$F = \text{cost}$

$$\begin{cases} \dot{\theta} = \omega \\ \dot{\omega} = -g\theta - \frac{b}{\mu}\omega + \frac{1}{\mu}F \end{cases}$$

$$\begin{cases} 0 = \omega \\ 0 = -g\theta - \cancel{\frac{b}{\mu}\omega} + \frac{1}{\mu}F \end{cases}$$

$$\begin{cases} \omega = 0 \\ 0 = -g\theta + \frac{1}{\mu}F \end{cases} \qquad \begin{cases} \omega = 0 \\ \theta = \frac{1}{\mu g}F \end{cases}$$

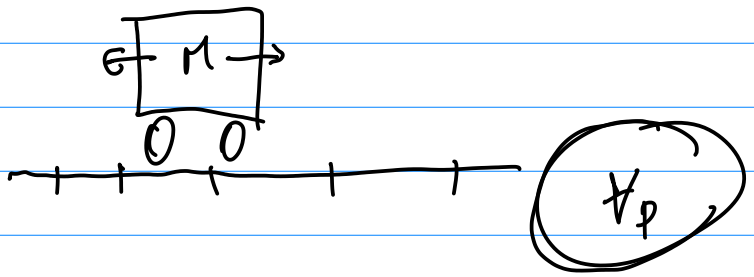
$F = 0$ $\rightarrow$ $\begin{cases} \omega = 0 \\ \theta = 0 \end{cases}$

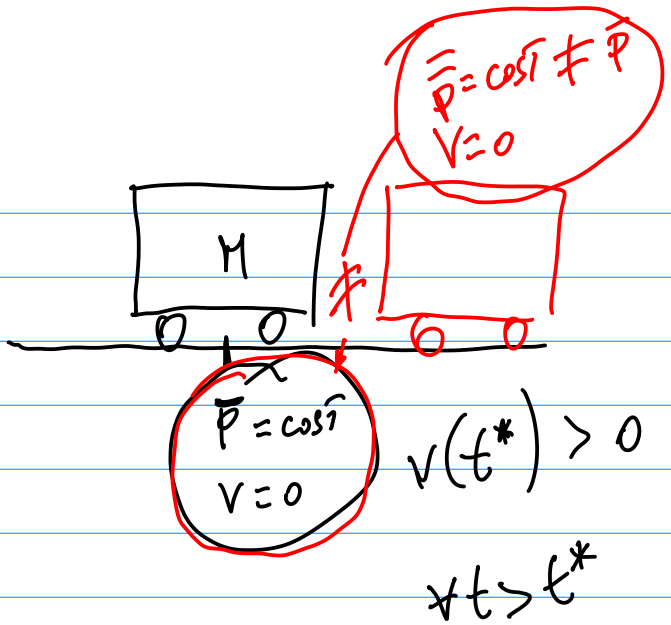
$$\begin{cases} \dot{v} = -\frac{b}{m}v + \frac{1}{m}f \\ \dot{p} = v \end{cases}$$

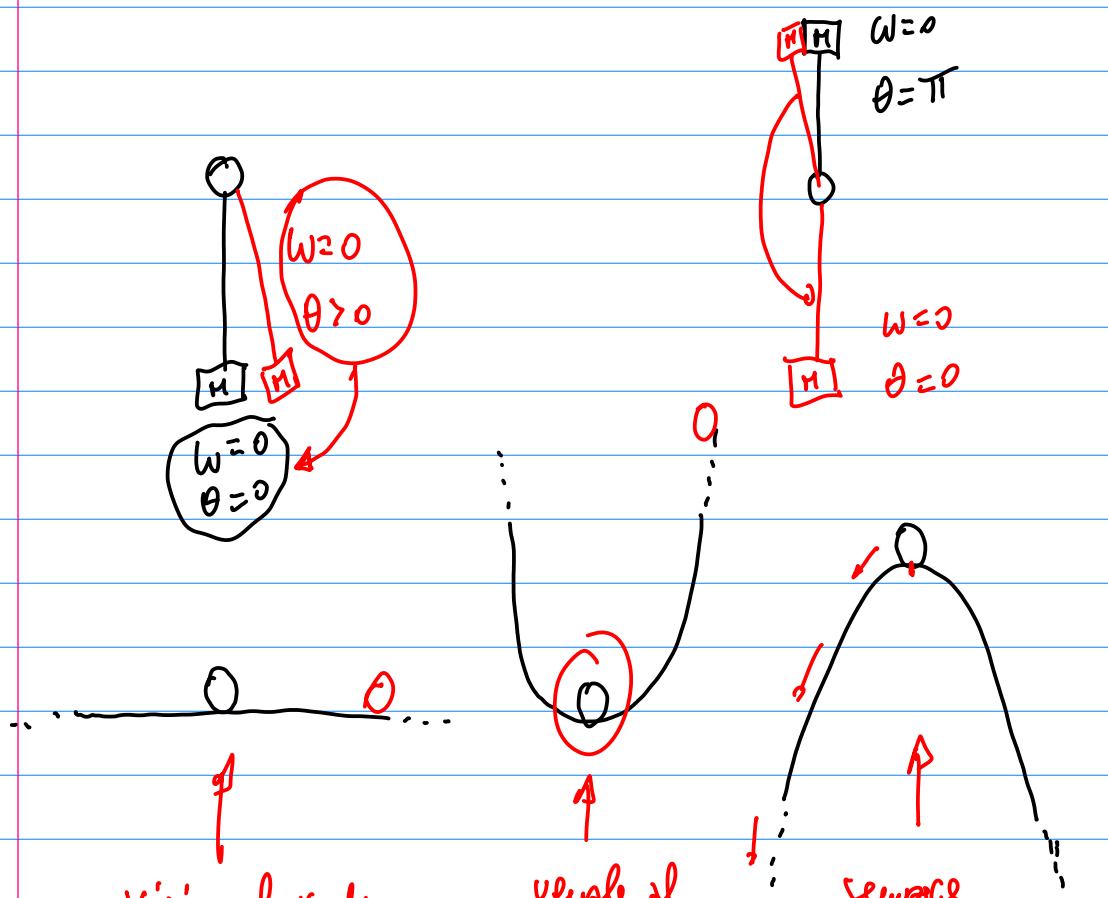
$$A = \begin{bmatrix} -\frac{b}{m} & 0 \\ 1 & 0 \end{bmatrix}$$

$v = 0 \rightarrow \forall p$

$$|A| = -\frac{b}{m} \cdot 0 - 0 \cdot 1 = 0$$







Vicino al vertice

EQ.

STABILE

(SEMPLICEMENTE)

Uguale al vertice

EQ.

ASINTOTICAMENTE STABILE

Sempre più distante dal vertice punto

EQ.

INSTABILE

$$A = \begin{bmatrix} -\frac{b}{M} & 0 \\ 1 & 0 \end{bmatrix} \qquad A = \begin{bmatrix} -0.5 & 0 \\ 1 & 0 \end{bmatrix}$$

$$|\lambda I - A| = 0 \qquad \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} - \begin{bmatrix} -0.5 & 0 \\ 1 & 0 \end{bmatrix} =$$

$$= \begin{bmatrix} \lambda + 0.5 & 0 \\ -1 & \lambda \end{bmatrix}$$

$$\begin{vmatrix} \lambda + 0.5 & 0 \\ -1 & \lambda \end{vmatrix} = (\lambda + 0.5)\lambda \qquad (\lambda + 0.5)\lambda = 0$$

$\lambda = 0$

$\lambda = -0.5$

$$A = \begin{bmatrix} 0 & 1 \\ -g & -\frac{b}{M} \end{bmatrix} \qquad A = \begin{bmatrix} 0 & 1 \\ -g & -0.5 \end{bmatrix}$$

$$[\lambda I - A] = \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} - \begin{bmatrix} 0 & 1 \\ -g & -0.5 \end{bmatrix} =$$

$$= \begin{bmatrix} \lambda & -1 \\ g & \lambda + 0.5 \end{bmatrix}$$

$$\begin{vmatrix} \lambda & -1 \\ g & \lambda + 0.5 \end{vmatrix} = \lambda(\lambda + 0.5) + g$$

$g = 9.81$

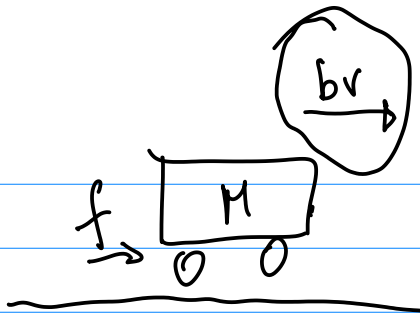
$$\lambda^2 + 0.5\lambda + g = 0$$

$$\lambda = \frac{-0.5 \pm \sqrt{0.25 - 4g}}{2} = \frac{-0.5 \pm i\bar{k}}{2} =$$

$$= -\frac{0.5}{2} \pm i\frac{\bar{k}}{2}$$

< 0

ASINTOTICAMENTE STABILE



$$A = \begin{bmatrix} +0.5 & 0 \\ 1 & 0 \end{bmatrix}$$

$$(\lambda - 0.5)\lambda = 0$$

$$\lambda = 0$$

$$\lambda = 0.5$$

INSTABILE

$A \in \mathbb{R}^{2x2}$ $\quad \lambda_1, \lambda_2$

$\dot{x} = Ax + Bu$

1) $k_1 e^{\lambda_1 t} + k_2 e^{\lambda_2 t}$

$t \geq 0$

1) $\lambda_1, \lambda_2 \in \mathbb{R}$

$\lambda_1 < 0$

$\lambda_2 < 0$

2) $\lambda_1, \lambda_2 \in \mathbb{C}$

$Re(\lambda_1) < 0$

$\Rightarrow Re(\lambda_2) < 0$

2) $\lambda = a \pm ib \rightarrow a < 0$

$k e^{at} \sin bt$

$A = 3\times3$ $\begin{bmatrix} 0 & 1 & 0 \\ 3 & -2 & 1 \\ 0 & -1 & 0 \end{bmatrix}$

3 autovalori

λ_1 reale <0

λ_2, λ_3 complessi e coniugati $\mathrm{Re}(\,) < 0$

$$K_1 e^{\lambda_1 t} + K_2 e^{\mathrm{Re}(\lambda_2)} \sin \mathrm{Im}(\lambda_2)\, t$$

$K_1 >> K_2$

$e^{-0.5t} + e^{-3t}$