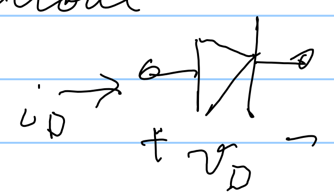
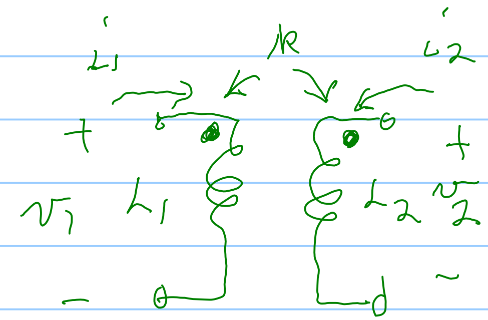
Note Title 2/3/2016

EE307
02/03/16

actual diode





$$Z(s) = sL = s\begin{bmatrix} L_1 & k\sqrt{L_1L_2} \\ k\sqrt{L_1L_2} & L_2 \end{bmatrix}$$

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = Z(s)\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} \qquad |k| \leq 1$$

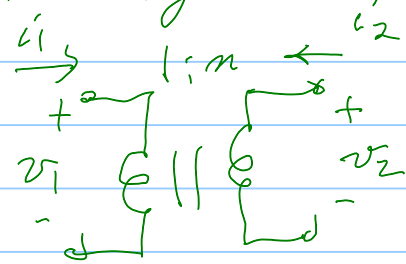
$$\det L = L_1L_2 - k^2 L_1L_2 = L_1L_2(1-k^2)$$

$$Y(s) = Z^{-1}(s) = \frac{1}{\det L}\begin{bmatrix} L_2 & -k\sqrt{L_1L_2} \\ -k\sqrt{L_1L_2} & L_1 \end{bmatrix}$$

This has trouble if $|k|=1$

no $Y(s)$ exists

ideal transformer



$v_2 = n v_1 \Rightarrow VCVS \Rightarrow E$

$i_1 = -n i_2 \Rightarrow CCCS \Rightarrow F$

$P_{in} = -P_{out} \Rightarrow P_{in} = v_1 i_1, \quad P_{out} = v_2 i_2$

$v_1 i_1 + v_2 i_2 = 0 \Rightarrow v_2 = n v_1$

$v_1 i_1 + n v_1 i_2 = 0 \Rightarrow i_1 = -n i_2$

To relate to coupled coils set $i_2 = 0$ & measure $v_2 = n v_1$

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = s \begin{bmatrix} L_1 & k\sqrt{L_1 L_2} \\ k\sqrt{L_1 L_2} & L_2 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} \Rightarrow v = Z(s)\, i$$

if $i_2 = 0 \Rightarrow v_2 = n v_1$

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = s \begin{bmatrix} L_1 \\ k\sqrt{L_1 L_2} \end{bmatrix} \begin{bmatrix} i_1 \end{bmatrix}$$

$$\frac{v_1}{v_2} = \frac{s L_1 i_1}{s k\sqrt{L_1 L_2}\, i_1} = \frac{L_1}{k\sqrt{L_1 L_2}} = \frac{1}{k}\sqrt{\frac{L_1}{L_2}} =$$

$$v_2 = k\sqrt{\frac{L_2}{L_1}} \cdot v_1 \qquad n = k\sqrt{\frac{L_2}{L_1}}$$

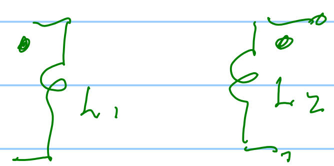
$k \approx 0.999..$ for iron cores

$$n \approx \sqrt{\frac{L_2}{L_1}}$$

also desire $i_1 = -n i_2$ let's set $v_2 = 0$

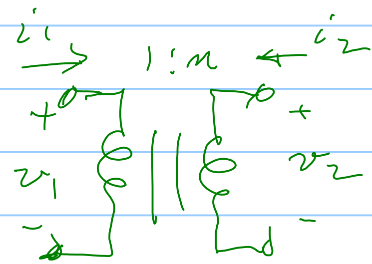
$$0 = k\sqrt{L_1 L_2}\, i_1 + L_2 i_2 \Rightarrow i_1 = -\frac{L_2}{k\sqrt{L_1 L_2}}\, i_2 \Rightarrow -n = -\frac{\sqrt{L_2/L_1}}{k} \approx -\sqrt{\frac{L_2}{L_1}}$$

K in spice gives the coupling coeff ≈ 1

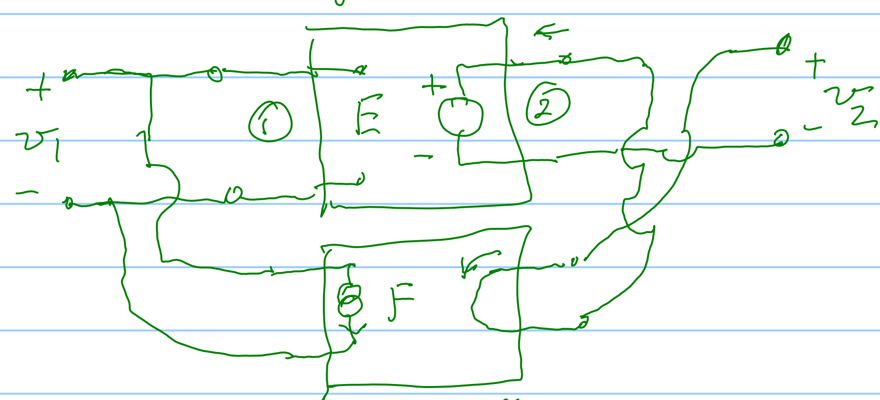


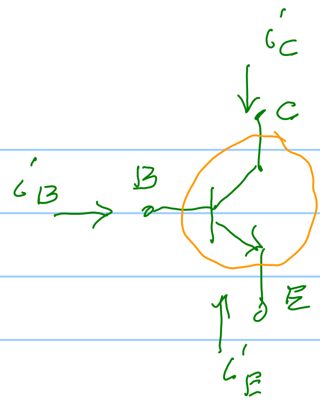
choose $\sqrt{\frac{L_2}{L_1}} = n$

$L_2 = n^2 L_1$ choose $L_1 \approx 10\,\mu H$



$v_2 = n v_1$, $i_1 = -n i_2$





npn
BJT

KCL $\Rightarrow 0 = i_B + i_E + i_C \Rightarrow i_E = -(i_B + i_C)$

if $i_C = \beta i_B$ $\quad i_E = -(\beta+1) i_B$