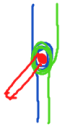
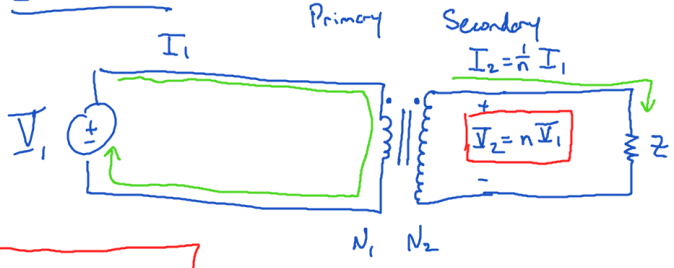
Transformers

- Intution ✓
- Uses – Impedance Matching ✓
  – Power Distribution ✓

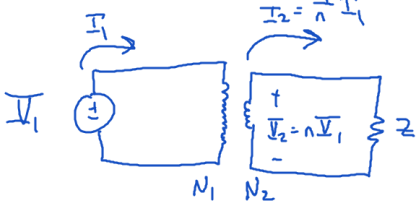


Intution = SSS

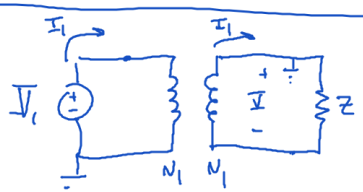


$n = \frac{N_2}{N_1}$

Rules for ideal transformer
- $V_2 = nV_1$
- $I_2 = \frac{1}{n} I_1$
- only SSS



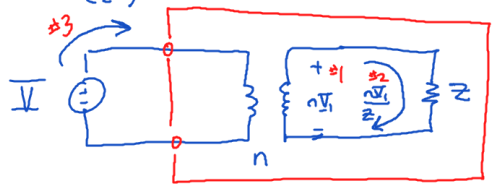
$n = \frac{N_2}{N_1}$

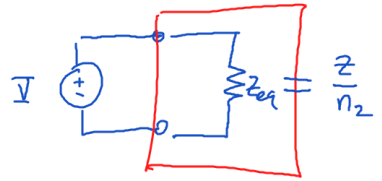


$n = 1$

Thevenin Equivalent = math

$I = n\left(\frac{nV_1}{Z}\right)$



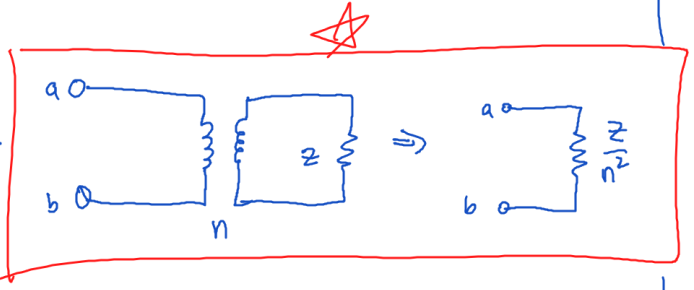


$Z_{eq} = \frac{V}{I}$

$= \frac{V}{n\left(\frac{nV}{Z}\right)}$

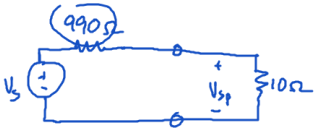
$= \frac{1}{n^2/Z}$

$= \frac{Z}{n^2}$



So what? Impedance Matching

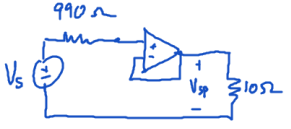
Design #1



$P_{sp} = V_{sp} \cdot I_{sp}$

$= \left(V_s \frac{10}{1000}\right)\left(\frac{V_s}{1000}\right) = \frac{V_s^2}{100{,}000}$

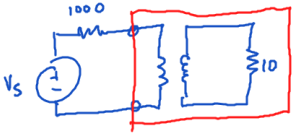
Design #2



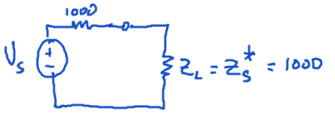
$P_{sp} = V_{sp} \cdot I_{sp}$

$= \left(V_s\right) \cdot \left(\frac{V_s}{10}\right) = \frac{V_s^2}{10}$

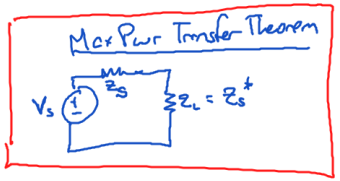
Design #3



$P_L = I_L \cdot V_L$



Max Pwr Transfer Theorem



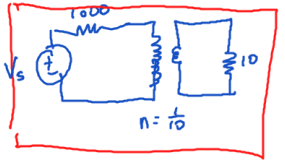
$\frac{Z_{on}}{n^2} = Z_{desired}$

$\frac{10}{n^2} = 1000$

$10 = 1000\, n^2$

$n^2 = \frac{1}{100}$

$n = \frac{1}{10}$



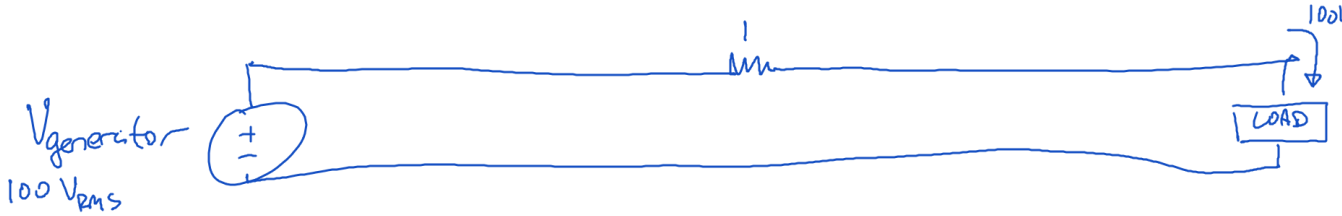
$P_{sp} = I_{sp} \cdot V_{sp}$

$= \left(\frac{V_s}{2000}\right)\left(\frac{V_s}{2}\right)$

$= \frac{V_s^2}{4000}$

ex $\begin{cases} N_1 = 1000 \\ N_2 = 100 \end{cases}$

Power Distribution

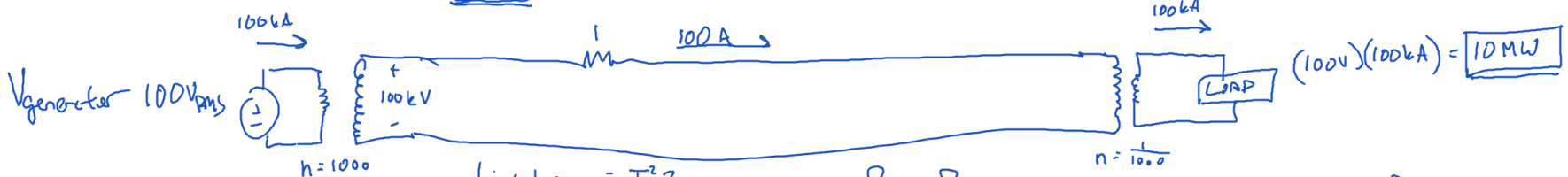


$(100V)(100kA) = 10000kW$

$= \boxed{10MW}$

$$\text{Line loss} = P_{1\Omega}$$
$$= I \cdot V_{1\Omega}$$
$$= I(I \cdot Z_L)$$
$$= I^2 Z$$
$$= (100k)^2 (1)$$
$$= 10000M$$
$$= \boxed{10GW}$$

$$\text{Efficiency} = \frac{P_{OUT}}{P_{IN}} = \frac{P_{LOAD}}{P_{LINE} + P_{LOAD}} = \frac{10M}{10M + 10G} = \frac{10M}{10.01G} \approx 0.1\%$$



$(100V)(100kA) = \boxed{10MW}$

$$\text{Line loss} = I^2 Z$$
$$= (100)^2$$
$$= \boxed{10kW}$$

$$\text{Eff.} = \frac{P_{OUT}}{P_{IN}} = \frac{P_{LOAD}}{P_{LINE} + P_{LOAD}} = \frac{10M}{10M + 10k} = \frac{10M}{10.01M} \approx 99.9\%$$