Transformers

Ideal Transformer

$k = 1$ (still) + inductances are "very large"

Recall: Inductors + Transformers cannot have DC voltage applied

- $V = \frac{dL}{dt} \rightarrow i = \int V dt \rightarrow$ DC voltage causes current to ramp up

- $V = \frac{d\Phi}{dt}, \Phi \gg \Phi_0 \rightarrow$ only get signal when $\frac{d\Phi}{dt} \neq 0$

- Materials: if using core material, cores "saturate" at high $I$
  permeability, $\mu \rightarrow 1 \rightarrow L_x$ to drop $\propto k$ drops drastically

with "large" inductances $E = \frac{1}{2} L_0 i^2 = \frac{1}{2} L_0 \left( \frac{1}{t_o} \int \dot{V} dt \right)^2 = \frac{1}{2} \frac{1}{t_o} \left( \dot{J} dt \right)^2$

- Transformer has zero energy stored (as long as $V \leq \Delta$)

\[ V_1 = \frac{N_1}{N_2} V_2 \]

\[ i_1 \frac{N_1}{N_2} + i_2 \frac{N_2}{N_3} = \phi \]
Transformer Uses

• ac voltage conversion
• impedance matching
• galvanic isolation
• common mode choke

Applications of Coupled Inductors
Transformer Design

I & E Sections inverted on alternate layers
"I" Section
"E" Section
Each individual lamina insulated with lacquer or metal oxide.

Former
Secondaries
Primary
Laminated soft iron core clamped with bolts
Insulating cover

https://www.altrancorp.com/products/toroidal-power-transformers/

Transformer Reflection

\[ \frac{v_1}{1} = \frac{v_2}{N} \quad , \quad v_2 = Nv_c \]

\[ \frac{1}{i_1} + Ni_2 = 0 \quad , \quad i_2 = i_{ac} \]

\[ i_1 = -Ni_{ac} \]
Example Circuit Simplification