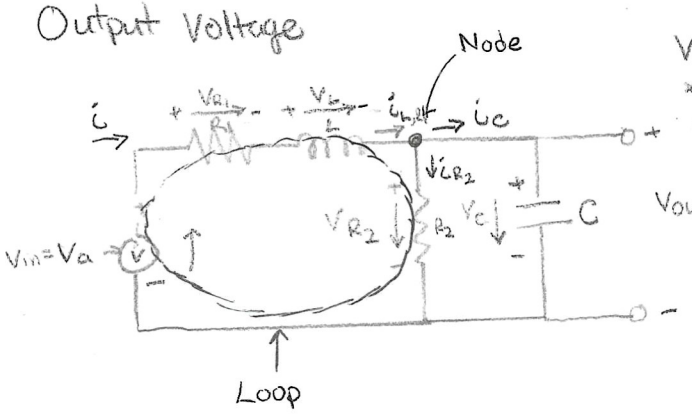
# Output Voltage

since $i_{R_1} = i_L$, just use $i_L$




$V = IR$ → $x_1 = i$, $x_2 =$ → 2 SV's $\begin{cases} x_1 = i_L \\ x_2 = V_C \end{cases}$ ⇒ 2SVE's $\begin{cases} \dot{x}_1 = \frac{di_L}{dt} = \frac{1}{L} V_L \\ \dot{x}_2 = \frac{dV_C}{dt} = \frac{1}{C} i_C \end{cases}$

$V_{out}$ ⇒ Voltage eqn's:
- $V_R = R i_R$
- $V_L = L \frac{di_L}{dt}$
- $V_C = \frac{1}{C} \int i_C dt$

Current Eqns:
- $i_R = \frac{V_R}{R}$
- $i_L = \frac{1}{L} \int V_L dt$
- $i_C = C \frac{dV_C}{dt}$

$\therefore$ KHV$_{Loop}$: $V_{R_1} - V_L + V_{R_2} - V_a = 0$ ⇒ $\begin{cases} V_L = V_a - V_{R_1} - V_C = V_a - R_1 i_L - V_C = \boxed{u - R_1 x_1 - x_2} \\ i_C = i_L - i_{R_2} = i_L - \frac{V_C}{R_2} = \boxed{x_1 - \frac{1}{R_2} x_2} \end{cases}$

KHC$_{node}$: $i_L - i_{R_2} - i_C = 0$

Let:
$\begin{cases} y = V_{out} = V_C = V_{R_2} = x_2 \\ u = V_a = \text{input} \end{cases}$

SS → $\begin{Bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{Bmatrix} = \begin{bmatrix} -\frac{R_1}{L} & -\frac{1}{L} \\ \frac{1}{C} & -\frac{1}{R_2 C} \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} + \begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix} u$ ; $y = [0 \ 1] \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} + 0 \cdot u$

A x + B u  C x + D