Lecture # 5 10/8/2021

- HW 1 due Monday 11:59 pm PT.

Last time

-> General procedure to computes S.S. values in a converter

↳ Using balance eqns.

Today

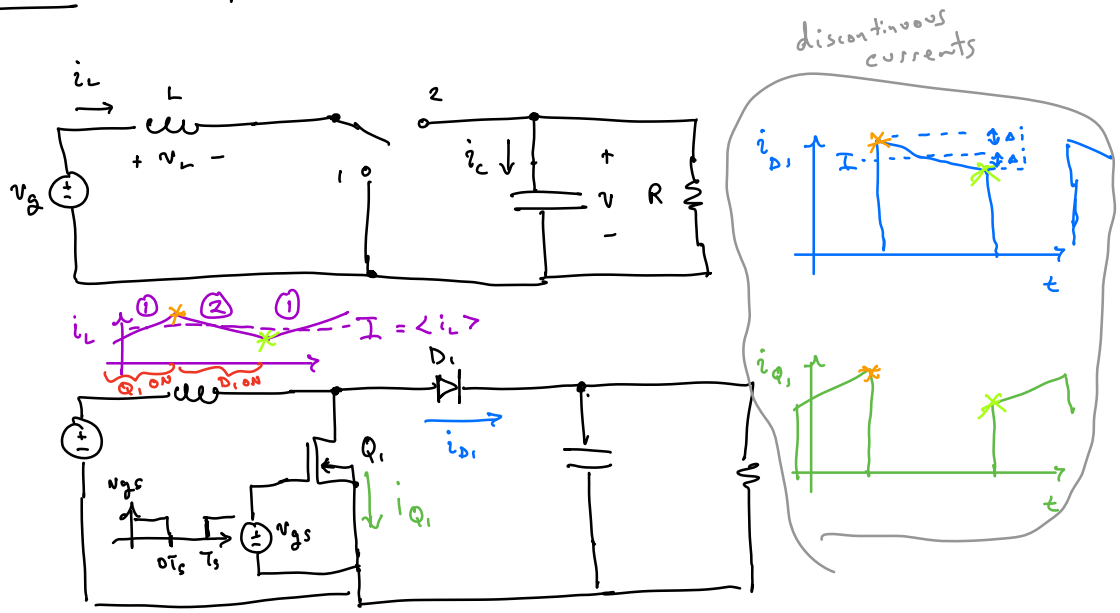
↳ Finish last set of blank pages

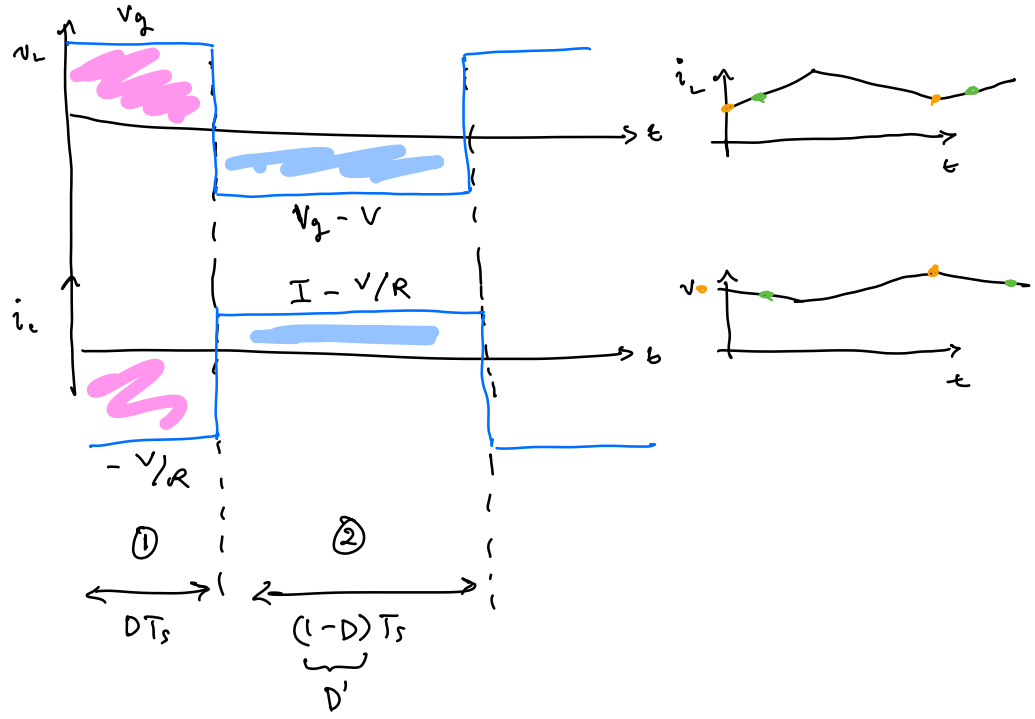
↳ Switch realization

Tip

↳ HW doesn't require a sim., but you can simulate it anyway.

- Boost Example





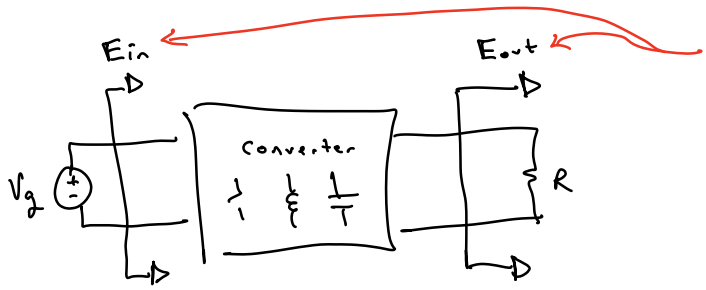
Lecture #6 10/11/2021

Last time
- SS ckt analysis via balance eqns

Today
- Cúk converter example w/ balance eqns } Finish Ch 2

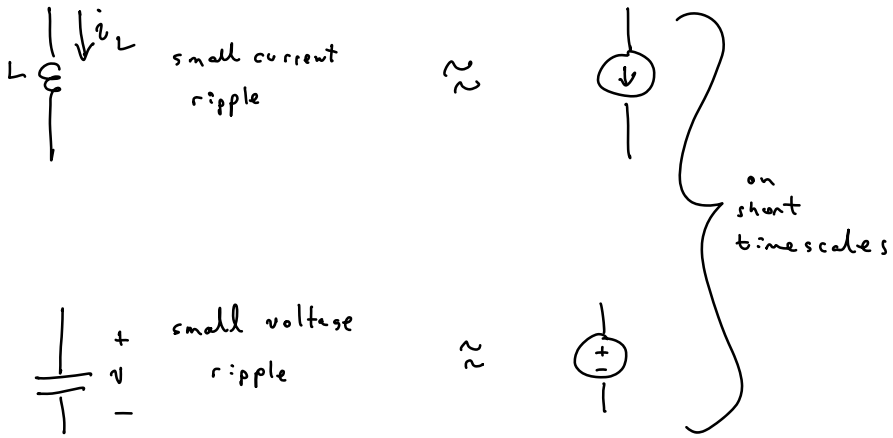
Next time (maybe today)
- Start ch 3 (ss balance eqns w/ nonideal ckt elements)

Logistics
- HW 1 deadline extended to Weds noon.



Cap & Inductor Behavior

$v_L = L \frac{di_L}{dt}$



$i_c = C \frac{dv}{dt}$

– Computing Ripple Amplitude

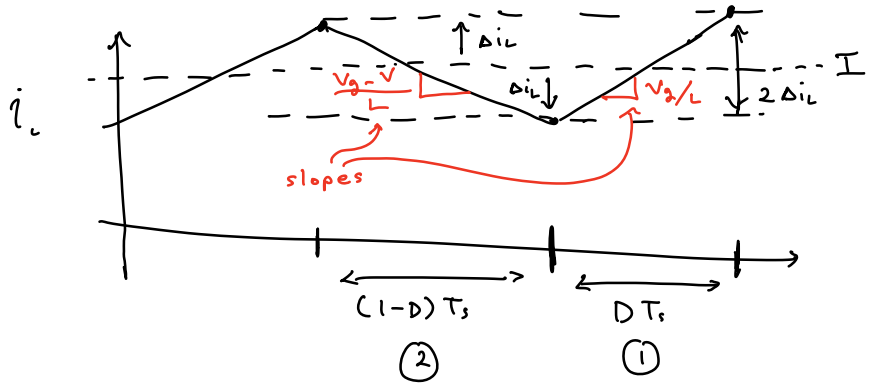
- For L in boost

generally $\frac{di_L}{dt} = \frac{v_L}{L}$ → ① V_g / L ; ② $\frac{(V_g - V)}{L}$

use linear approximation ... rewrite derivative

① $\frac{2\Delta i_L}{\Delta t_①} = \frac{2\Delta i_L}{D T_s} = \left| \frac{V_g}{L} \right| \Rightarrow \Delta i_L = \frac{D T_s V_g}{2L}$

② $\frac{2\Delta i_L}{\Delta t_②} = \frac{2\Delta i_L}{\underbrace{(1-D)}_{D'} T_s} = \left| \frac{V_g - V}{L} \right|$



... similar story for cap

- For C

$$\frac{dv}{dt} = \frac{i_c}{C}$$

① $\frac{-V/R}{C}$

② $\frac{I - V/R}{C}$

use approx for derivative

$$\frac{2\Delta V}{\Delta t_1} = \frac{2\Delta V}{D T_s} = \left| \frac{-V/R}{C} \right|$$

OR

$$\frac{2\Delta V}{\Delta t_2} = \frac{2\Delta V}{(1-D)T_s} = \left| \frac{I - V/R}{C} \right|$$

solve either to get ΔV

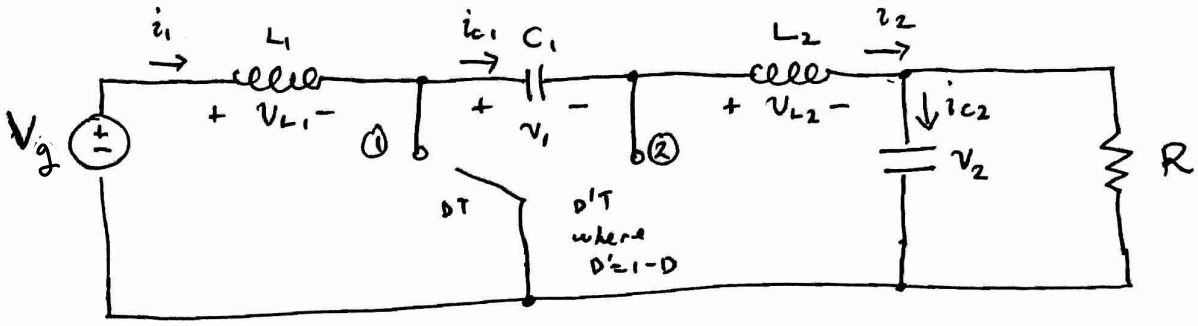
— Discontinuous waveforms through switches

- Look @ boost again

Middlebrook was Cúk's advisor @ Caltech

— Cúk Converter Example

→ D. Maksimovic's advisor @ Caltech



Objective:

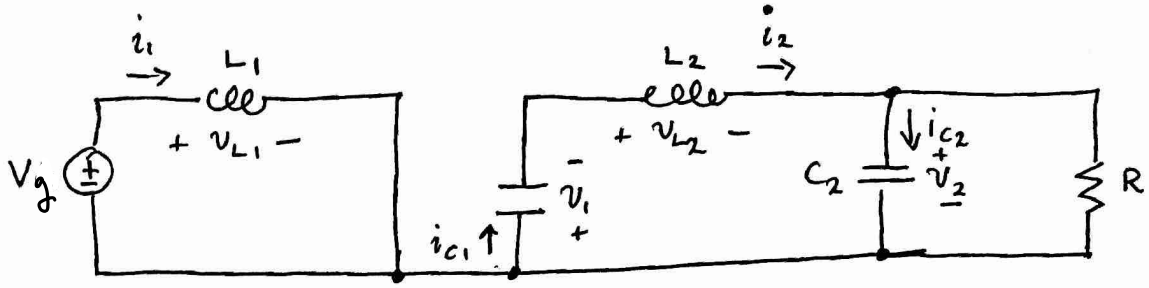
Solve for $V_{s.s.}$ inductor currents & cap voltages
(dc component of)

Approach

→ 1) Compute balance eqns

2) Do a bunch of algebra

- Cuk : State # 1



$$v_{L1} = V_g$$

$$v_{L2} = -v_1 - v_2$$

$$i_{c_1} = i_2$$

$$i_{c_2} = i_2 - \frac{v_2}{R}$$

small ripple approx "SRA"

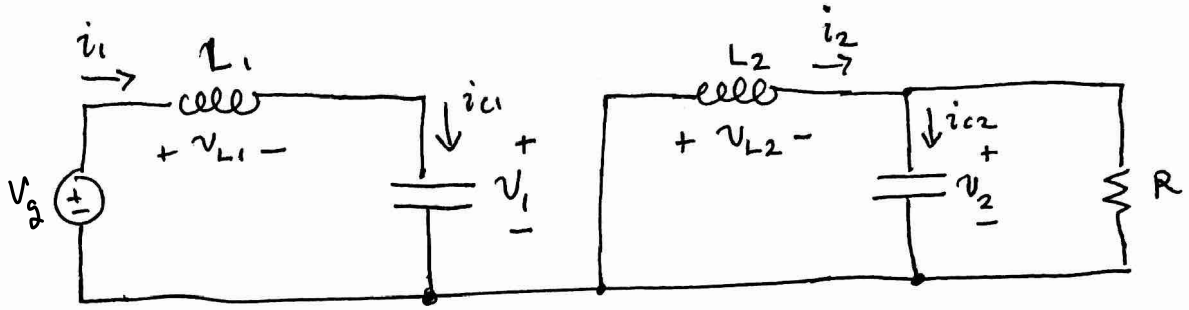
$$v_{L_1} = V_g$$

$$v_{L2} = -V_1 - V_2$$

$$i_{C_1} = I_2$$

$$i_{c_2} = I_2 - \frac{V_2}{R}$$

- Cuk State #2



$$v_{L1} = V_g - v_1$$

$$v_{L2} = -v_2$$

$$i_{c1} = i_1$$

$$i_{c2} = i_2 - \frac{v_2}{R}$$

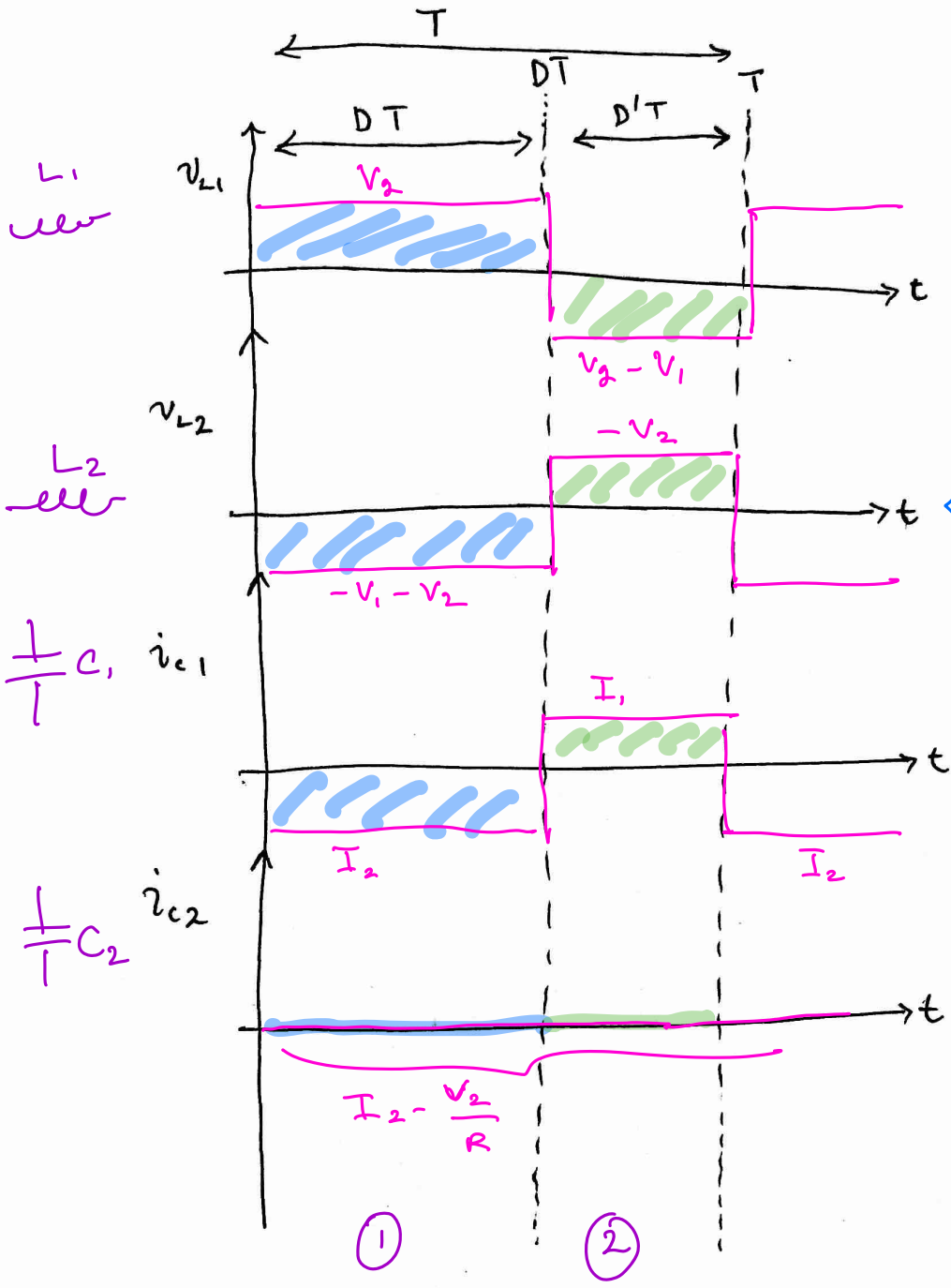
SRA $\longrightarrow$

$$v_{L1} = V_g - V_1$$

$$v_{L2} = -V_2$$

$$i_{c1} = I_1$$

$$i_{c2} = I_2 - \frac{V_2}{R}$$



Balance eqns: set avg to zero.

$$\langle v_{L1} \rangle = D V_g + D'(V_2 - V_1) = 0$$

$$\langle v_{L2} \rangle = D(-V_1 - V_2) + D'(-V_2) = 0$$

$$\langle i_{C1} \rangle = D I_2 + D' I_1 = 0$$

$$\langle i_{C2} \rangle = I_2 - \frac{V_2}{R} = 0$$

Take stock:

unknowns: I_1, I_2, V_1, V_2

# of equations = 4

} can do a bunch of algebra to solve for I_1, I_2, V_1, V_2

— Recap of some basic converters