① $\dot{x} = -2x - 0.4x^3 + 0.3u = f(x,u), \quad \bar{u} = 2$

en un punto de equilibrio $\dot{x} = f(x,u) = 0$

$$-2\bar{x} - 0.4\bar{x}^3 + 0.3\bar{u} = 0$$

$$0.4\bar{x}^3 + 2\bar{x} + 0.6 = 0$$

Las raíces del polinomio son:

$$\bar{x} = \begin{cases} -0.2949 \\ 0.1474 \pm j2.2506 \end{cases}$$

$\bar{x} = -0.2949.$

$$\frac{\partial f}{\partial x} = -2 - 3(0.4)x^2$$

$$\left.\frac{\partial f}{\partial x}\right|_{(\bar{x},\bar{u})} = -2 - 1.2(-0.2949)^2 = -2.1044$$

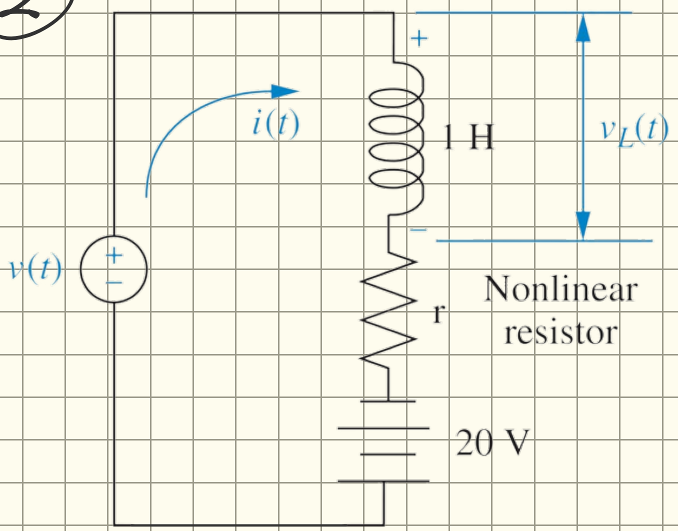
$$\frac{\partial f}{\partial u} = 0.3$$

$$\left.\frac{\partial f}{\partial u}\right|_{(\bar{x},\bar{u})} = 0.3$$

$$\boxed{\frac{d}{dt}(\delta x) = -2.1044\,\delta x + 0.3\,\delta u}$$

//

(2)



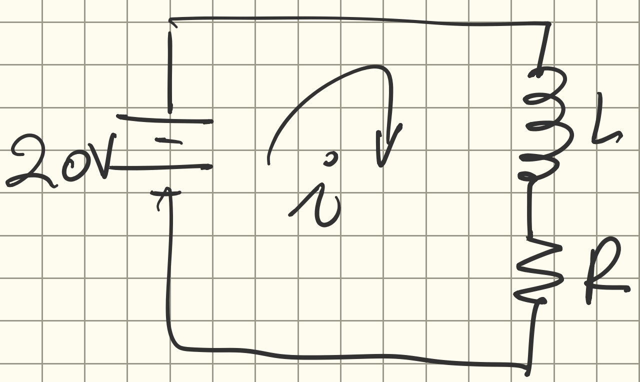
$$V = V_L + V_r - 20V$$

Como $i_r = 2e^{0.1 v_r}$

$$V_r = 10 \ln\left(\frac{i_r}{2}\right)$$

$$V = L\frac{di}{dt} + 10\ln\left(\frac{i}{2}\right) - 20 = \frac{di}{dt} + 10\ln\left(\frac{i}{2}\right) - 20$$

Para hallar el Punto de equilibrio, hacemos $V(t) = 0$.



Como $V_L = L\frac{di}{dt} = 0$.

$$\bar{V} = 20V.$$

y la corriente $\bar{i} = 2e^{-0.2} = 14.7781$

$$\frac{di}{dt} = -10\ln\left(\frac{i}{2}\right) + V + 20 = f(i,v)$$

$$\frac{\partial f}{\partial i} = -\frac{10}{i} \quad / \quad \left.\frac{\partial f}{\partial i}\right|_{(\bar{i},\bar{v})} = -0.6767$$

$$\frac{\partial f}{\partial v} = 1$$

$$\frac{d}{dt}(\delta i) = -0.6767\,\delta i + \delta V$$

$$\frac{d}{dt}(\delta i) + 0.6767\,\delta i = \delta V$$

$$\Big\downarrow \mathcal{L}$$

$$(s + 0.6767)\,\Delta I = \Delta V$$

$$\frac{\Delta I}{\Delta V} = \frac{1}{s + 0.6767}$$

y como $\delta V_L = L \frac{d}{dt} \delta i \xrightarrow{\mathcal{L}} \Delta V_L = L s \Delta I.$

$$\boxed{\frac{\Delta V_L}{\Delta V} = \frac{s}{s + 0.6767}}$$

//

(3) $$\frac{dv(t)}{dt} = \frac{1}{2085}\left(u(t) - 0.4v^2(t) - 228\right)$$

en un punto de equilibrio:

$$\bar{u} - 0.4\bar{v}^2 - 228 = 0 \qquad (\text{sup op. } \bar{u} = 400)$$

$$\bar{v} = \sqrt{\frac{\bar{u} - 228}{0.4}} = 20.7$$

$$\frac{\partial f}{\partial u} = \frac{1}{2085} \quad / \quad \frac{\partial f}{\partial v} = \frac{1}{2085}\left(-0.8v\right)\Big|_{\bar{v}=20.7} = \frac{-16.56}{2085}$$

$$\frac{d}{dt}(\delta v) = -\frac{16.56}{2085}\delta v + \frac{1}{2085}\delta u$$

$$\frac{\Delta v}{\Delta u} = \bar{G}(s) = \frac{\frac{1}{2085}}{s + \frac{16.56}{2085}} = \frac{1}{2085s + 16.56}$$