A1 ES steel Problem A $\quad 0 \leq \alpha \leq 90$

$\dot{x} = v \overset{!}{=} 0 \Rightarrow v = 0$

$\dot{v} = \left(\frac{F - kv - mg\sin(\alpha)}{m}\right) \overset{!}{=} 0 \Rightarrow F - mg\sin(\alpha) = 0$

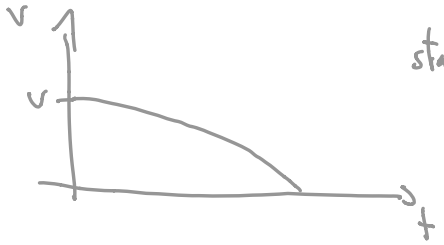
all rates of changes have to be zero.

infinite eq. states: either Thrust to balance for stability or

equilibrium: x arbitrary
$v = 0$
$F = mg\sin(\alpha)$

unrealistic

If $F = 0$ results in either $\int$, S or $\sin(\alpha)$ being zero $\Rightarrow \alpha = 0$



stable but not asymptotically stable

A2

a) $\frac{d^2}{dt^2}\Theta = \frac{ds}{\ell} = \sin(\alpha)$ Drawing ans Matlab, solve Matlab!!!

b) $\Theta(t) = \Theta_0 + \int_0^t w(\gamma)\,d\gamma$

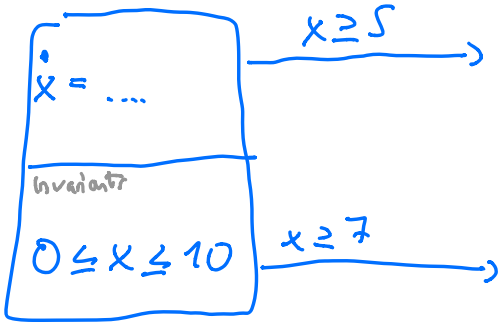
$w(t) = w_0 + \int_0^t \alpha(\gamma)\,d\gamma$

$\alpha(t) = \frac{ds}{\ell} \cdot \sin(\Theta)$

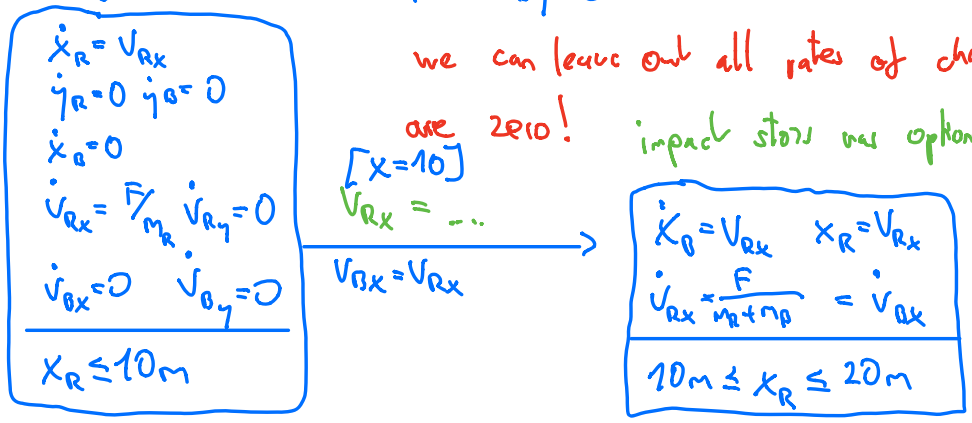
c) chose F such that it is -1 if sin is negative and $+1$ if sin positive, this will cause integrators to accumulate values $\rightarrow$ not bounded!

A4 Hybrid Automata Example

Non deterministic if we take transition at $x=5$ or not

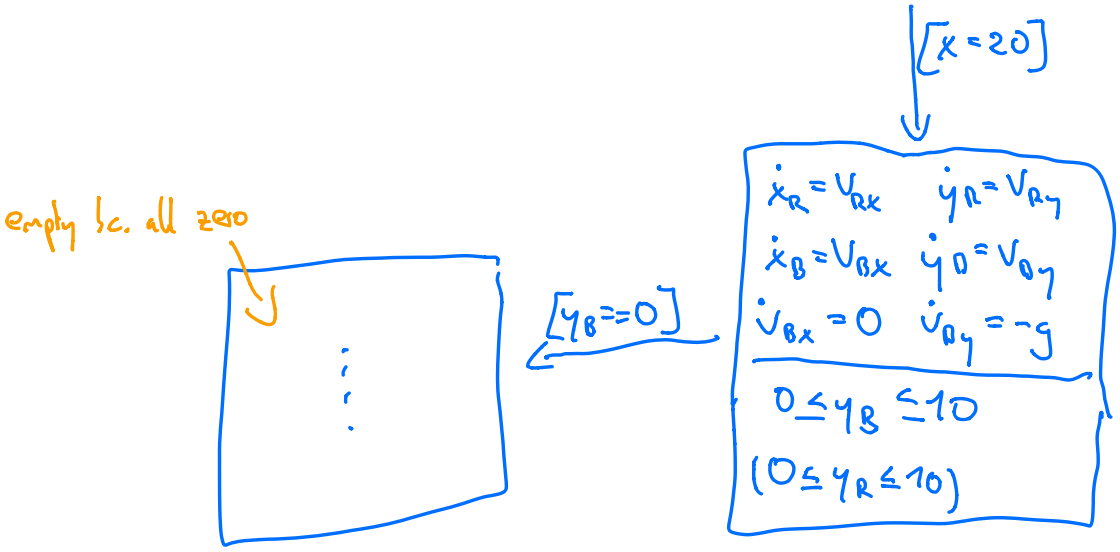


a) $x_R=0$ $y_R=-10$ $v_{Rx}=0$ $v_{Ry}=0$
$x_B=10$ $y_B=10$ $v_{Bx}=0$ $v_{By}=0$



we can leave out all rates of changes that are zero!

impact stops was optional to calc.


[x = 20]
$\dot{x}_R = v_{Rx}$ $\dot{y}_R = v_{Ry}$
$\dot{x}_B = v_{Bx}$ $\dot{y}_B = v_{By}$
$\dot{v}_{Bx} = 0$ $\dot{v}_{By} = -g$
$0 \le y_B \le 10$
$(0 \le y_R \le 10)$
[$y_B == 0$]
empty lc. all zero

b) ....

c)