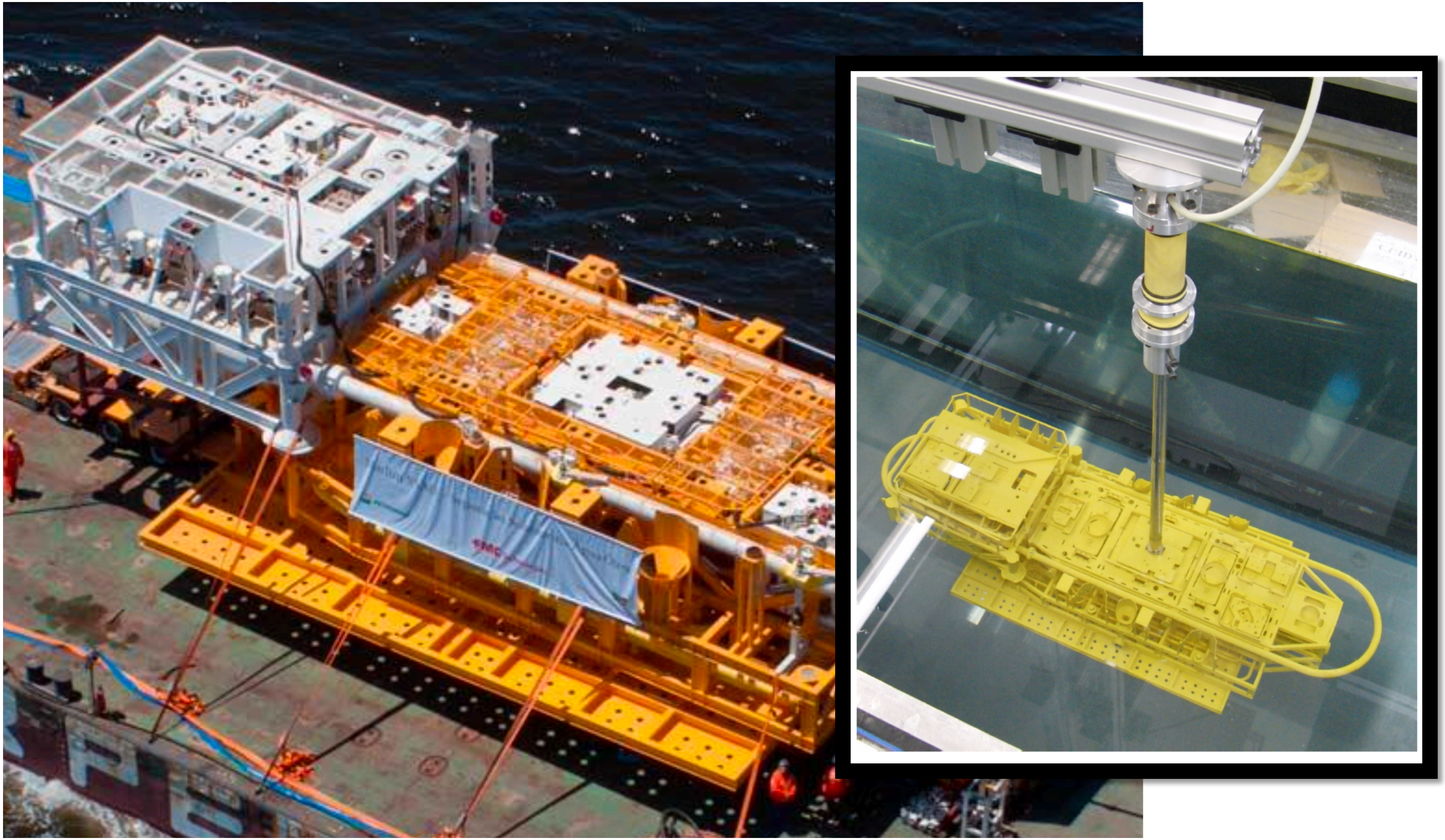
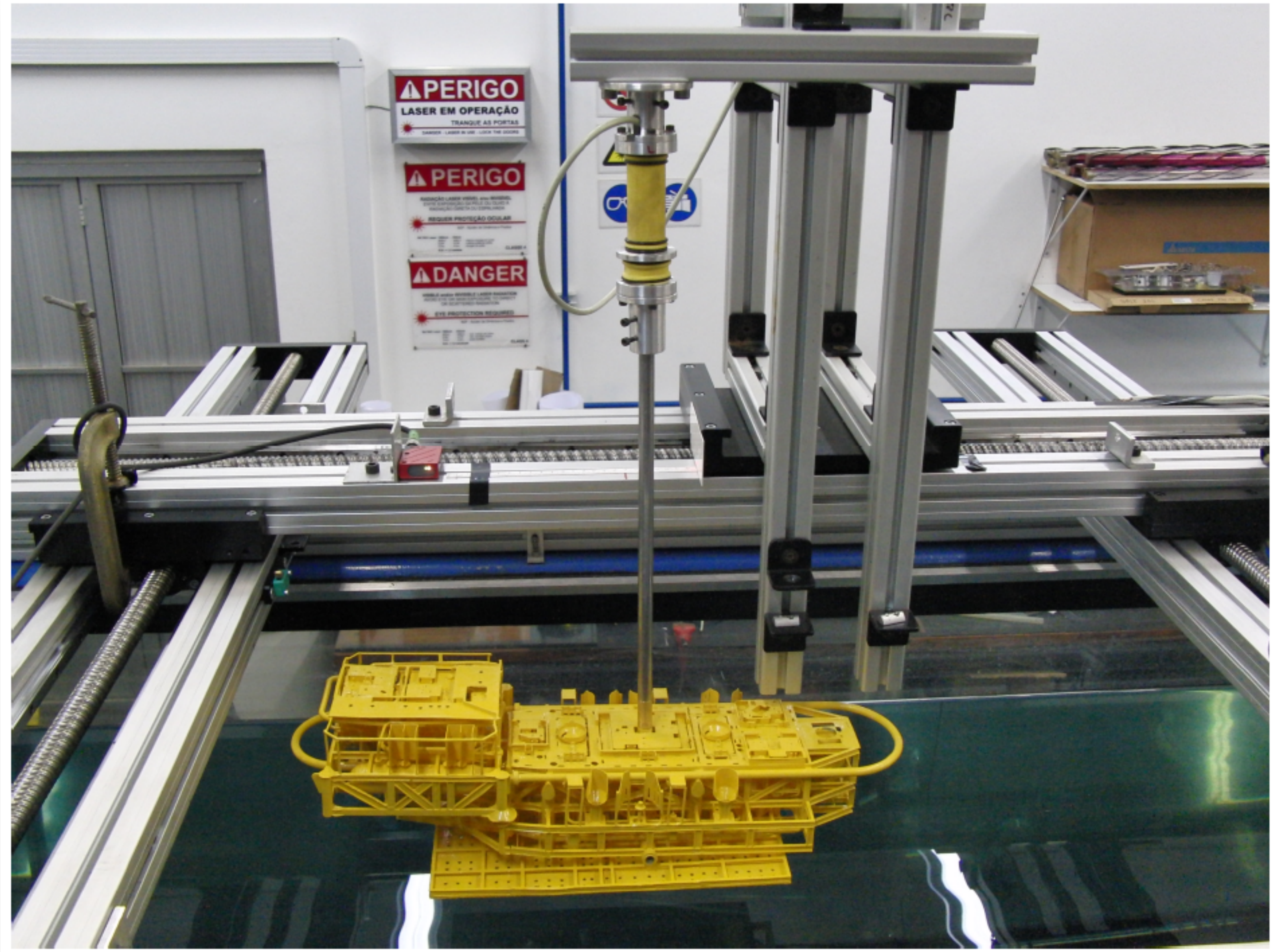


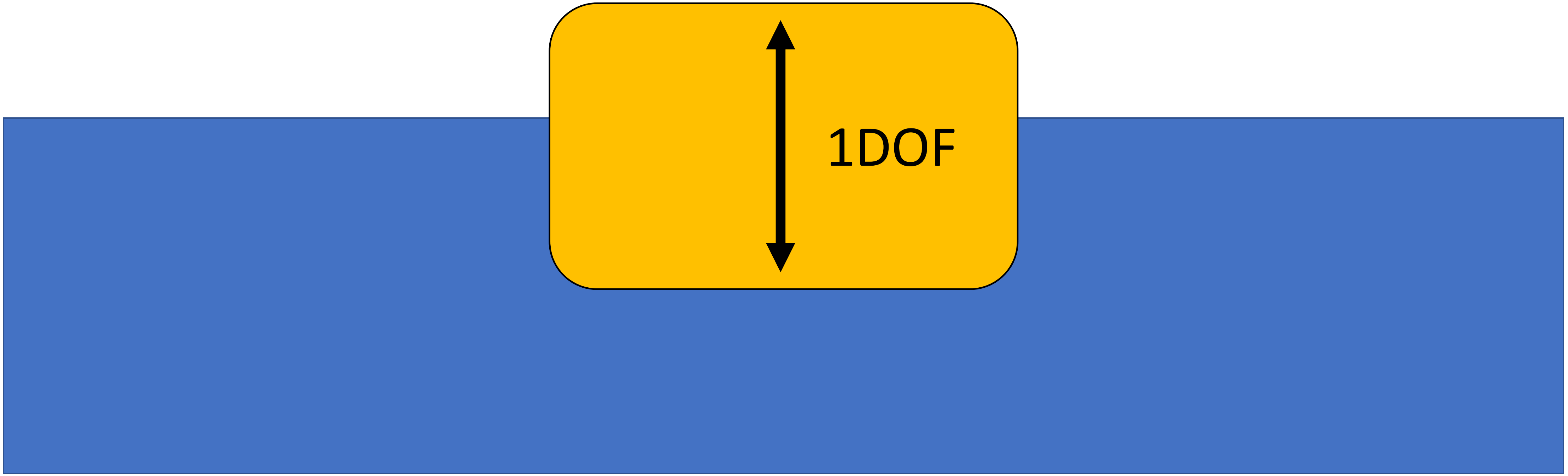
Figure 1.1: Tehe Six Degrees of Freedeom (6DOF)

1. Surge
2. Sway
3. Heave
4. Roll
5. Pitch
6. Yaw




PERIGO
LASER EM OPERAÇÃO
TRANQUE AS PORTAS
PERIGO
DANGER

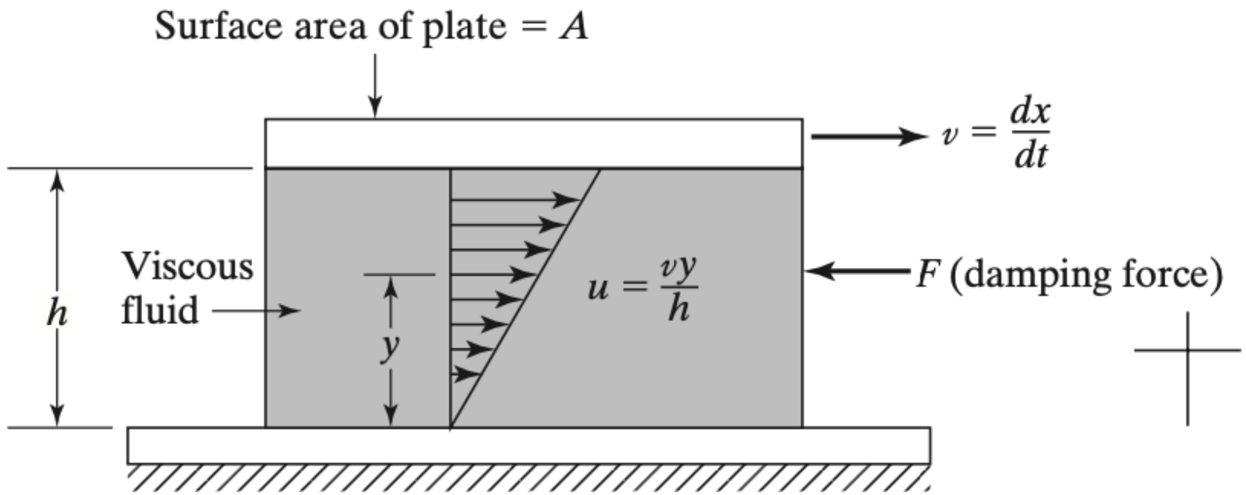
$$(a+m)\ddot{x}+b\dot{x}+cx=F_0\sin\omega t.$$



Amortecimento seco (de Coulomb)

- Força de amortecimento é constante, independe da velocidade.
- Exemplo: atrito seco entre duas peças sólidas (sem lubrificante).

Amortecimento viscoso



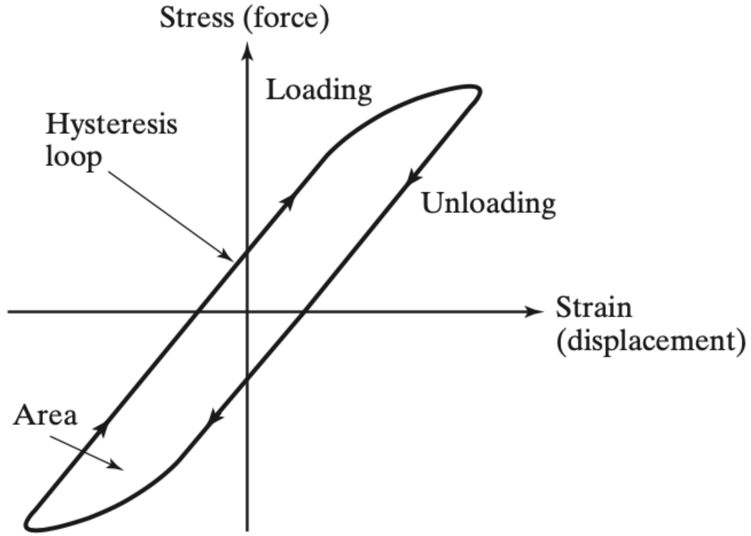
$$\tau = \mu \frac{du}{dy}$$

$$F = \tau A = \frac{\mu A v}{h}$$

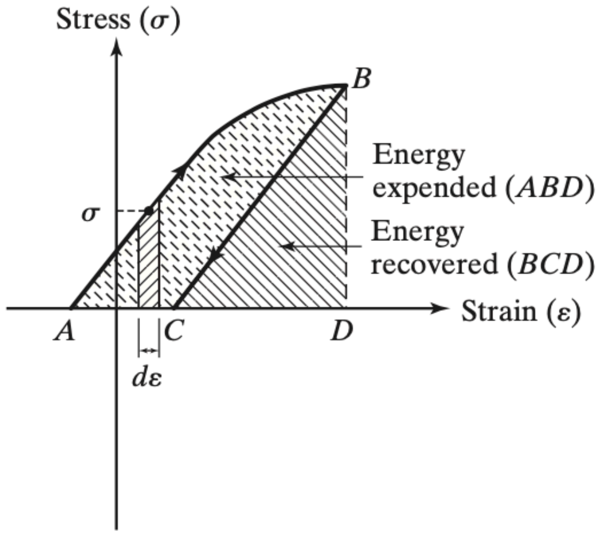
$$F = cv$$

$$c = \frac{\mu A}{h}$$

Amortecimento histerético

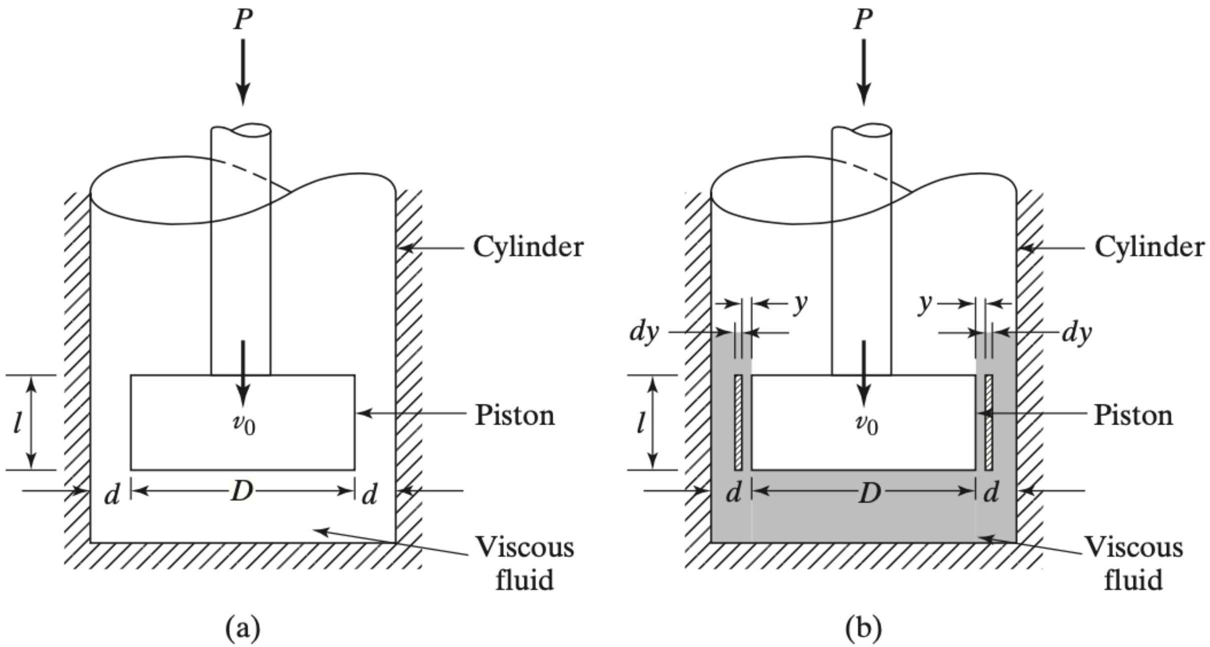


(a)



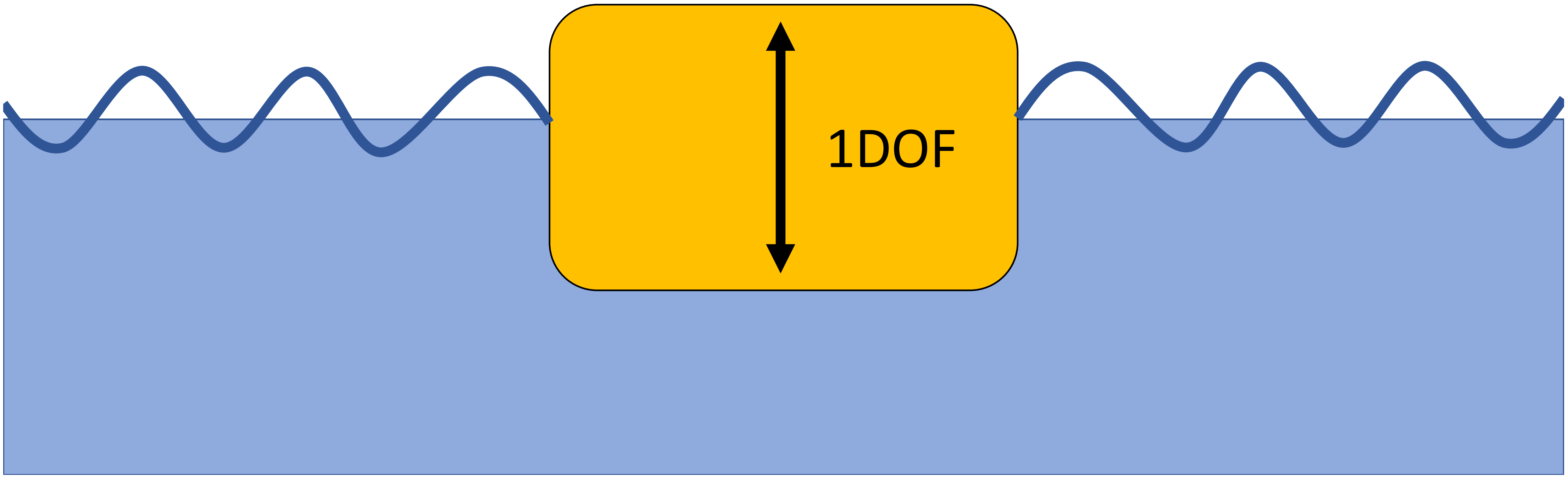
(b)

Exemplo: pistão

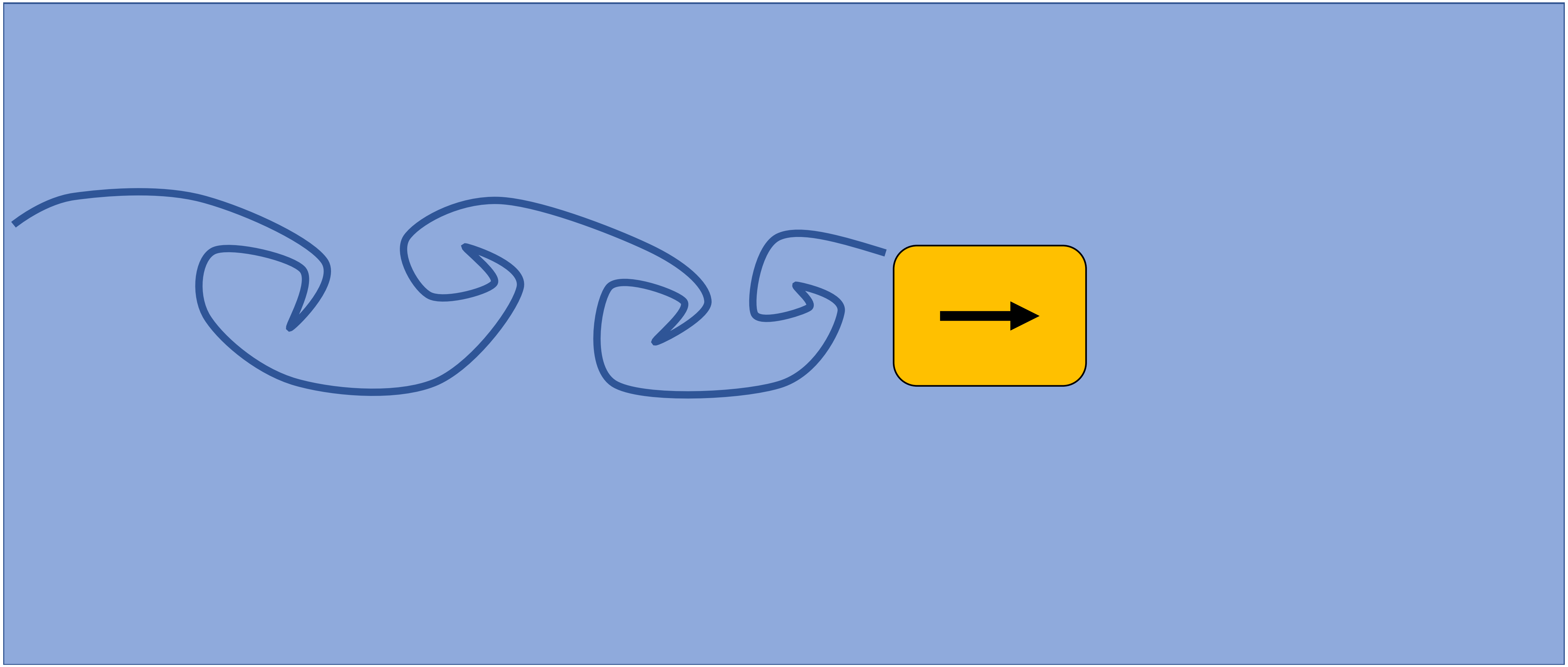


$$c = \mu\left[\frac{3\pi D^3 l}{4d^3}\left(1 + \frac{2d}{D}\right)\right]$$

Amortecimento: radiação de onda



Amortecimento: arrasto hidrodinâmico



Amortecimento equivalente

Parallel dampers: $$c_{\mathrm{eq}} = c_1 + c_2$$

Series dampers: $$\frac{1}{c_{\mathrm{eq}}} = \frac{1}{c_1} + \frac{1}{c_2}$$

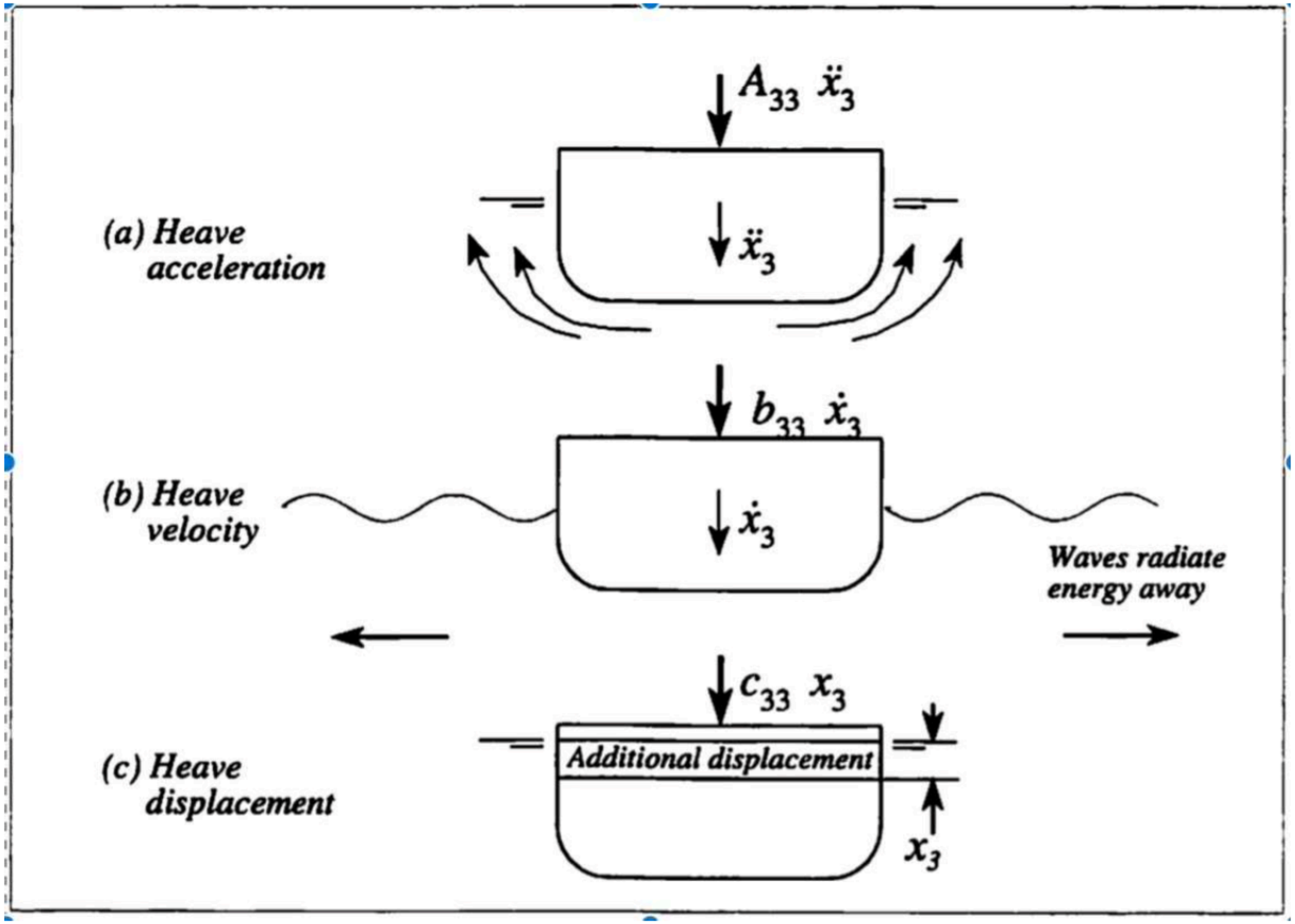


Figure 4.3: Effects of terms in the Equation of Motion (EOM) (Figure 3.4 in reference 2)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