3a) $\ddot{x} + (\dot{x})^2 + x = 3$

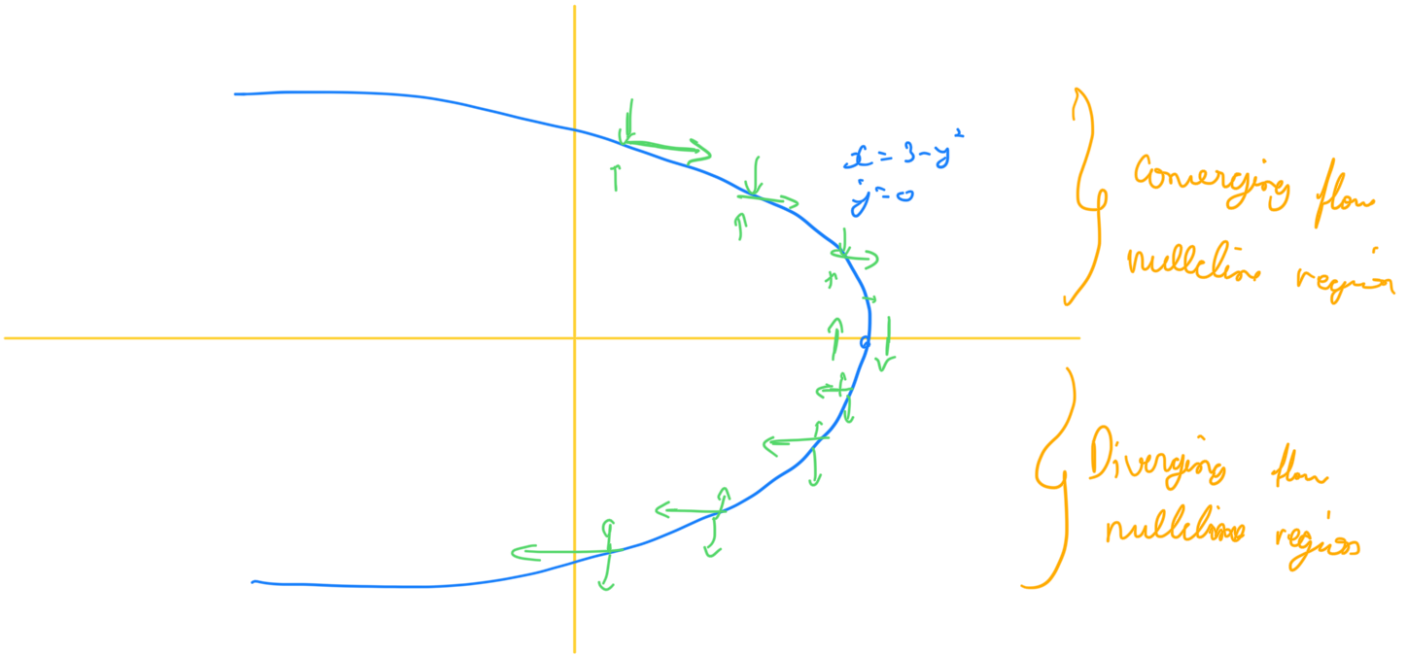
$\Rightarrow \quad \dot{y} = 3 - x - y^2$

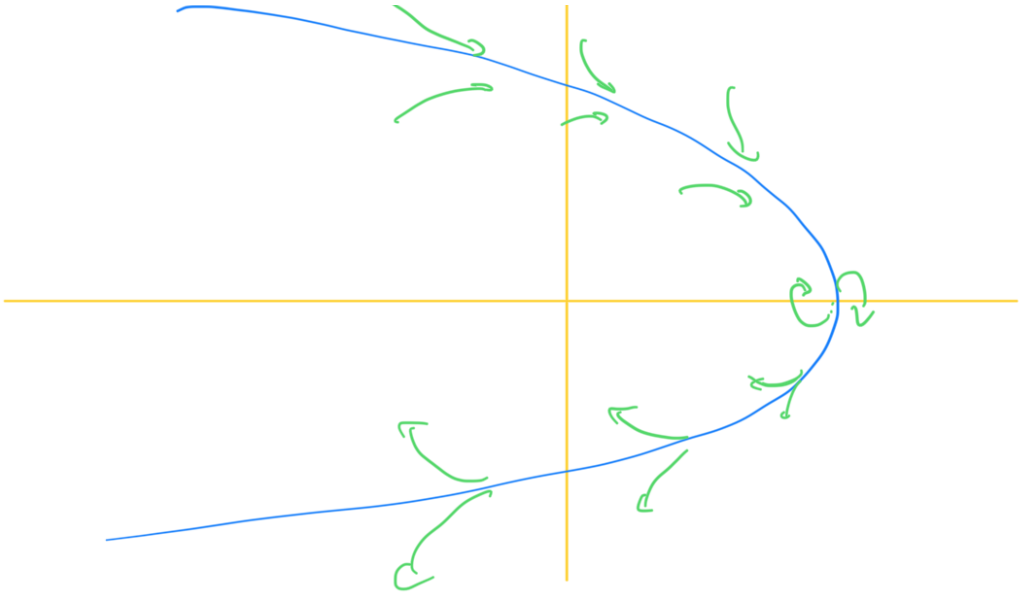
$\dot{x} = y$

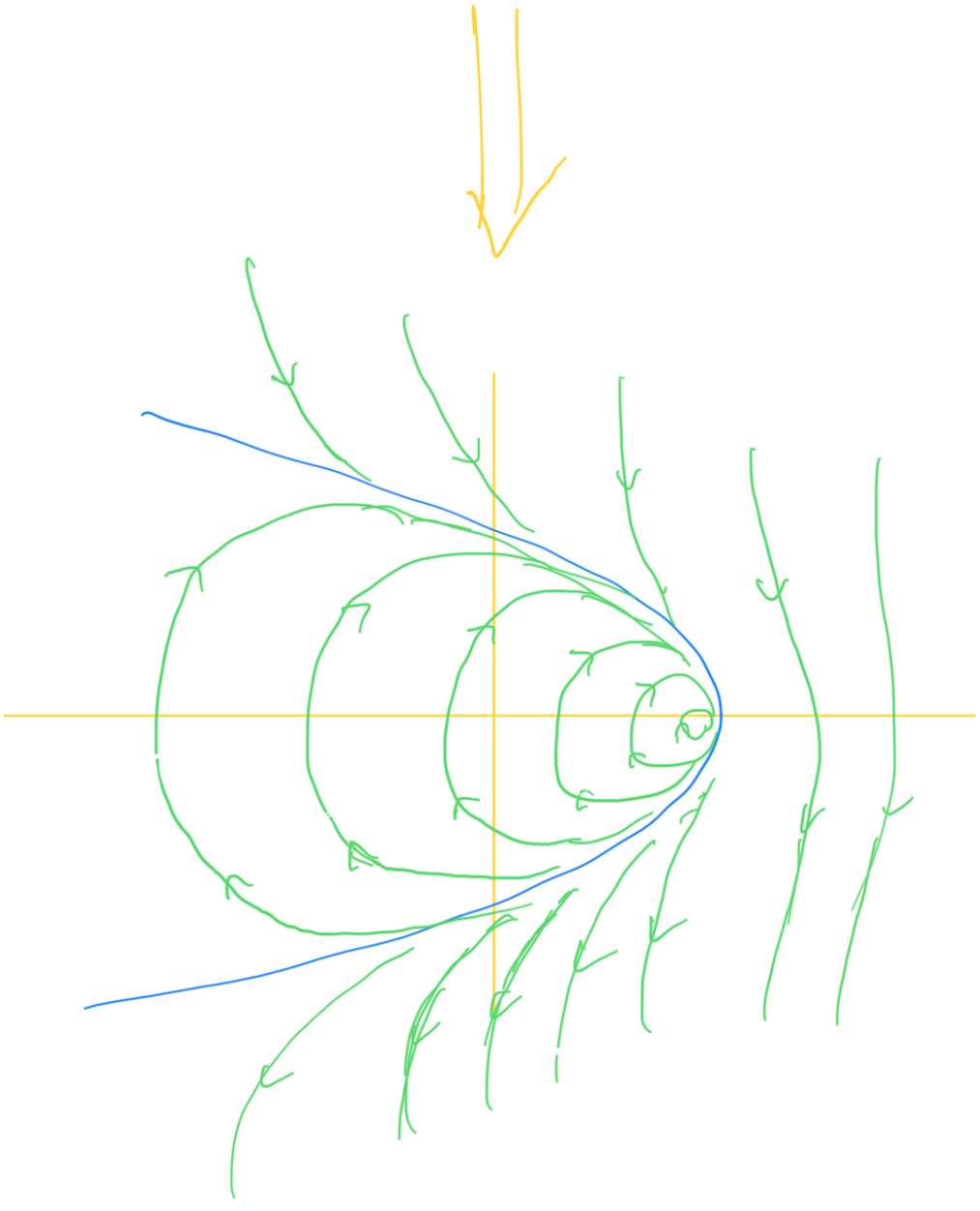
We first plot nullclines

$\dot{x} = 0$ nullcline $\Rightarrow \quad y = 0$

$\dot{y} = 0$ nullcline $\Rightarrow \quad x = 3 - y^2$







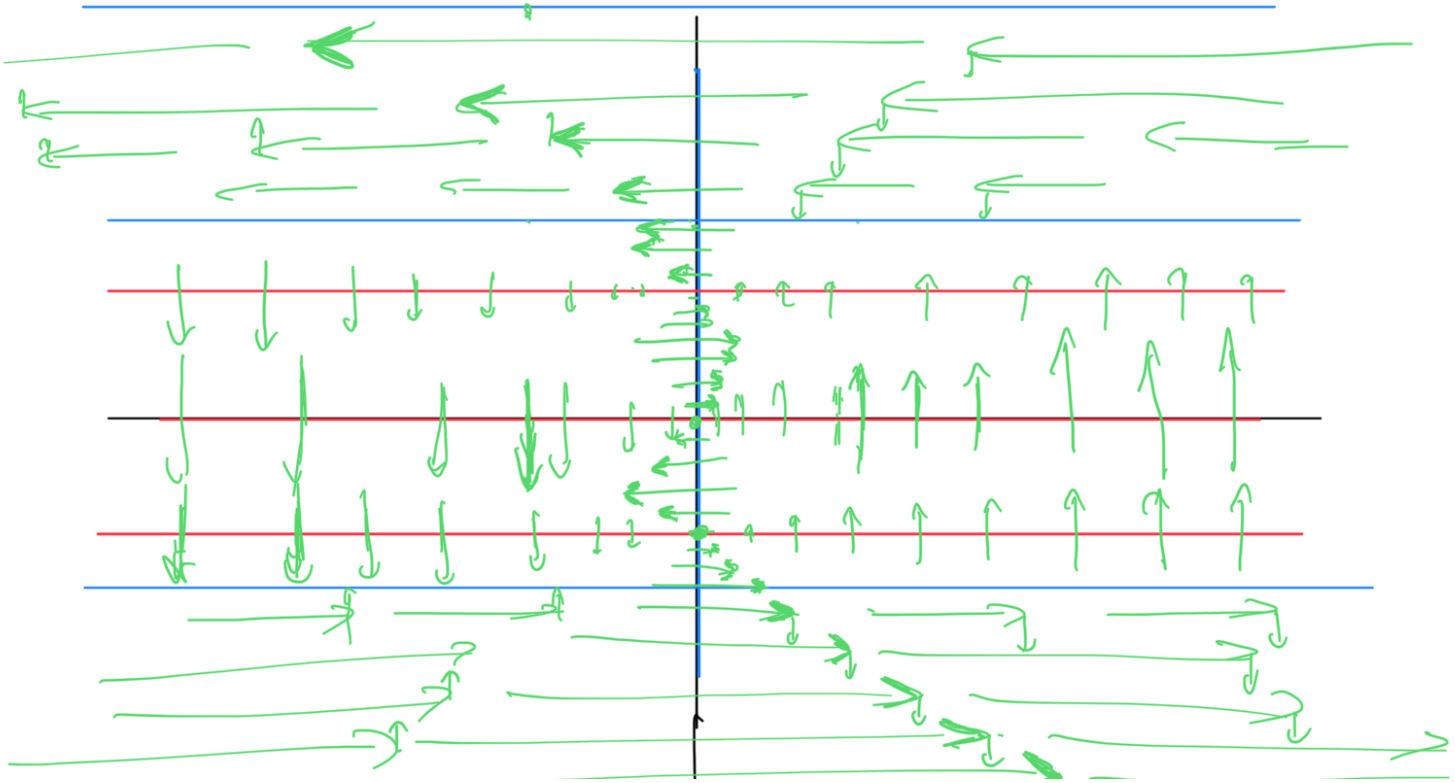
Plot as expected

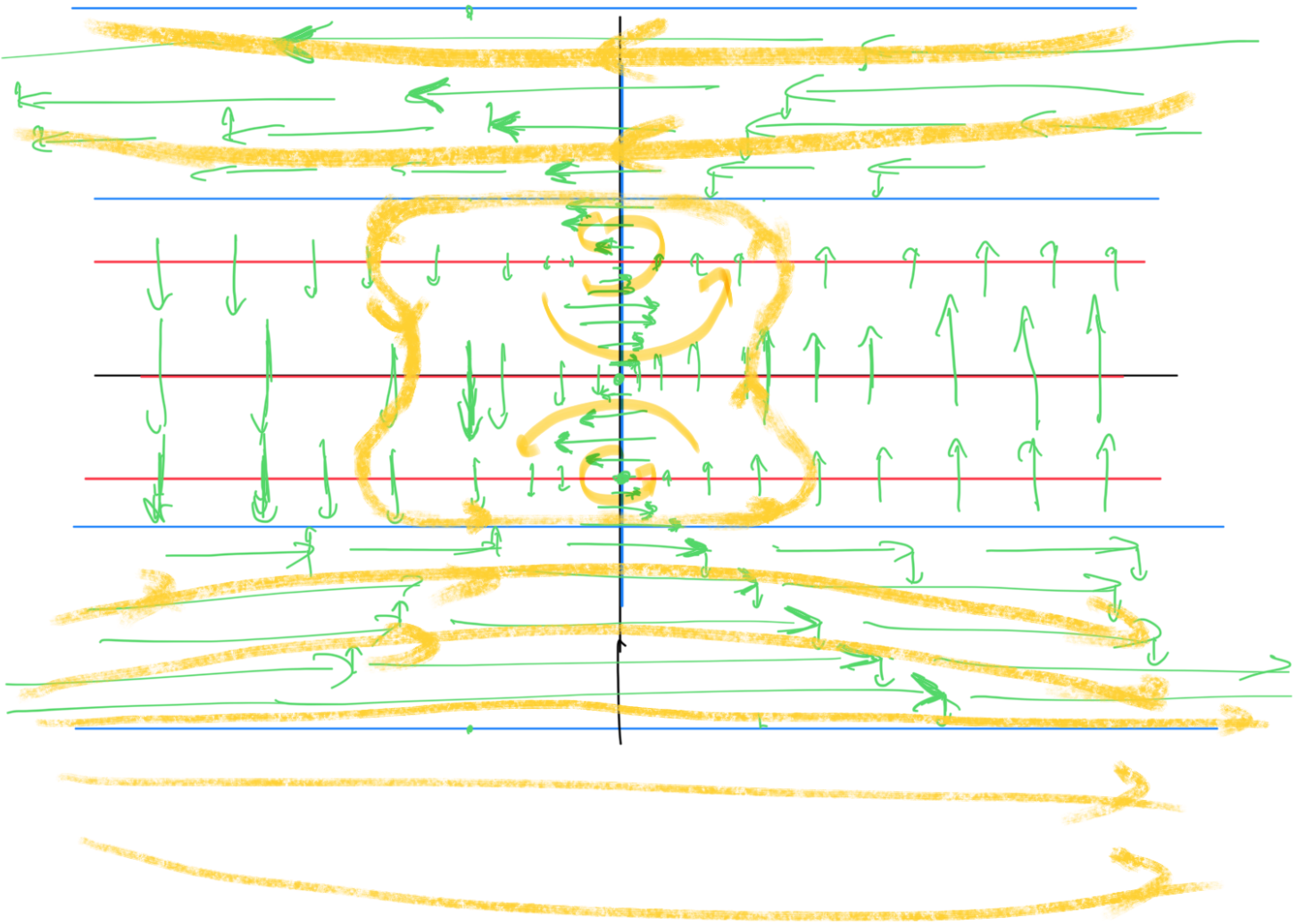
b) $\dot{y} = x \omega y$

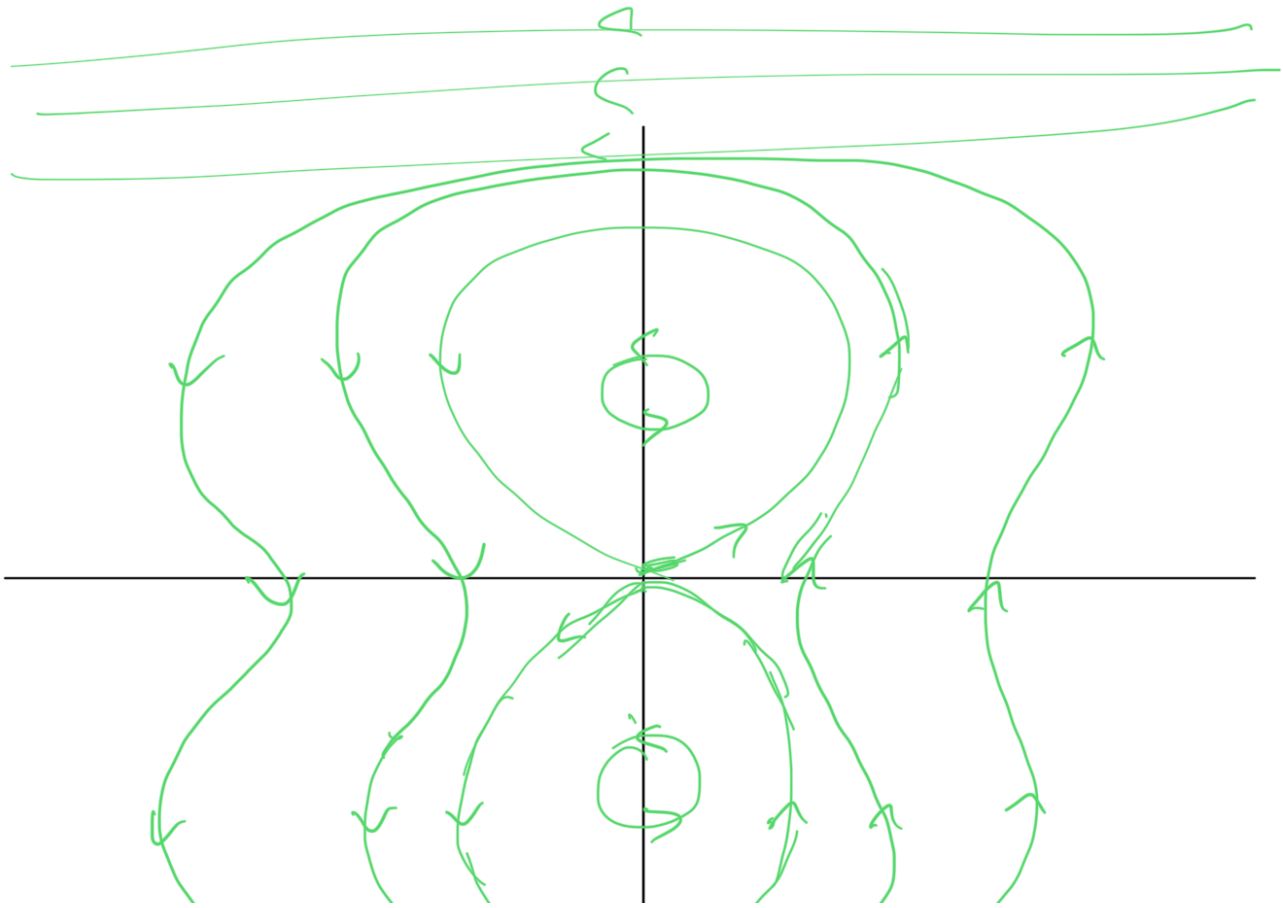
$\dot{x} = y - y^3$

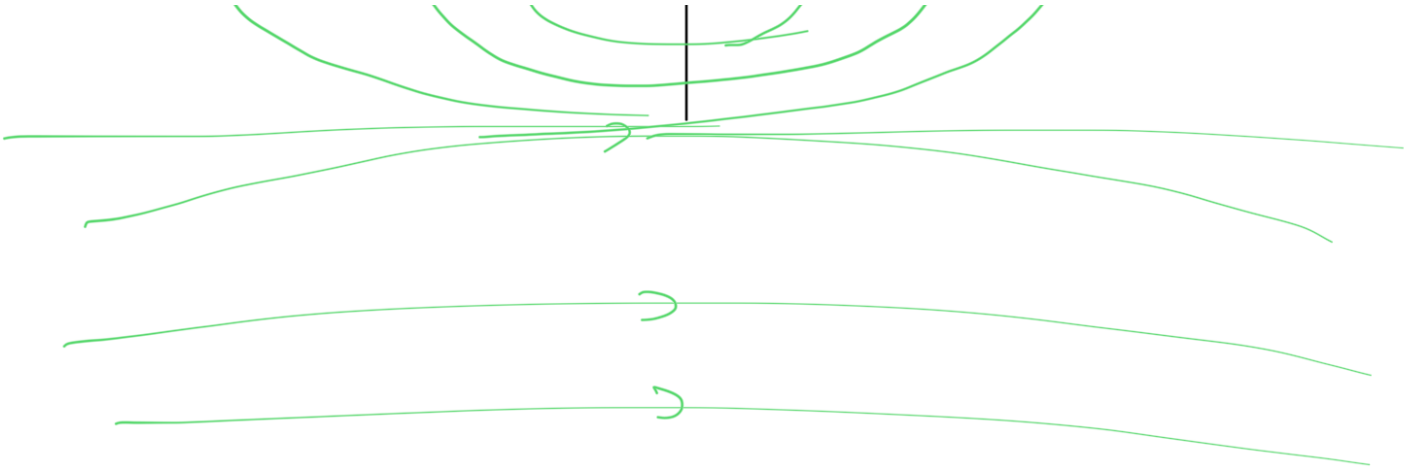
$\dot{y}=0$ nullcline $\Rightarrow$ $x=0$, $y=\frac{\pi}{2}\pm n\pi$

$\dot{x}=0$ nullcline $\Rightarrow$ $y=0$, $y=1,-1$









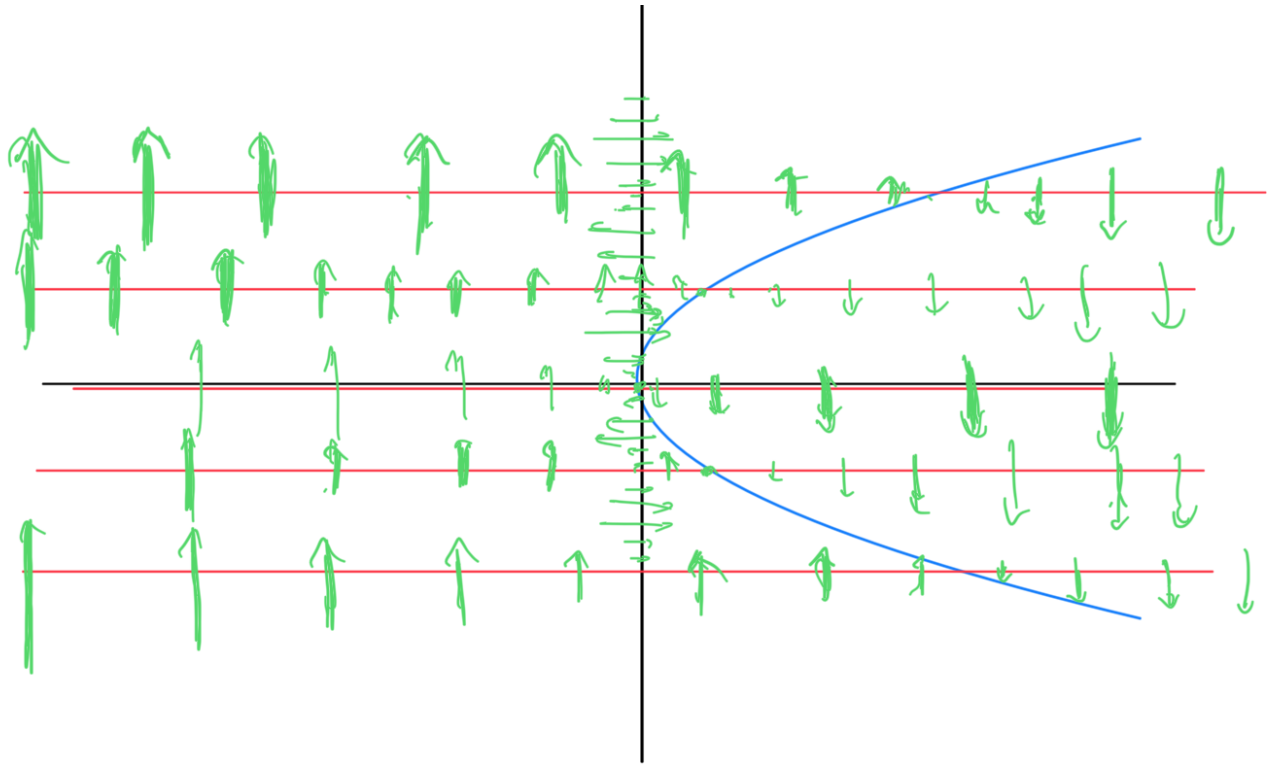
Plot as expected

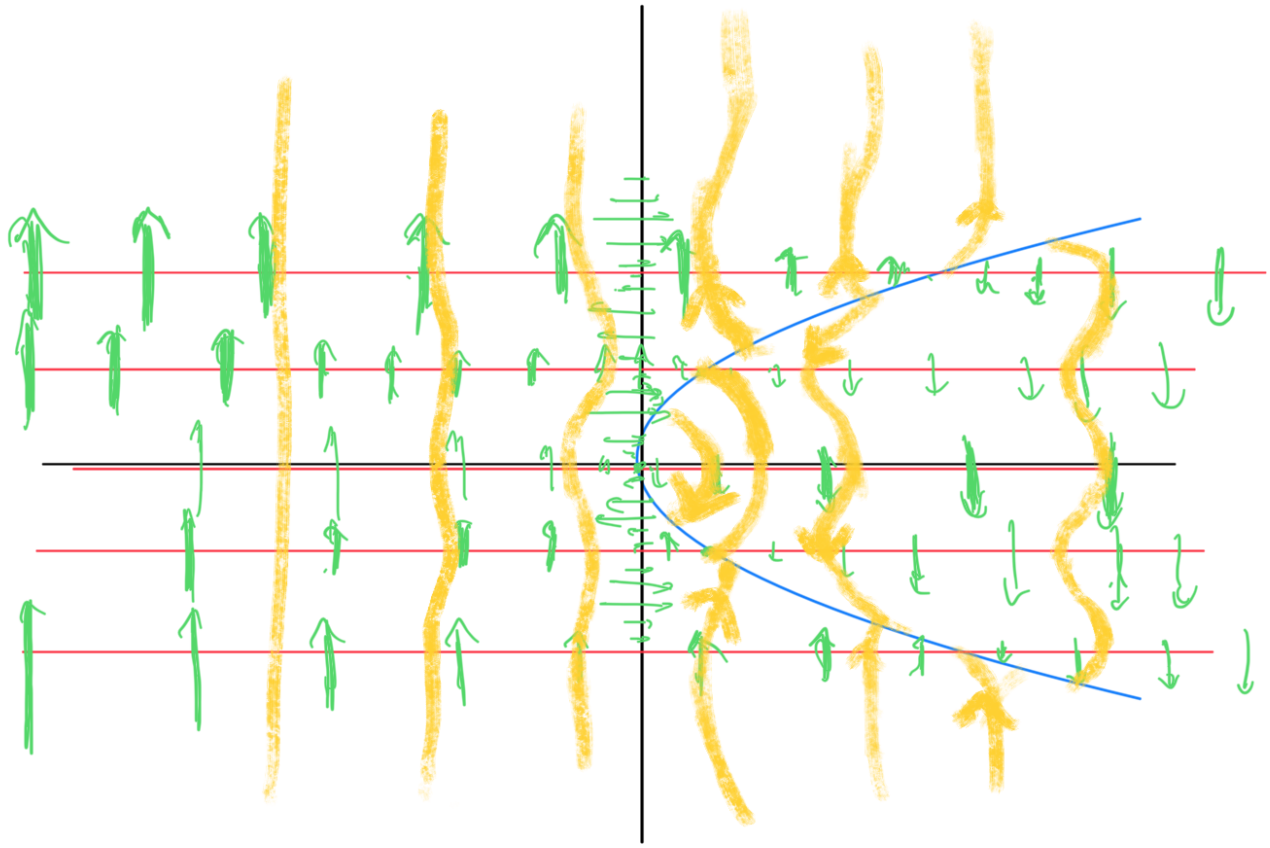
c) $\dot{y} = y^2 - x$

$\dot{x} = \sin(y)$

$\dot{y}$ nullcline $\Rightarrow$ $y = \pm\sqrt{x}$

$\dot{x}$ nullcline $\Rightarrow$ $y = n\pi$





Plot as expected