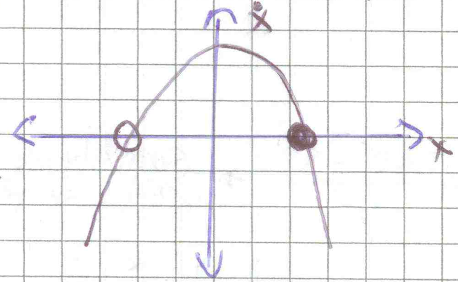
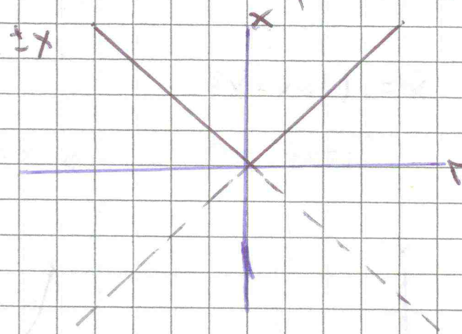
3.1.5.

a) $\dot{x} = r^2 - x^2 = a - x^2 \rightarrow x = \pm\sqrt{a} = \pm r \rightarrow$ Equilibrios





b) $\dot{x} = r^2 + x^2$

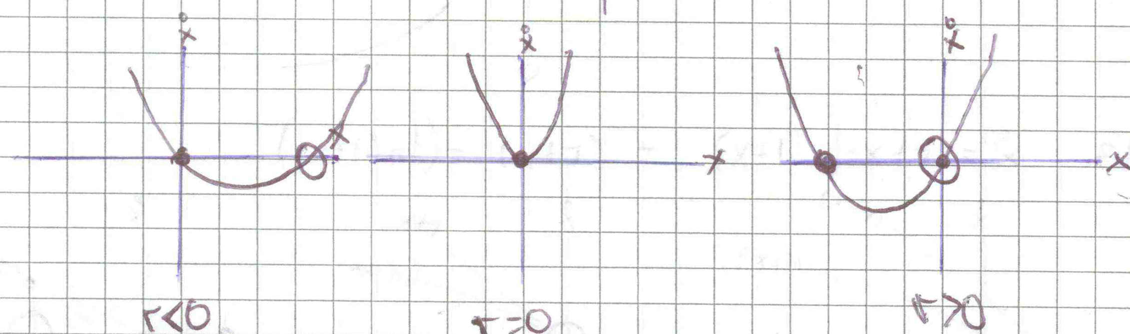
$x = \pm\sqrt{-r^2}$ → Un equilibrio en $r=0$, no hay equilibrios en $r \neq 0$.

3.2

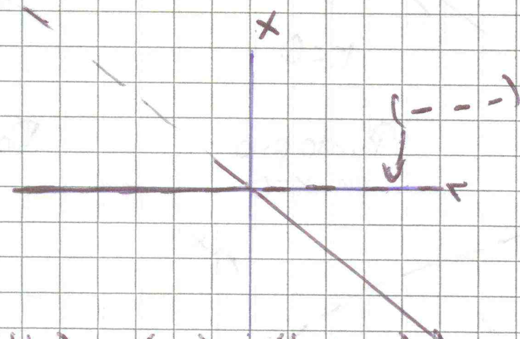
3.2.1. $\dot{x} = rx + x^2$

$\dot{x} = 0 \longrightarrow 0 = x(x+r) \rightarrow$ Equilibrio en $x=0$ y $x=-r$

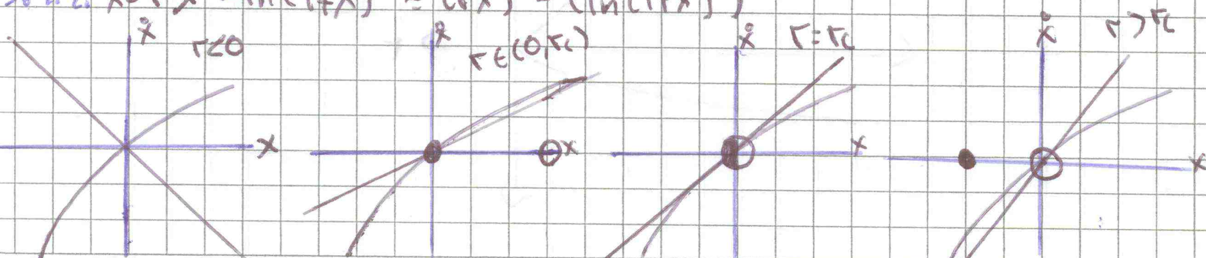
Si $r \neq 0$ se tienen dos equilibrios, si $r=0$ se tiene un equilibrio.



Punto transcrítico.



3.2.2. $\dot{x} = rx - \ln(1+x) = (rx) - (\ln(1+x))$



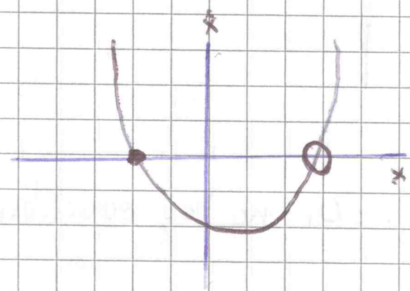
Santiago Rincón C. - 816052

CAPÍTULO 3.

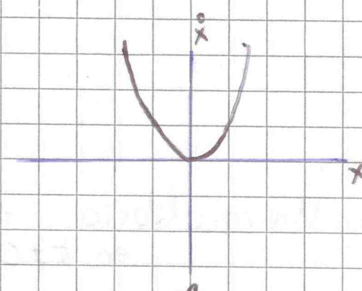
3.1

3.1.1. $\dot{x} = 1 + rx + x^2$

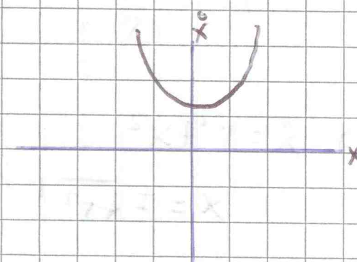
$x^2 + rx + 1 = 0 \longrightarrow x = \dfrac{-r \pm \sqrt{r^2 - 4}}{2} \rightarrow$ Equilibrios válidos si $r^2 > 4$



$r^2 > 4$



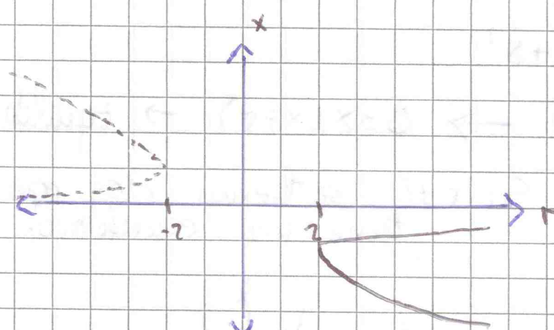
$r^2 = 4$



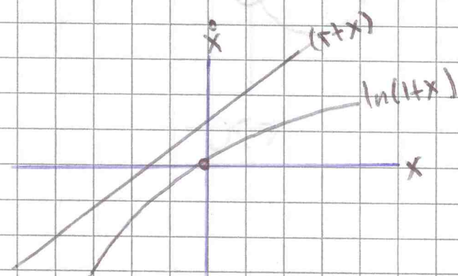
$r^2 < 4$

$-rx = x^2 + 1$

$r = -\left(\frac{1}{x} + x\right)$

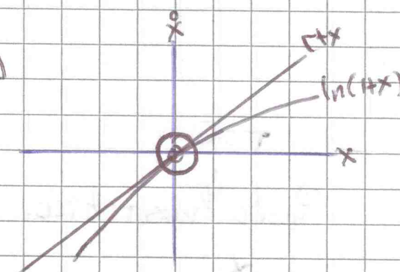


3.1.3. $\dot{x} = r + x - \ln(1+x) = (r+x) - (\ln(1+x))$



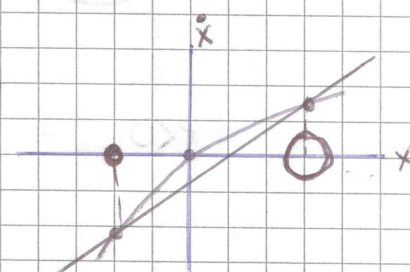
$r > 0$

No hay puntos fijos



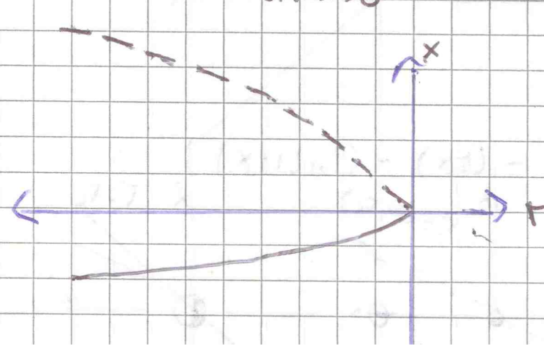
$r = 0$

Punto fijo en $x = 0$

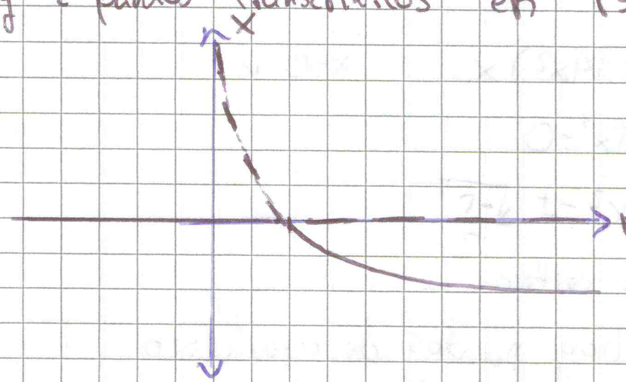


Dos puntos fijos

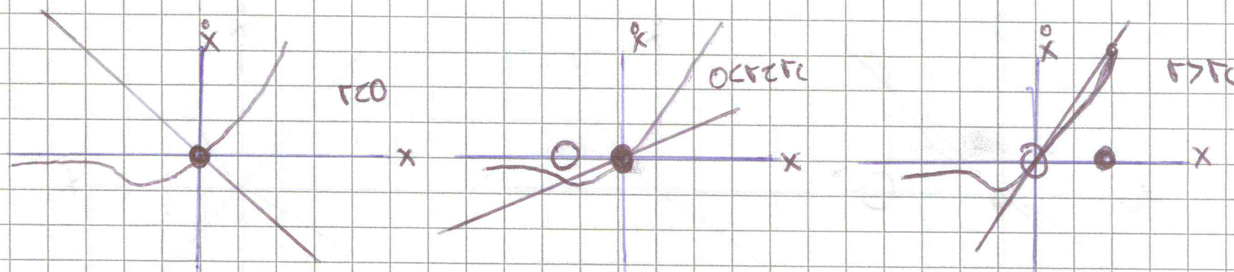
$r = -x + \ln(1+x)$



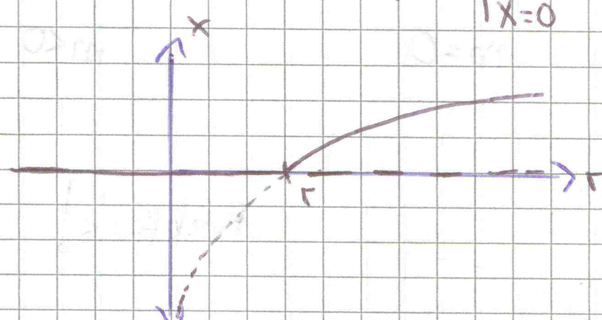
Hay 2 puntos transcríticos en $r = r_c$ y $r = 0^+$:



3.2.1. $\dot{x} = x(r - e^x) = (xr) - (xe^x)$



Para: $xr = xe^x \Big|_{x=0} \rightarrow r = 1$



3.3

3.3.2. $\dot{P} = r_1(ED - P) \rightarrow 0 = r_1(ED - P) \rightarrow P = ED$

$\dot{D} = r_2(\lambda + 1 - D - \lambda EP) \rightarrow 0 = r_2(\lambda + 1 - D - \lambda EP) \rightarrow D = \lambda + 1 - \lambda EP$

$D = \lambda + 1 - \lambda E^2 D \rightarrow D = \dfrac{\lambda + 1}{1 + \lambda E^2}$

a) $\dot{E} = K(P - E) = K(ED - E) = KE\left(\dfrac{\lambda + 1}{1 + \lambda E^2} - 1\right)$

b) $\dot{E} = 0 = KE\left(\dfrac{\lambda + 1}{1 + \lambda E^2} - 1\right) \rightarrow E = 0$ es un punto de equilibrio $\forall \lambda$.

$\dfrac{\lambda + 1}{1 + \lambda E^2} = 1 \rightarrow \lambda + 1 = 1 + \lambda E^2 \rightarrow E = \pm\sqrt{\dfrac{\lambda}{\lambda}} = 1 \rightarrow$ Punto de equilib...

3.4

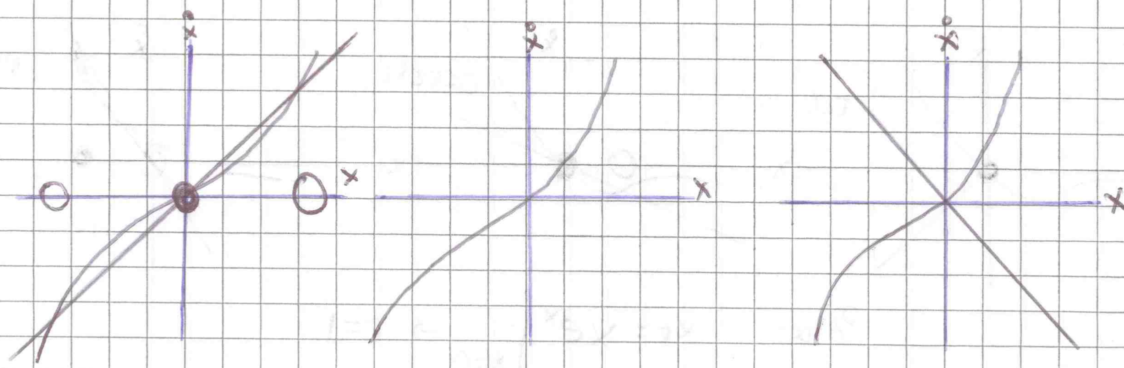
3.4.1. $\dot{x} = rx + 4x^3 = (r+4x^2)x$ $\quad x=0$ ✓

$$r + 4x^2 = 0$$

$$x^2 = \pm\frac{\sqrt{-r}}{2}$$

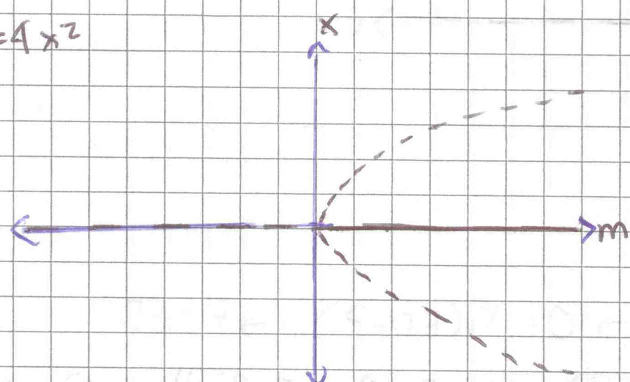
- $r=0$, punto crítico
- $r>0$, no hay puntos de equilibrio
- $r<0$, hay 2 equilibrios.

Si $m=-r$:



$m>0$ $\qquad$ $m=0$ $\qquad$ $m<0$

$m = 4x^2$

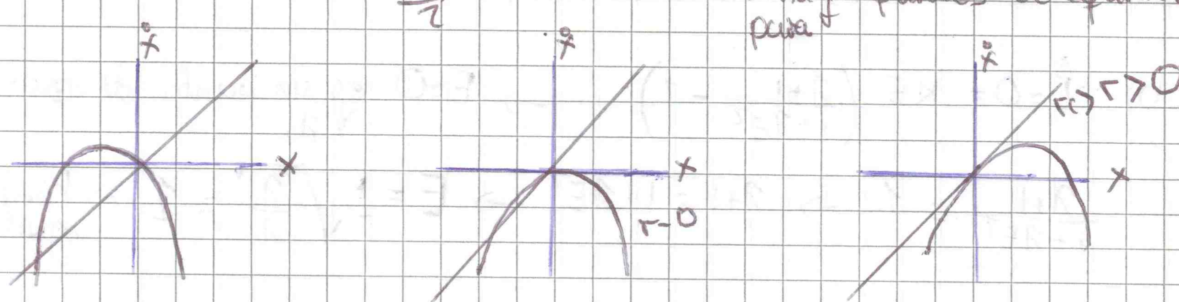


Pitchfork!

3.4.3. $\dot{x} = rx - 4x^3 = (r-4x^2)x$

- $x=0$
- $x = \pm\frac{\sqrt{r}}{2}$

$\Big\} \to$ Puntos de equilibrio para $r \geq 0$, no hay puntos de equilibrio para



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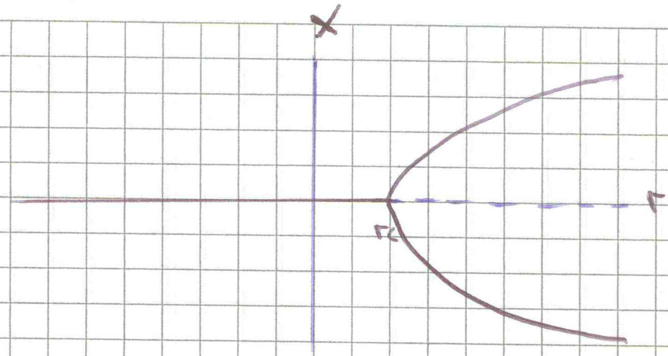


Pitchfork!!!

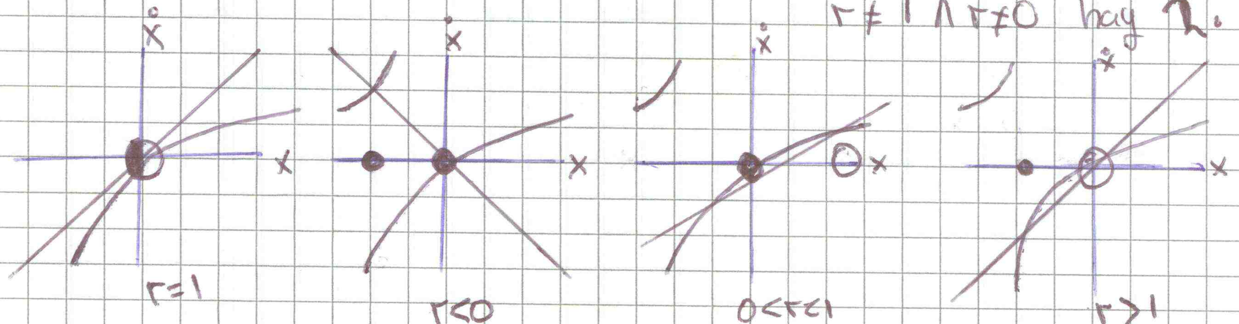
3.4.6. $\dot{x} = rx - \frac{x}{1+x}$

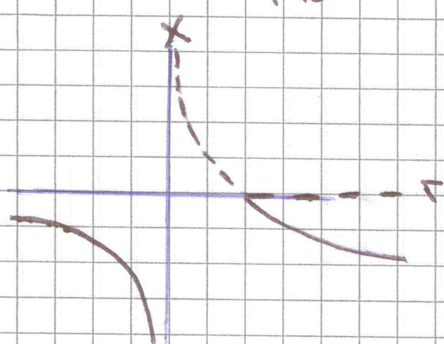
$0 = rx - \frac{x}{1+x}$

$0 = x\left(r - \frac{1}{1+x}\right)$

$x = 0$

$x = \frac{1}{r} - 1 \quad \forall r \neq 0$, en $r = 1$ hay un punto de equilibrio, en $r \neq 1 \wedge r \neq 0$ hay 2.





Transcrítico.