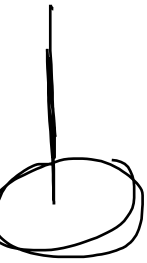
Sliding Mode Controller

where R, L, C, V0 > 0.■■The control signal u can only take on binary values, i.e., u ∈ {0, 1}.

This is a test!



Excercise:

$\dot{\underline{x}} = 0$

$\dot{\underline{x}}^* = 0$

Determine EP for unforced System: $u = 0$

Filippous method:

$\dot{x}_{av} = \alpha \underline{f}^+ + (1-\alpha)\underline{f}^-$

$\dfrac{x\, f^- \alpha}{} = \dfrac{ds}{d}$

$\dfrac{ds}{dx}(f^- - f^+)$

$s = x_1 - x_1^*$

$\dfrac{ds}{dx} = \begin{bmatrix} 1 & 0 \end{bmatrix}^T$

new controller $u^+ = \frac{1}{2}(1-1) = 0$

$$f^+ = \begin{bmatrix} -\frac{1}{L}x_2 \\ \frac{1}{C_1}x_1 - \frac{1}{RC}x_2 \end{bmatrix}$$

$$f^- = \begin{bmatrix} -\frac{1}{L}x_2 + \frac{V_0}{L} \\ \frac{1}{C}x_1 - \frac{1}{RC}x_2 \end{bmatrix}$$

$$\alpha = \frac{-\frac{1}{L}x_2 + \frac{V_0}{L}}{\phantom{xxxxxxxx}}$$

$$\dot{x}_{av} = \begin{bmatrix} eq\,1 \\ eq\,2 \end{bmatrix}$$

$u^-, u^+$

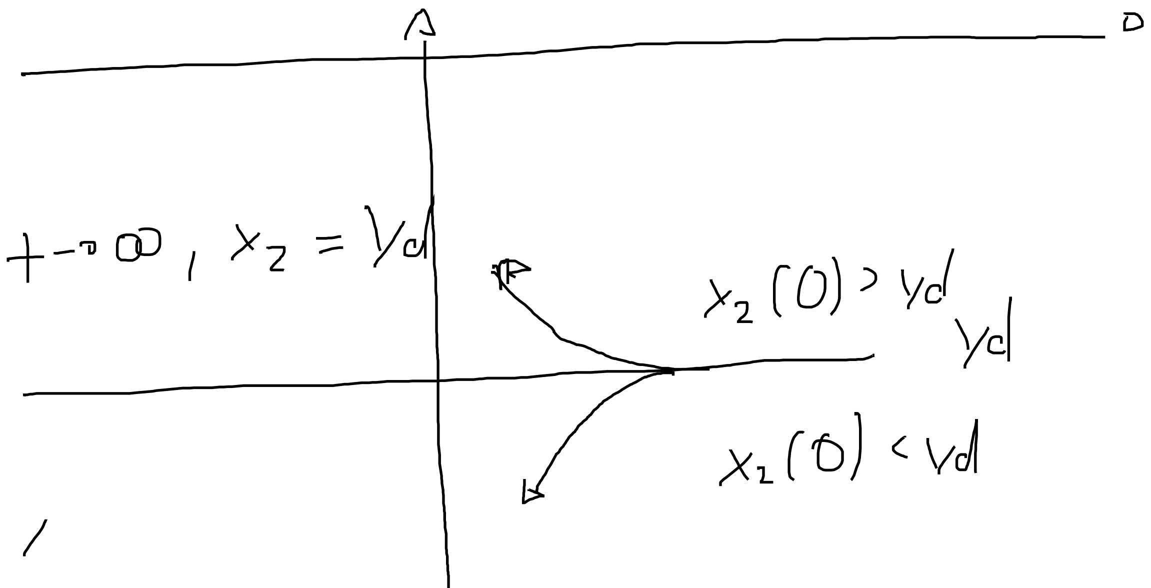
$= \ldots$

$= s > 0 : u = \frac{1}{2}(1 - \text{sign}(s))$

1.35 < ~~Sketch~~ $\frac{1}{2}$ behaviour ~~sign(s)~~ of $x_2(t)$

- OS: $x_1 = \lambda_1^* = \frac{V_D}{R}$

$$x_2(t) = V_d + \left(x_2(0) - V_d\right)e^{-\frac{t}{RC}} \qquad \dot{x}_2 = \frac{V_D}{RC} - \frac{1}{RC}x_2$$

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$x_2(t)$

1.4 Case study for existence

$s > 0$ : $\dot{s} = \dot{x}_1 = -\frac{1}{L}x_2 + \frac{V_0}{L}u^+ \qquad u^+ = 0$

$= -\frac{1}{L}x_2 < 0$

$\Omega_1 = \{x_2 : x_2 > 0\}$

$s < 0$ $\dot{s} = \dot{x}_1 = -\frac{1}{L}x_2 + \frac{V_0}{L}u^-, \quad u^- = 0$

$-\frac{1}{L}x_2 + \frac{V_0}{L} > 0$

$\Omega_2 = \{x_2 : x_2 < V_0\}$

$\lim_{s \to 0^+}$ $-\frac{1}{L}x_2 < 0 \qquad \Omega_3 = \Omega_1$

$\lim_{s \to 0^-}$ $-\frac{1}{L}x_2 + \frac{V_0}{L} > 0 \qquad \Omega_4 = \Omega_2$

$\Omega = \Omega_1 \wedge \Omega_2 \wedge \Omega_3 \wedge \Omega_4 = [x_2 : 0 < x_2 < V_0]$

exists $\Omega$ sliding mode

limit value
equals to
itself

$\wedge$

-dditional excerase:

$\cancel{x}_2 2x^* + 06u x_1^* = 0$ if $u \neq \frac{1}{3}$ $x_1^* = 0$

1)

2) $u = \frac{1}{3}$

-

second equation holds

no information

$2x_1^* + 3x_2^* = 0$

$x_1^* = t$, $x_2^* = -\frac{2}{3}t$ $x^* = \begin{bmatrix} t \\ -\frac{2}{3}t \end{bmatrix}$

.2 - Lyapunov indirect method

if $Re(\lambda(A)) < 0$ then the system would be stable

Approximation with Taylor

Determine matrix A

2. Determine $\lambda(A)$ solving $|\lambda I - A| = 0$

3. Check weather all $Re(\lambda(A)) < 0$

2.3. $s = x_1 + x_2$, $u = sign(x_1 s)$

· $s > 0$ ·

$\dot{s} = \dot{x}_1 + \dot{x}_2 = \dots$

$< 0, \quad x_1 s < 0, \quad u = \text{sign}(x_1 s) = -1$

Then $s =$

$\Omega_1$

$) \ \Omega_2 \dot{s} = \dots$

ifs :

Z4. $\alpha$ :

Look at this.

$x_2 = -2x_1$

$x_2 = 2x_1$