Lecture #26, 12/3/21

Last time:

↳ Finished magnetics & transformers (ch 10)

□ HW7 deadline extended to Sunday night 11:59pm.

Today:

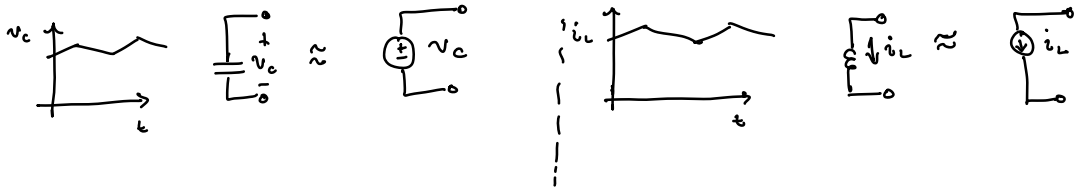
↳ Converter structures, Ch 6

Reading Assignment

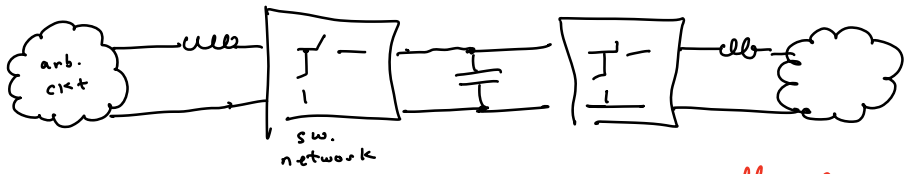
↳ Read Ch 6 over next 1 week.

– Patterns/Rules that Govern most converter topologies

• Main idea

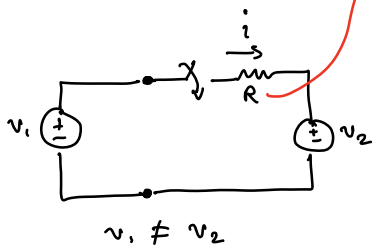


Converters generally built by cascading alternating L's (≈ current source) & C's (≈ voltage source)



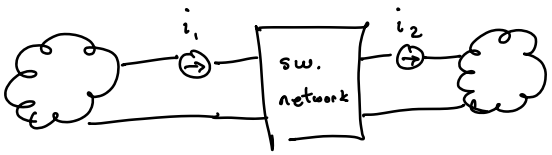
Why?

→ R is very small, R → 0



i will be very large b/c differing v source voltages

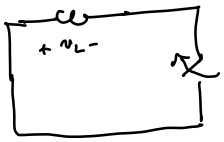
* don't connect to dissimilar voltages in parallel.



$i_1 \neq i_2$

* don't connect 2 mismatched currents in series

ex:



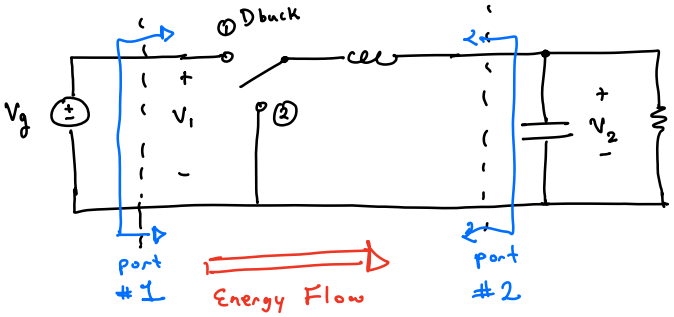
$v_L = L \frac{di}{dt}$

↳ goes to ∞ @ t_0

$\Rightarrow v_L \to \infty$ @ t_0

– Circuit Inversions

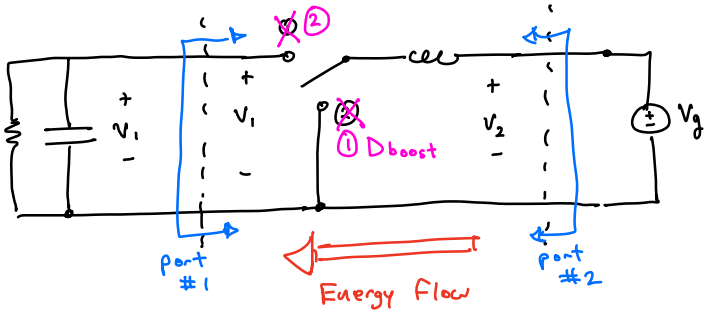
• Buck is simplest, start here



know $V_2 = V_1 D_{buck}$, D_{buck} → position ① duty

$$M(D_{buck}) = \frac{V_2}{V_1} = D_{buck}$$

• Swap input/output ckt elements



D_{boost} is new ① position duty

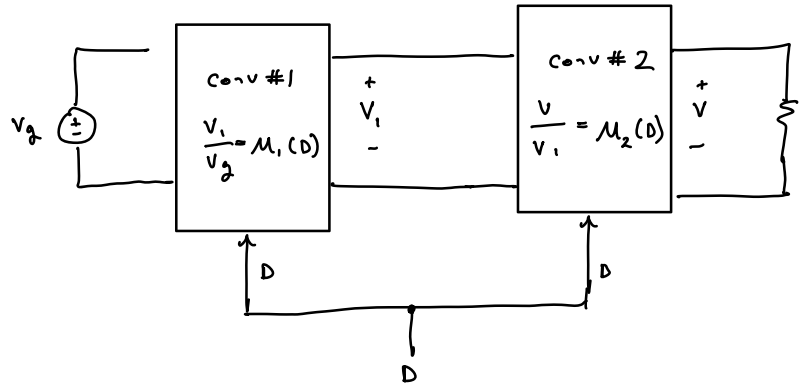
↳ It's a boost!

Boost is a buck w/ input/output external elements swapped & duties swapped.

$$D_{boost} = 1 - D_{buck} = D'_{buck}$$

– Cascaded Converters

* Build more complex ckts with multiple cascaded converters



$$\frac{V}{V_g} = M_1(D)\, M_2(D)$$

Example: Buck + Boost

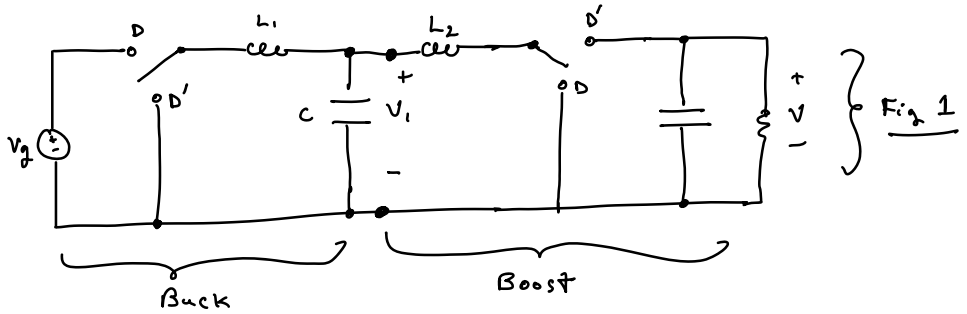


Fig 1

$$M_1(D) = \frac{V_1}{V_g} = D \qquad M_2(D) = \frac{V}{V_1} = \frac{1}{1-D}$$

multiply

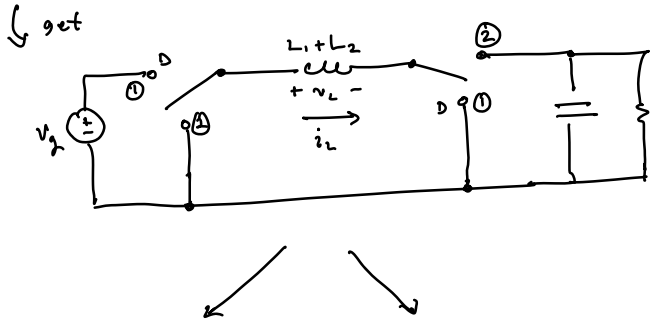
$$\frac{V}{V_g} = M_1(D)\, M_2(D) = \frac{D}{1-D}$$ ← "non-inverting buck-boost"

↓ abstract analysis to show "hiding" buck boost

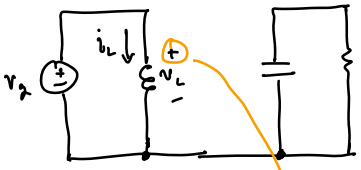
* Redraw Fig 1 to recover classic buck-boost

Step 1 : Simplify filter

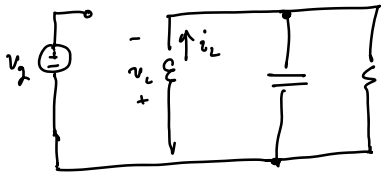
↳ Remove intermediate cap & combine L's



config ①



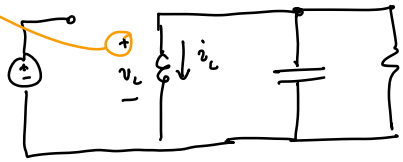
config ②



modify ② ckt to obtain basic buck-boost. Get rid of redundant switches

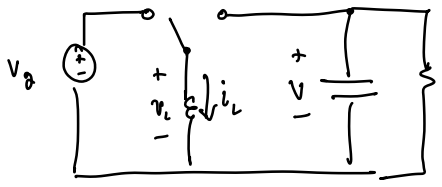
stays on top now

redraw



Use ① & ② to get classic buck boost

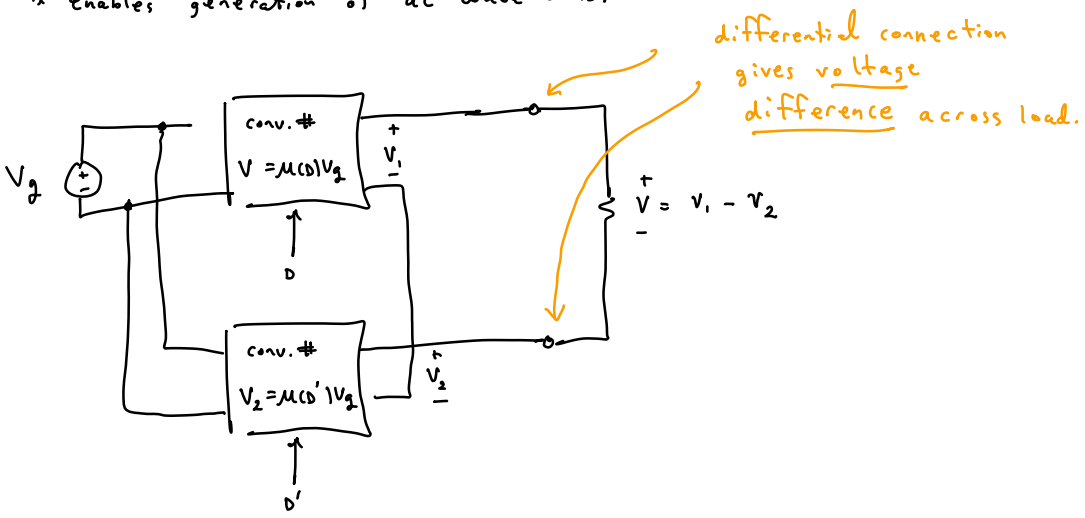
↳



$$\frac{V}{V_g} = \frac{D}{1-D}$$

– Differential Connections

* Enables generation of ac waveforms.



even if V_1 & V_2 are each ⊕, the difference $V_1 - V_2$ can be negative by manipulating V_1 & V_2.

⇒ allows us to produce an ac waveform.