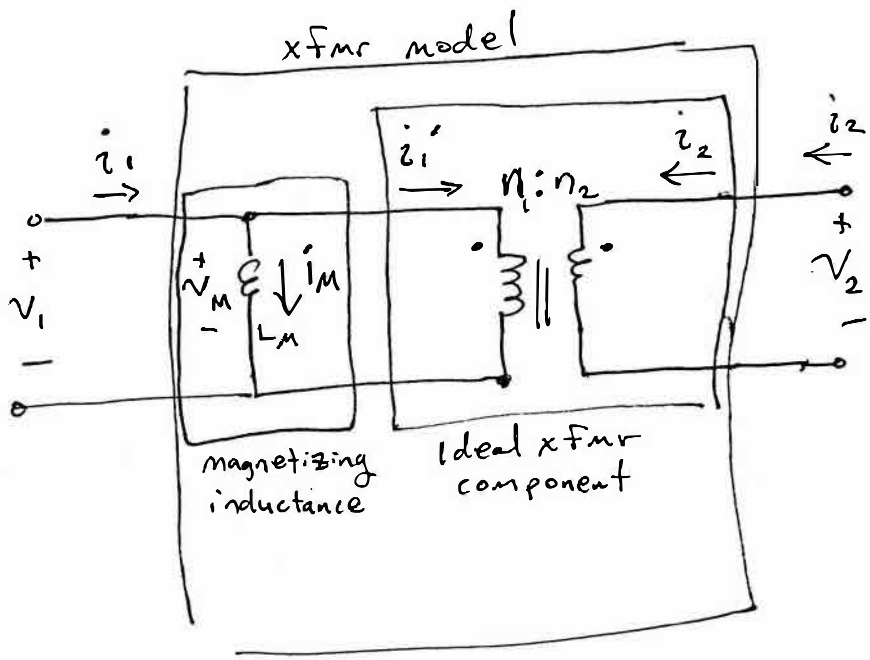
- Recap of the xfmr model

=> symbol

This is the symbol.
The model is below:



From notes in Lecture we know that

$$\frac{v_1}{n_1} = \frac{v_2}{n_2} \quad \leftarrow \text{voltage transformation expression} \qquad (1)$$

and

$$i_1' n_1 + i_2 n_2 = 0 \quad \leftarrow \text{current transformation expression} \qquad (2)$$

- <u>Sign conventions</u>: The dots on the ideal xfmr component of the model imply the following:

→ ⊕ terminal on a given winding coincides with the placement of the dot.

→ All currents in the ideal xfmr component flow into the dot when those currents are positive. In other words, positive current goes into the dot. For a given winding.

↳ Take a closer look @ eqn (2)

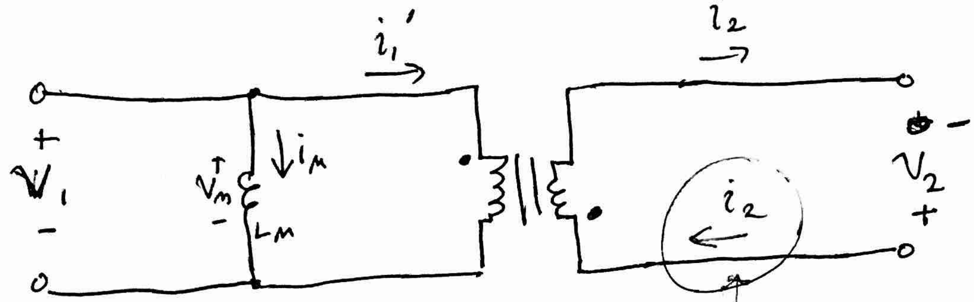
$$i_1' n_1 + i_2 n_2 = 0$$

$$\Rightarrow \quad i_2 = -\frac{i_1' n_1}{n_2} \qquad (3)$$

Reflecting on eqn (3), it is evident that if i_1' is ⊕ & flowing into the dot on the primary side, then i_2 is ⊖ which implies current flowing out of the dot on the secondary side. You must be careful & systematic with the sign conventions & ~~apply~~ use eqn (2) as your "golden rule" for current sign conventions.

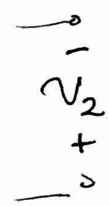
– Invert dot on secondary side:

The configuration below appears quite often in converters:



Following the sign conventions we get:

→ the polarity on V_2 flips so that its ⊕ terminal is on the bottom w/ the dot ⇒



→ i_2 flows into the secondary dot, so it too flips direction ⇒

• Both eqns (1)–(2) are "golden rules" and are not violated.

→ (1) implies a ⊕ v_1 induces a value of v_2 ~~wha~~ with the polarity in the new diagram above.

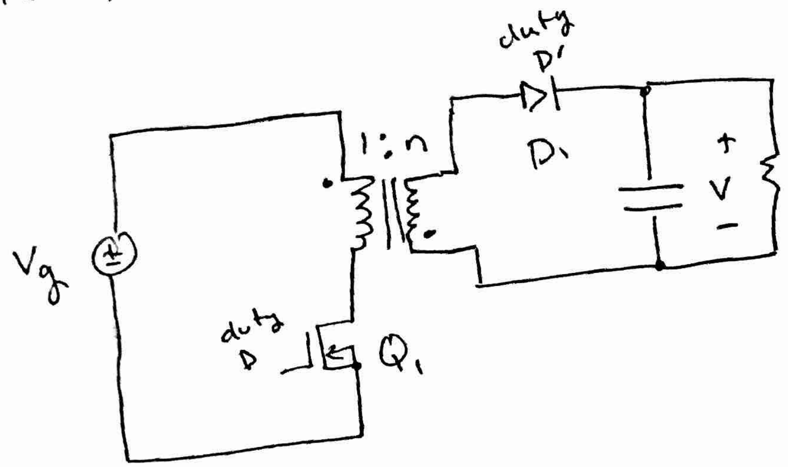
→ (2) ~~implies~~ and (3) ~~both imply~~ are unchanged & imply

$$i_2 = -i_1' \frac{n_1}{n_2}$$

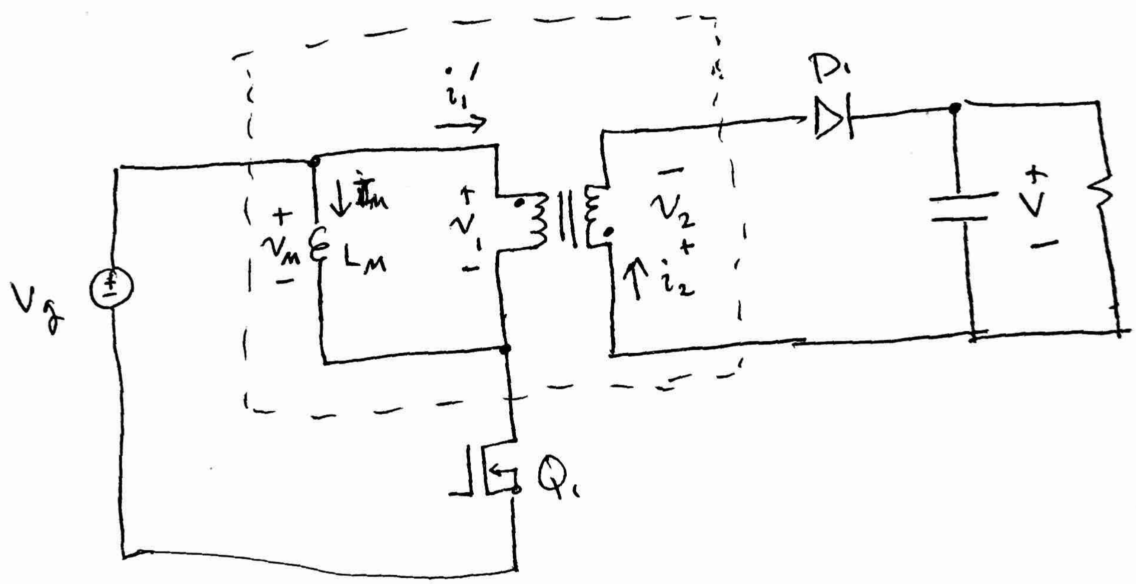
that a ⊕ i_1' induces a ⊖ value of i_2 according to the polarity drawn above. Only the drawing polarities change & the equations stay the same. Hence current will flow out of the secondary dot & hence out of the $+V_2$ terminal

– Revisit Flyback in more detail

The symbol of the ideal Flyback is:



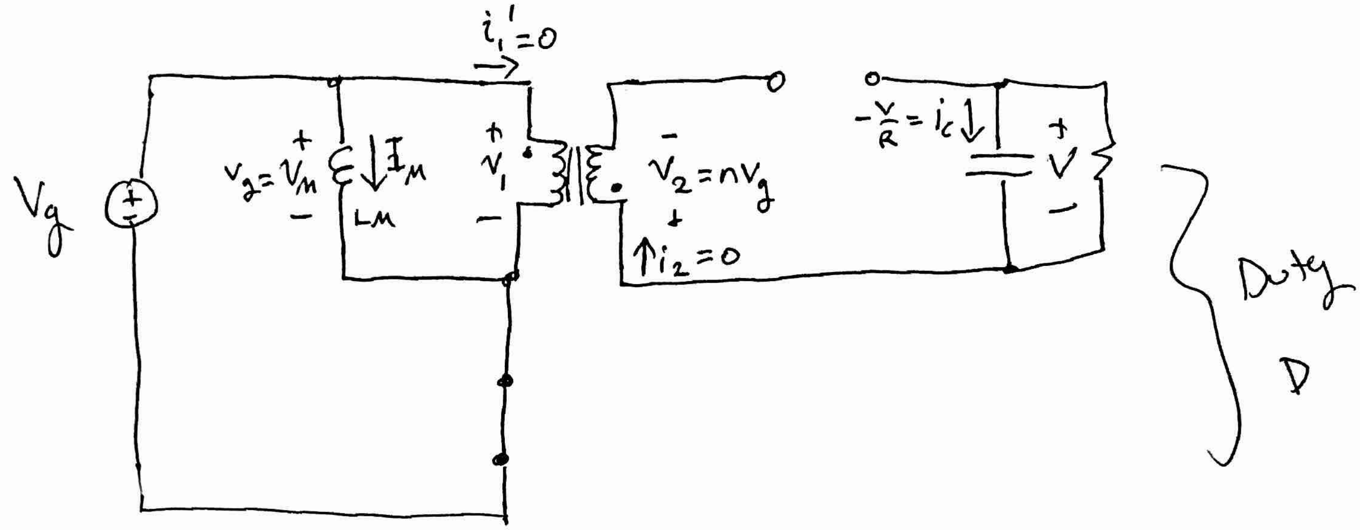
Now add the xfmr model



~~Now lets look @~~

- when adding the xfmr model, I was very careful to obey the dot sign convention rules.
- Now lets look @ both possible ckt configurations.
- Use the SRA, and assume dc magnetizing current I_M & dc output voltage V.

— Configuration #1: Q_1 on, D_1 diode off



• According to the current equation (2) golden rule

$$i_1' + n\cancel{i_2}^{\,0} = 0$$

Since $i_2 = 0$ due to the secondary side open ckt, then i_1' must also be zero.

$$\Rightarrow i_1' = i_2 = 0$$

• According to the voltage equation (1), we know

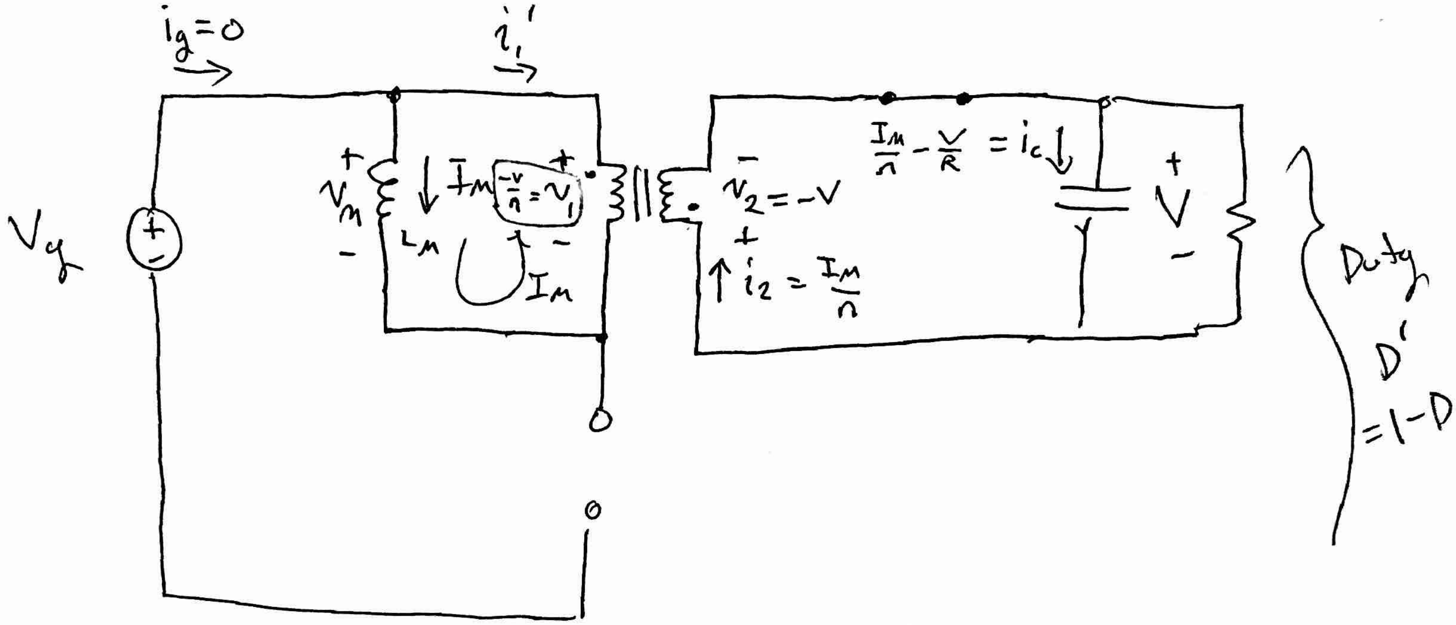
$$v_1 = \frac{v_2}{n}$$

$$\Rightarrow v_2 = nv_1 = nv_g$$

• Now look @ v_m & i_c to analyze voltsecond & charge equations

$$\underbrace{v_m = V_g, \quad i_c = -\frac{V}{R}}_{\text{save for later}} \quad (4)$$

Configuration #2: Q_1 off, D_1 diode ON



- In this configuration, the magnetizing dc current I_M has nowhere to go except into the ideal xfmr winding. Hence $i_1' = -I_M$ & I_M flows in a loop through the primary windings.
- Always check the "golden rule" for xfmr currents in (2). We get

$$i_1' + n i_2 = \overbrace{(-I_M)}^{i_1'} + n i_2 = 0$$

$$\rightarrow \quad i_2 = \frac{I_M}{n}$$

- Voltage also has its golden rule in (1). We get

$$v_1 = \frac{v_2}{n} = \frac{(-V)}{n}$$

- Now look @ v_M & i_c again

$$v_M = v_1 = \frac{-V}{n} \quad \& \quad i_c = i_2 - \frac{V}{R} = \frac{I_M}{n} - \frac{V}{R} \qquad (5)$$

- Balance equations in steady state

Now look @ voltsecond & charge balance equations using (4)-(5)

$$\langle v_M \rangle = 0 = D(V_g) + D'\left(-\frac{V}{n}\right) \qquad (6)$$

&

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

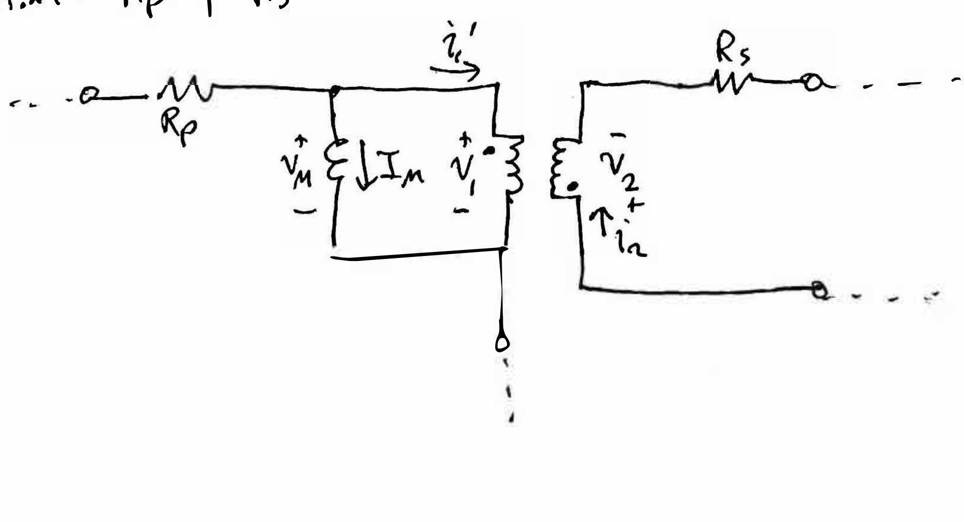
$$= -\frac{V}{R} + D'\frac{I_M}{n} \qquad (7)$$

Eqn (6) gives us M:

$$M = \frac{V}{V_g} = n\frac{D}{D'} = \boxed{n\frac{D}{1-D} = M}$$

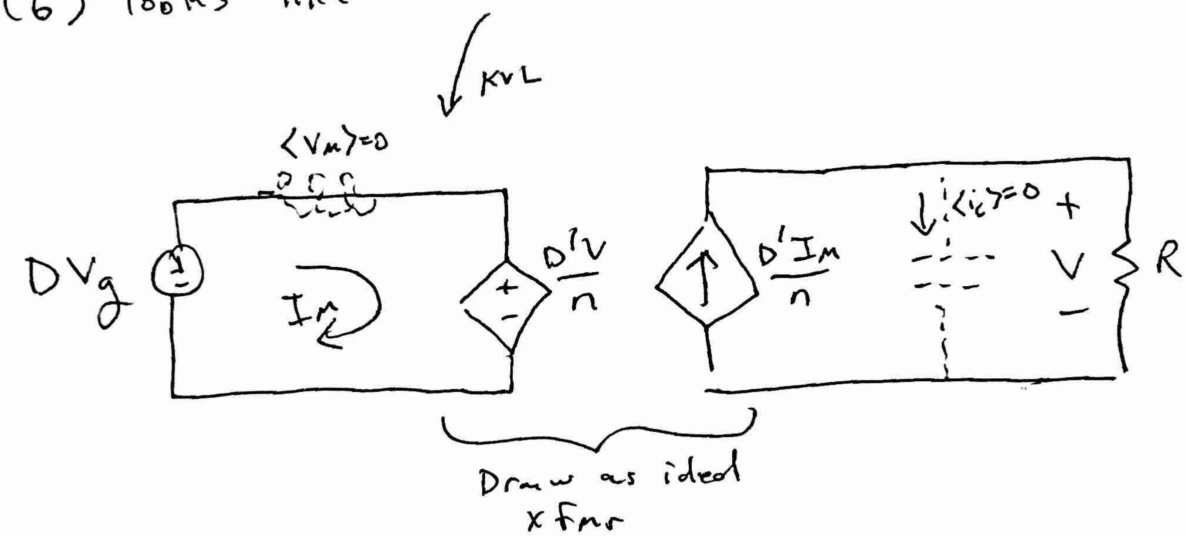
- Now you have enough information to do HW5. All you need to do is add the on resistance R_{on}, primary & secondary winding resistances R_p & R_s, & diode drop V_F. Then repeat the analysis.

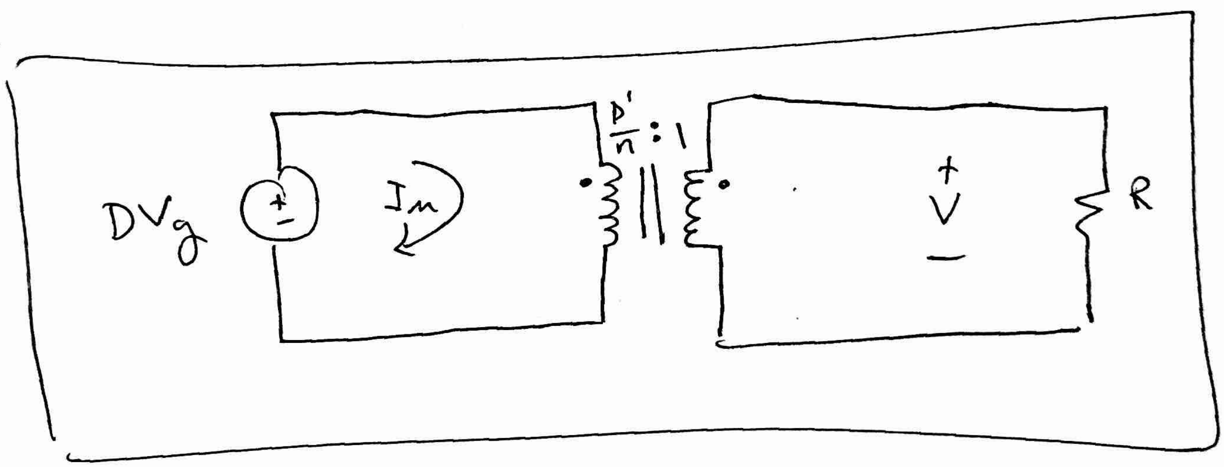
Hint: R_p & R_s are added to the xfmr as shown below



One last hint: the equiv ckt model.

- (6) looks like a KVL loop & (7) is KCL.





Equiv ckt model.