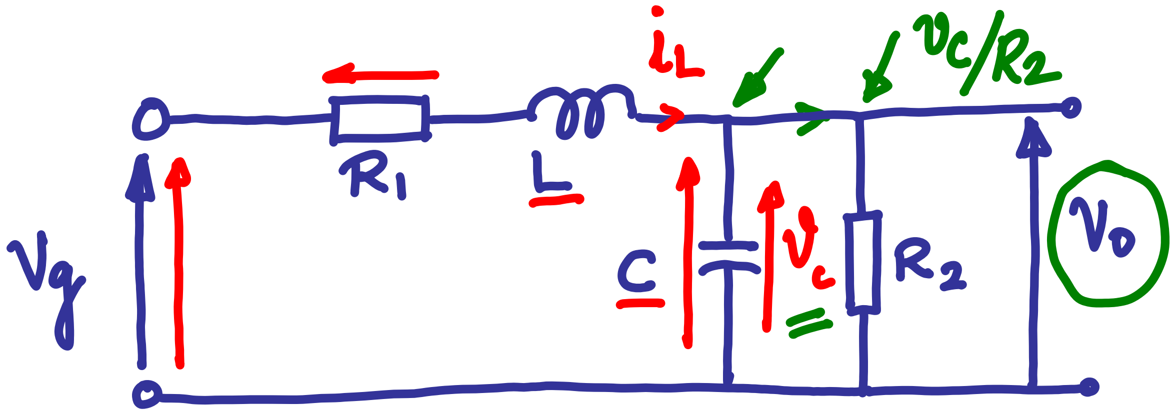


$$C: \quad C\frac{dv_c}{dt} = i_L - \frac{v_c}{R_2}$$

$$\frac{di_L}{dt} = -\left(\frac{R_1}{L}\right)(i_L) - \left(\frac{1}{L}\right)(v_c) + \left(\frac{1}{L}\right)v_g$$

$$\frac{dv_c}{dt} = \left(\frac{1}{C}\right)i_L - \left(\frac{1}{R_2C}\right)v_c + 0\,v_g$$

$$\frac{di_L}{dt} = -\left(\frac{R_1}{L}\right)(i_L) - \left(\frac{1}{L}\right)(v_c) + \left(\frac{1}{L}\right) v_g$$

$$\frac{dv_c}{dt} = \underbrace{\left(\frac{1}{C}\right) i_L - \left(\frac{1}{R_2 C}\right) v_c}\; + \underbrace{0\; v_g}$$

$$\underbrace{\begin{bmatrix} \dot{i}_L \\ \dot{v}_c \end{bmatrix}}_{\dot{x}} = \underbrace{\begin{bmatrix} -\frac{R_1}{L} & -\frac{1}{L} \\ \frac{1}{C} & -\frac{1}{R_2 C} \end{bmatrix}}_{A} \cdot \underbrace{\begin{bmatrix} i_L \\ v_c \end{bmatrix}}_{x} + \underbrace{\begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix}}_{B} \cdot \underbrace{\begin{bmatrix} v_g \end{bmatrix}}_{u}$$

STATE EQUATION

$$y = \mathbb{C} \cdot x + \mathbb{D} \cdot u$$

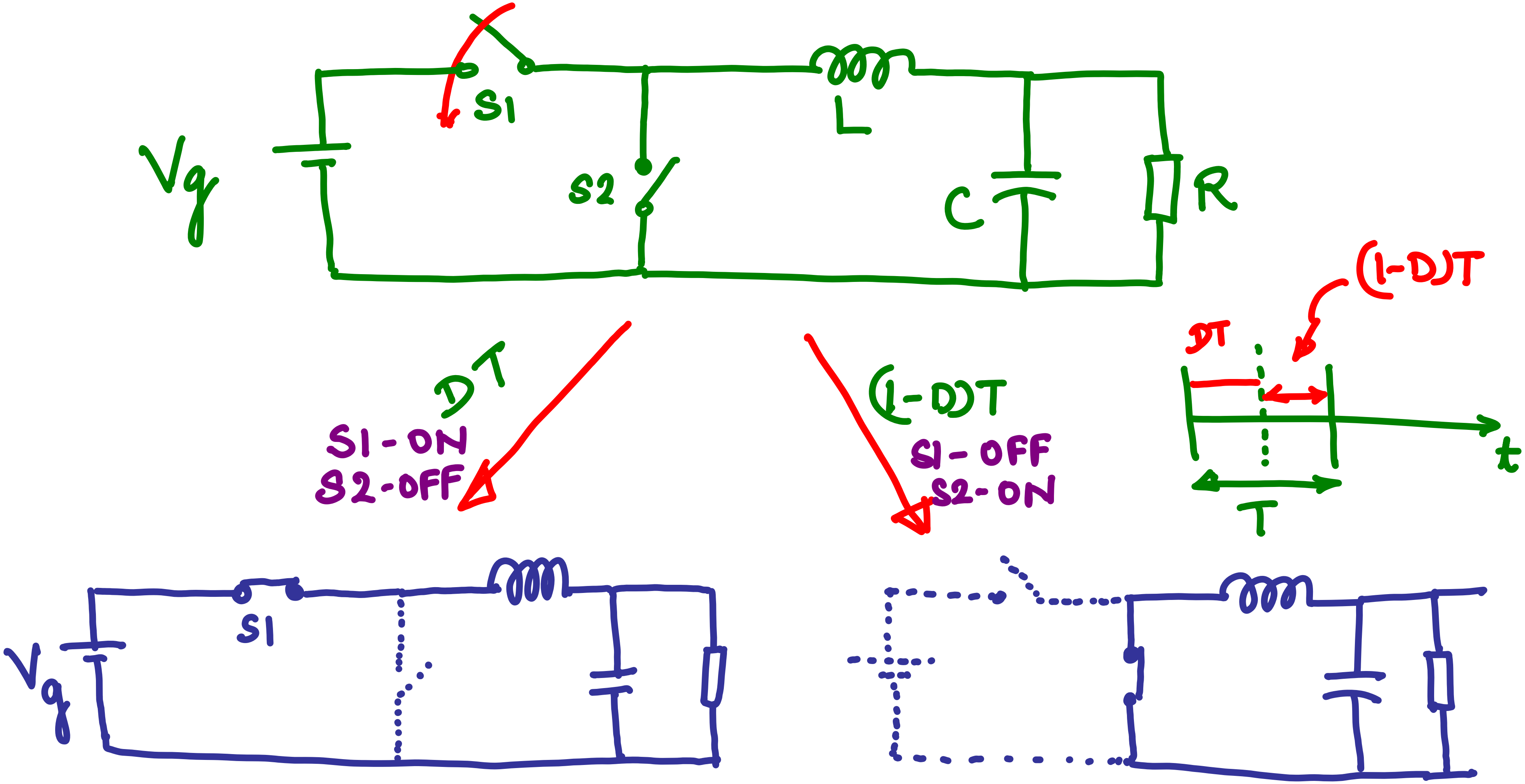
$$\| \quad v_o = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} i_L \\ v_c \end{bmatrix} + \begin{bmatrix} 0 \end{bmatrix} \begin{bmatrix} v_g \end{bmatrix}$$

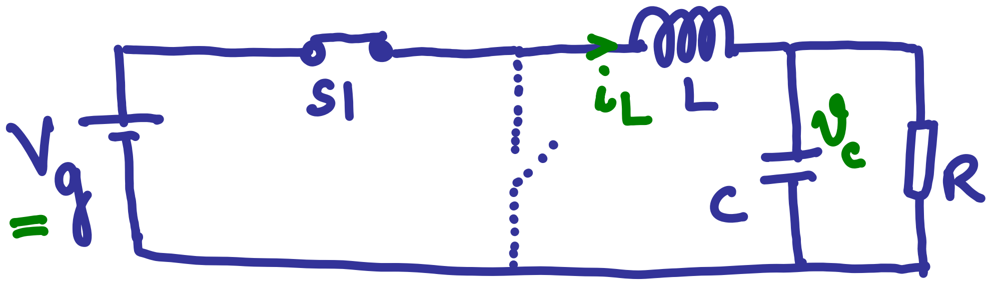
OUTPUT EQUATION

$\dot{x} = \mathbb{A}x + \mathbb{B}u$ state equation

$y = \mathbb{C}x + \mathbb{D}u$ output equation

BUCK DC-DC CONVERTER





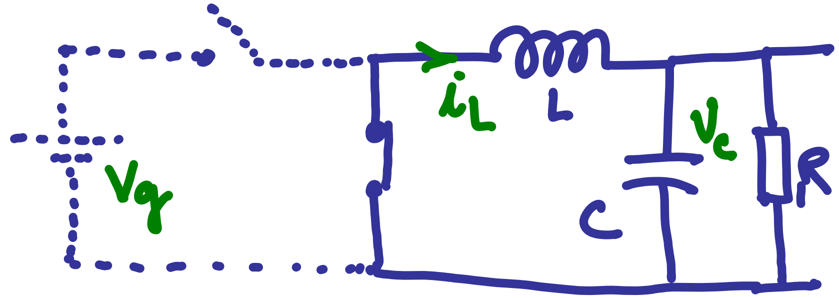
MODE – DT

$$L\frac{di_L}{dt} = v_g - v_c$$

$$C\frac{dv_c}{dt} = i_L - \frac{v_c}{R}$$

$$\begin{bmatrix} \dot{i}_L \\ \dot{v}_c \end{bmatrix} = \begin{bmatrix} 0 & -\frac{1}{L} \\ \frac{1}{C} & -\frac{1}{RC} \end{bmatrix} \begin{bmatrix} i_L \\ v_c \end{bmatrix} + \begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix} \begin{bmatrix} v_g \end{bmatrix}$$

$$\dot{x} = A_1 x + B_1 u$$



MODE – (1-D)T

$$L\frac{di_L}{dt} = 0 - v_c$$

$$C\frac{dv_c}{dt} = i_L - \frac{v_c}{R}$$

$$\begin{bmatrix} \dot{i}_L \\ \dot{v}_c \end{bmatrix} = \begin{bmatrix} 0 & -\frac{1}{L} \\ \frac{1}{C} & -\frac{1}{RC} \end{bmatrix} \begin{bmatrix} i_L \\ v_c \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} \begin{bmatrix} v_g \end{bmatrix}$$

$$\dot{x} = A_2 x + B_2 u$$

$$y = \mathbb{C}_1 x + \mathbb{D}_1 u$$

$$V_o = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} i_L \\ v_C \end{bmatrix}$$

$$y = \mathbb{C}_2 x + \mathbb{D}_2 u$$

$$V_o = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} i_L \\ v_C \end{bmatrix}$$

$$\dot{x} = \mathbb{A}_1 x + \mathbb{B}_1 u$$

$$y = \mathbb{C}_1 x + \mathbb{D}_1 u$$

Large Signal Model during DT

$$\dot{x} = \mathbb{A}_2 x + \mathbb{B}_2 u$$

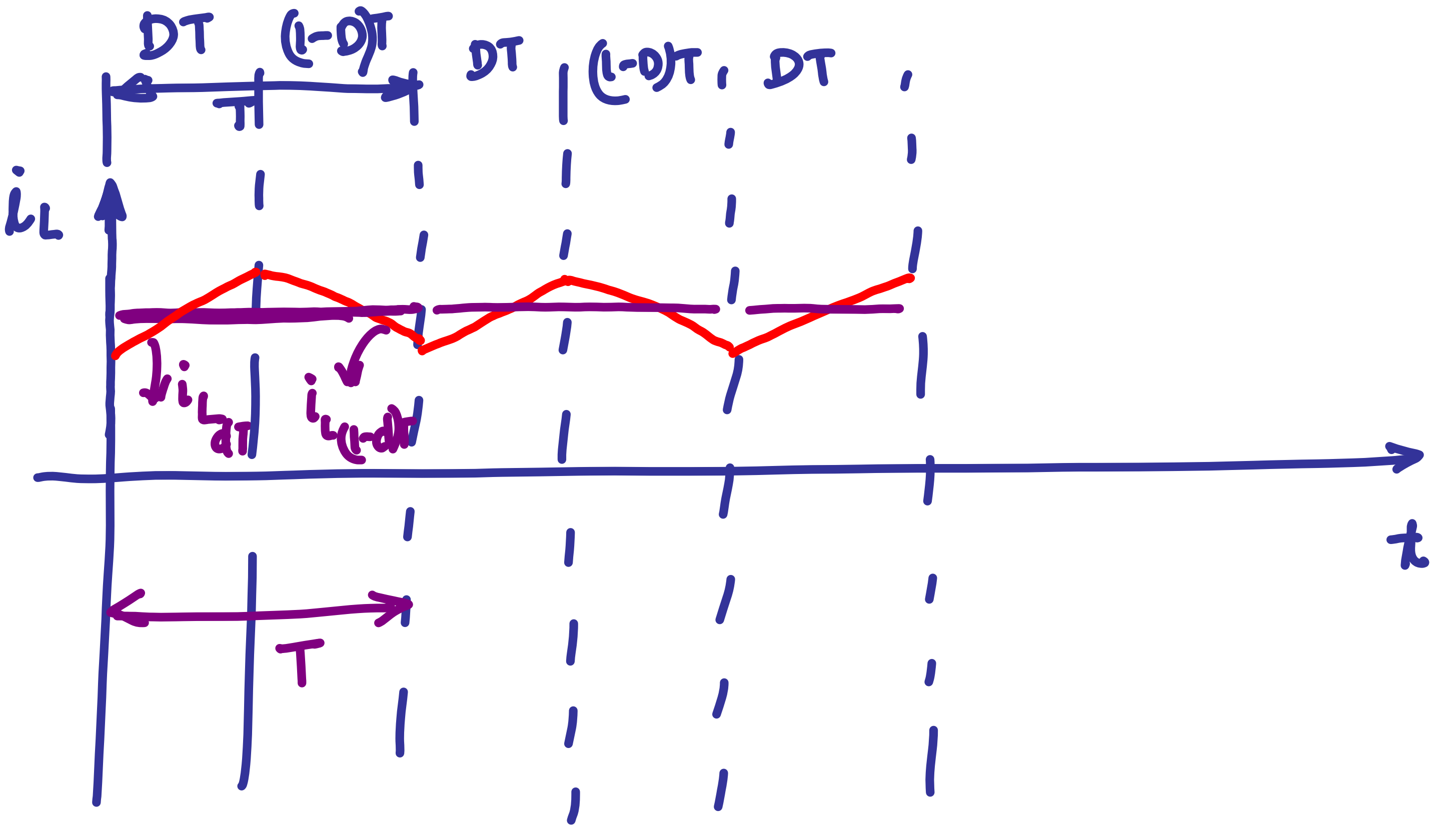
$$y = \mathbb{C}_2 x + \mathbb{D}_2 u$$

Large Signal Model during (1-D)T

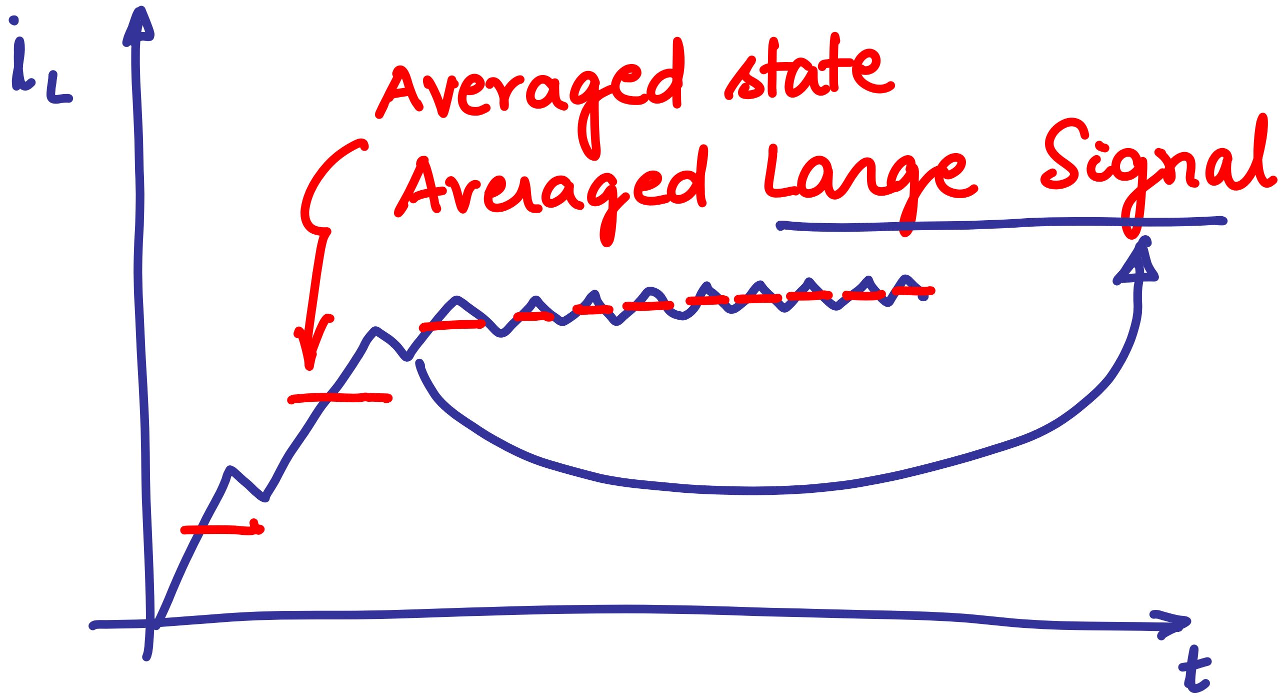
D

(1-D)

$$x_{avg} = \underline{x_{dT} \cdot D + x_{(1-d)T}(1-D)}$$



$$\underline{\underline{i_{L\,avg}}} = \frac{i_{L_{dT}} \cdot D\cancel{T} + i_{L_{(1-d)T}} \cdot (1-D)\cancel{T}}{\cancel{T}}$$



$$x_{avg} = x_d \cdot d + x_{(1-d)}(1-d)$$

$$\dot{x} = \mathbb{A}_1 x + \mathbb{B}_1 u \quad \& \quad \dot{x} = \mathbb{A}_2 x + \mathbb{B}_2 u$$

D (d) $(1-D)$ $(1-d)$

$$\dot{x} = \mathbb{A} x + \mathbb{B} u$$

Averaged Large Signal Model