Lecture # 7 10/13/2021

Last time
- Finished Ch 2 and Ćuk converter example
  Ch 2: s.s. analysis of ided converters

Today
- Start Ch 3 → Read over next 1 week
  Ch 3: s.s. analysis w/ non-idealities

Logistics
- HW 1 solution posted
- HW 2 posted today, due Wed 10/20 11:59pm PT.

- Closing Thoughts on Cúk converter example:

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

After solving, we get:

$$V_1 = \frac{V_g}{D}$$

$$V_2 = -\frac{D}{D'} V_g$$

$$I_1 = -\frac{D}{D'} \left(\cdots \right)$$

$$I_2 = \left(\frac{D}{D'}\right)^2 \frac{V_g}{R}$$

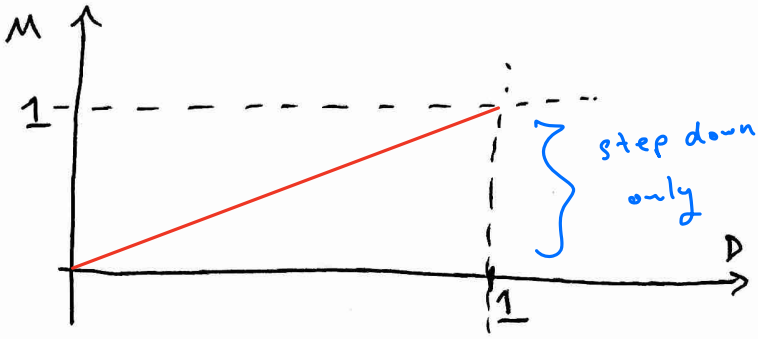
Conversion Ratio?

$$M(D) = \frac{V_2}{V_g} = -\frac{D}{1-D}$$

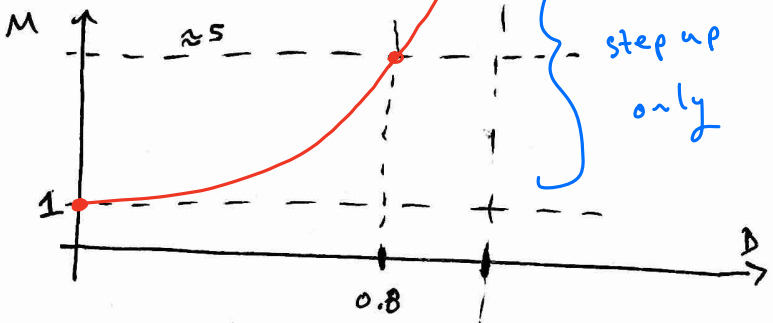
} similar/identical buck boost

– Recap of some basic converters

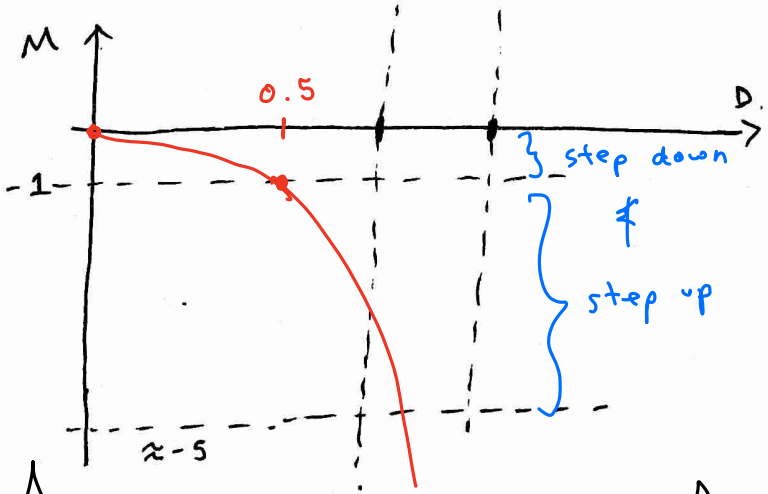
$M = D$



$M = \frac{1}{1-D}$



$M = \frac{-D}{1-D}$



ch 2

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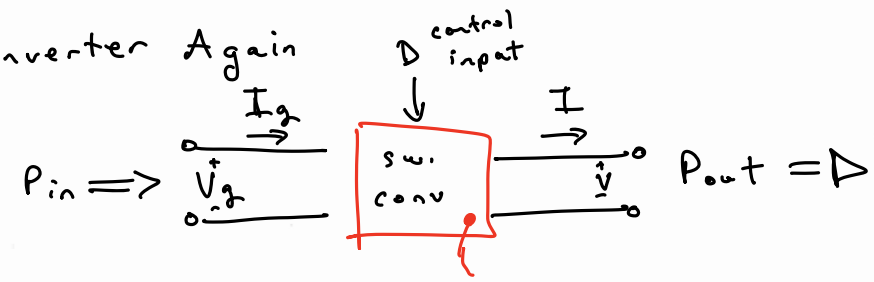
ch 3

– Ideal Converter Again



$P_{in} = P_{out}$

$\Downarrow$

$V_g I_g = V I$

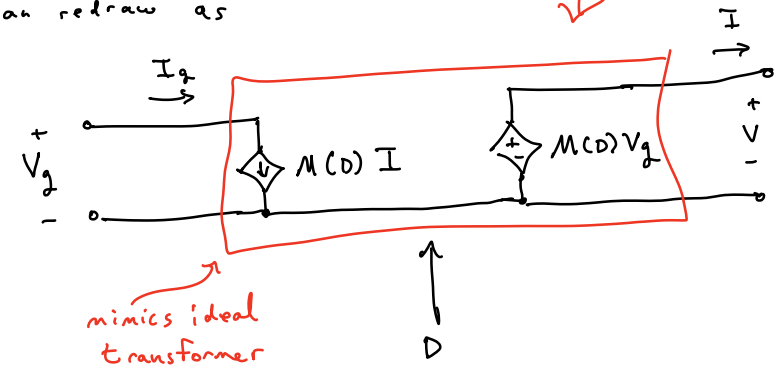
$\Rightarrow$ efficiency $\eta = 1$ (Greek symbol eta)

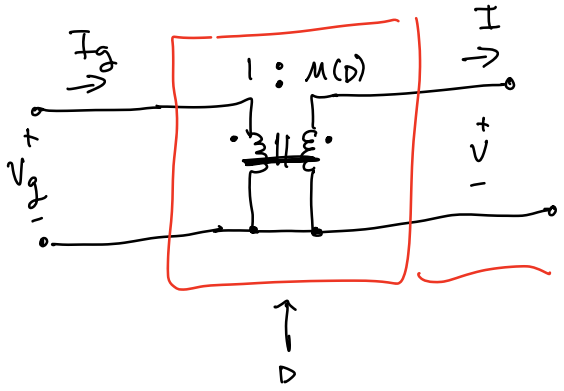
$$\frac{V}{V_g} = M(D)$$

$$\frac{I_g}{I} = M(D)$$

ideal conversion ratios

Can redraw as



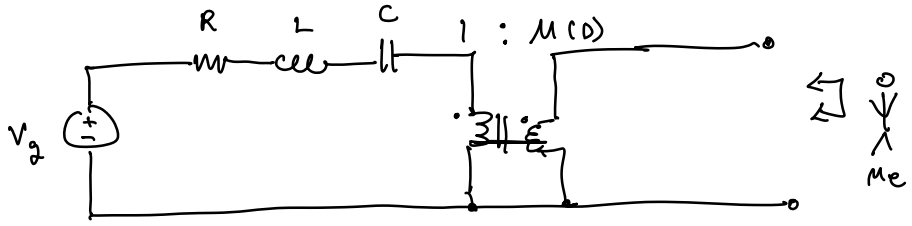


Unicorn xfmr: Different from a real-world xfmr

- Adjustable
- Non-integer turns
- Passes dc power

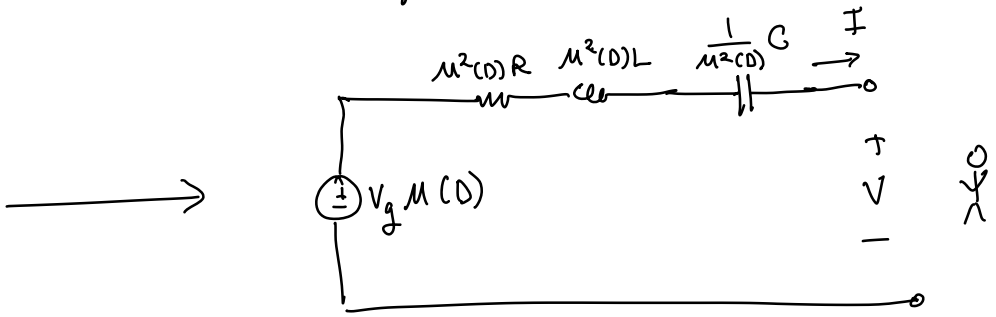
* Ideal converter mimics an adjustable xfmr.

- Rules for "reflecting" ckt elements through a xfmr



Want equiv elements on other side

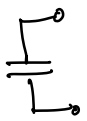
Result after reflecting elements



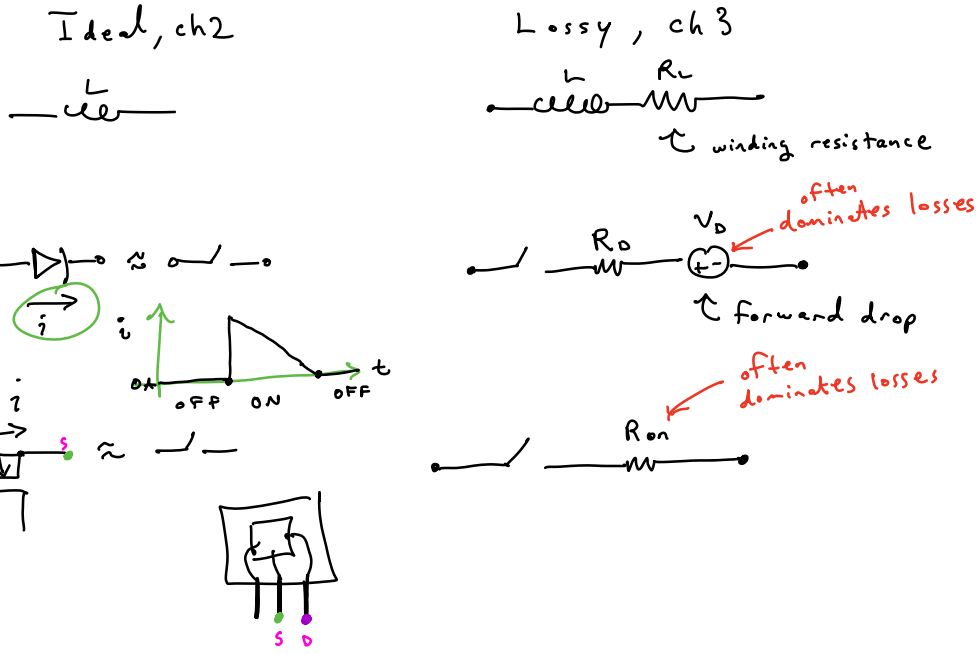
easier to analyze


→ scale by $M(D)$


→ scale by $M^2(D)$

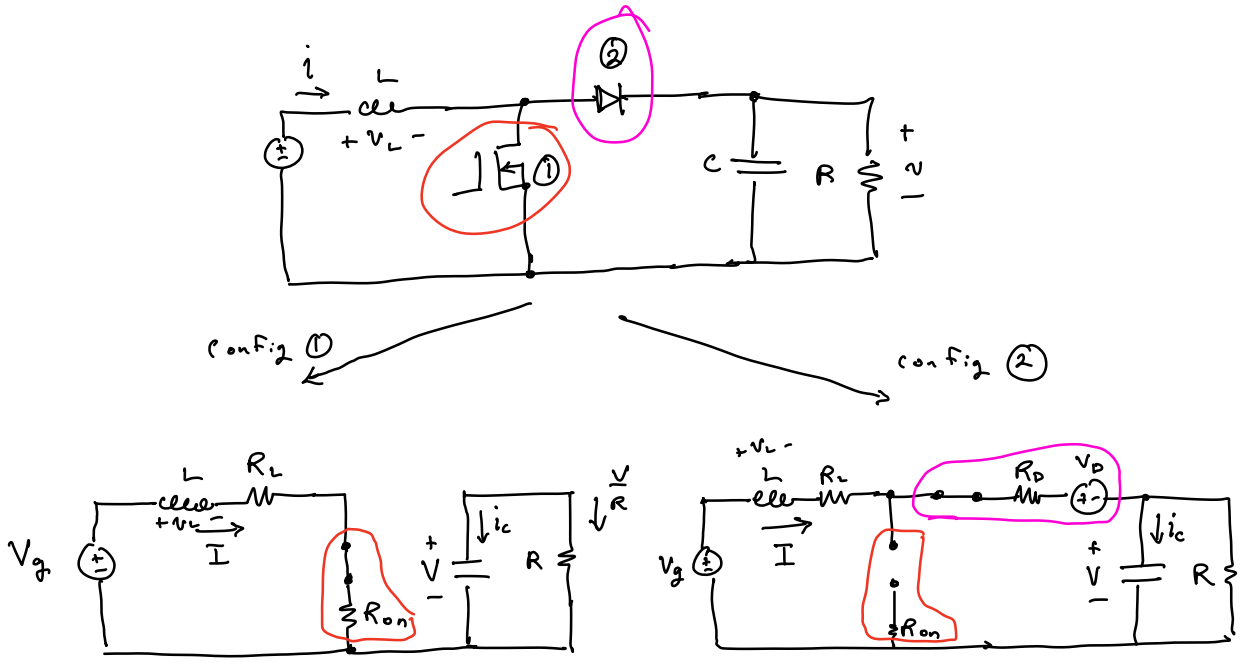

→ scale by $\frac{1}{M^2(D)}$

– Including Loss Mechanisms



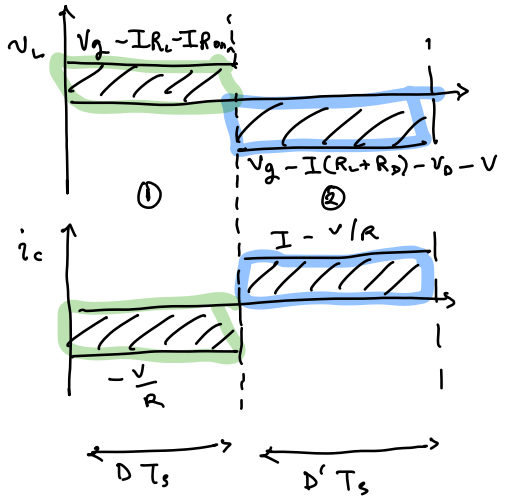
Repeat ch 2 w/ lossy elements above.

– Boost Convert Model w/ Losses



Goal is to compute V & I. 2 unknowns w/ 2 equations.

Look @ balance eqns



$$\langle v_L \rangle = 0 = D\left(V_g - I R_L - I R_{on}\right) + D'\left(V_g - I(R_L+R_D) - V_D - V\right) \quad (1)$$

$$\langle i_c \rangle = 0 = D\left(-\frac{V}{R}\right) + D'\left(I - \frac{V}{R}\right) \quad (2)$$

Clean up (1)

$$0 = V_g D - I R_L D - I R_{on} D + V_g - V_g D - I(R_L+R_D) + I(R_L+R_D)D - V_D + V_D D - V + VD$$

$$= V_g - I R_L - I R_{on} D - I R_D D' - V_D D' - V D' = 0 \quad (1')$$

↖ mimics a KVL loop

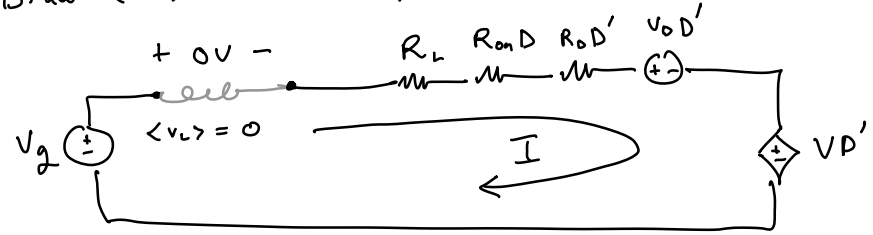
and (2)

$$0 = -\frac{V}{R} D + I D' - \frac{V}{R} + \frac{V}{R} D$$

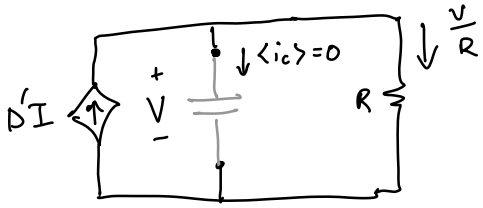
$$= I D' - \frac{V}{R} = 0 \quad (2')$$

↔ mimics KCL

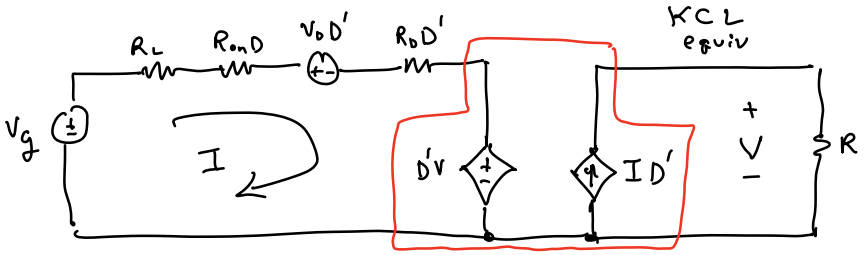
Draw (1') KVL loop

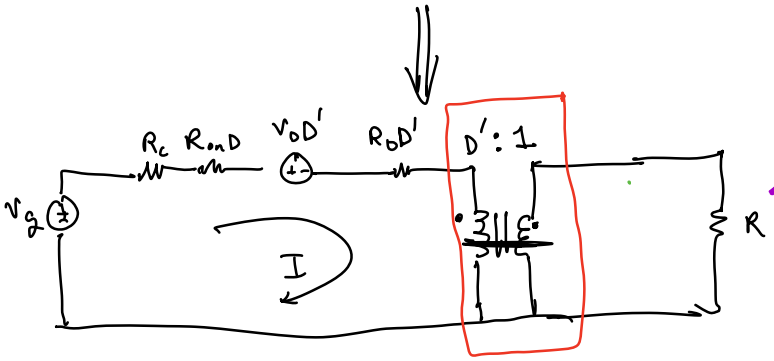


Draw (2') KCL



- Combine into 2 coupled ckts





Next, we will push R to LHS.

Can apply ckt tricks to solve this & get V, I