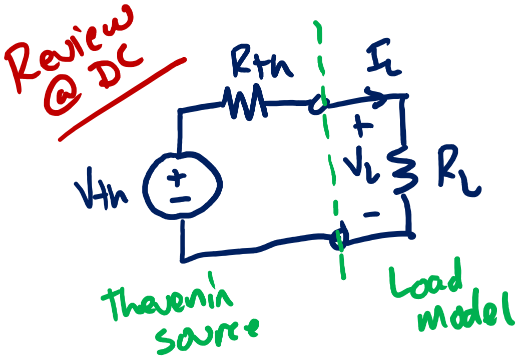
Maximum Power Transfer



What value of R_L results in maximum power $P_L = V_L \cdot I_L$

Answer: $R_L = R_{th}$

$$P_L = \left(V_{th}\frac{R_L}{R_{th}+R_L}\right)\left(\frac{V_{th}}{R_{th}+R_L}\right) = V_{th}^2 \frac{R_L}{(R_L+R_{th})^2}$$

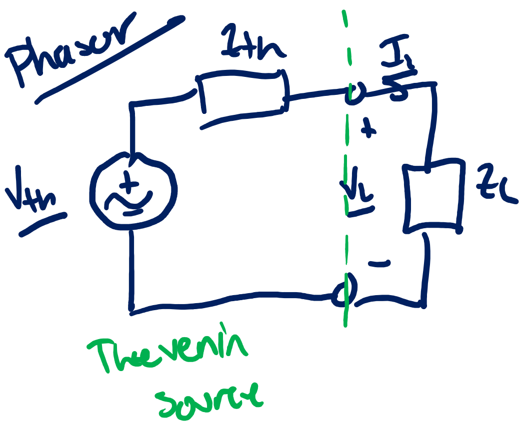
$$\frac{\partial P_L}{\partial R_L} = \phi = V_{th}^2 \left[\frac{1}{(R_L+R_{th})^2} + \frac{R_L(-2)}{(R_L+R_{th})^3}\right]$$

Numerator only: $R_L + R_{th} - 2R_L = \phi$

$$\boxed{R_L = R_{th}}$$

What value of R_{th} gives maximum power to a fixed R_L?

$$\boxed{R_{th} = \phi}$$



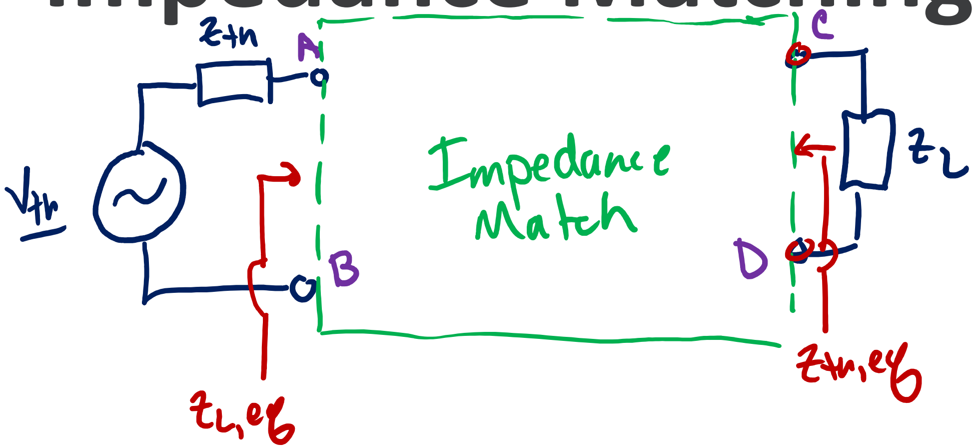
What value of Z_L results in maximum $P_L = \frac{1}{2} Re\{\underline{V_L}\, \underline{I_L}^*\}$

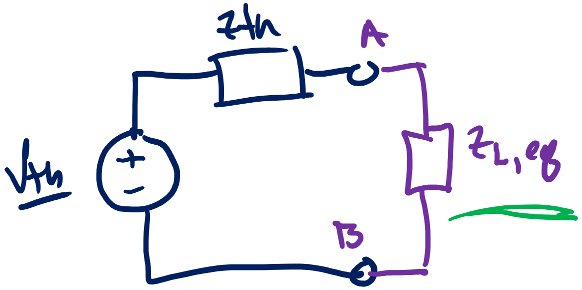
Cancel out imaginary & set real parts equal

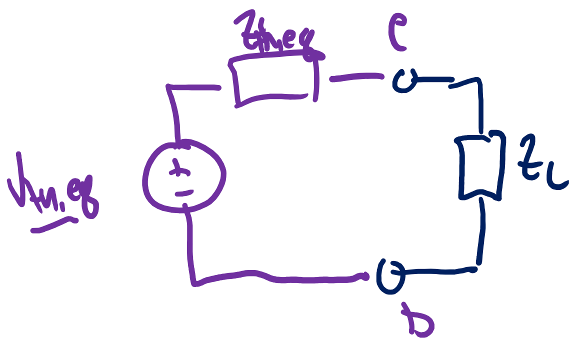
$$Z_L = Re\{Z_{th}\} - Im\{Z_{th}\}$$

$$\boxed{Z_L = Z_{th}^*}$$

Impedance Matching



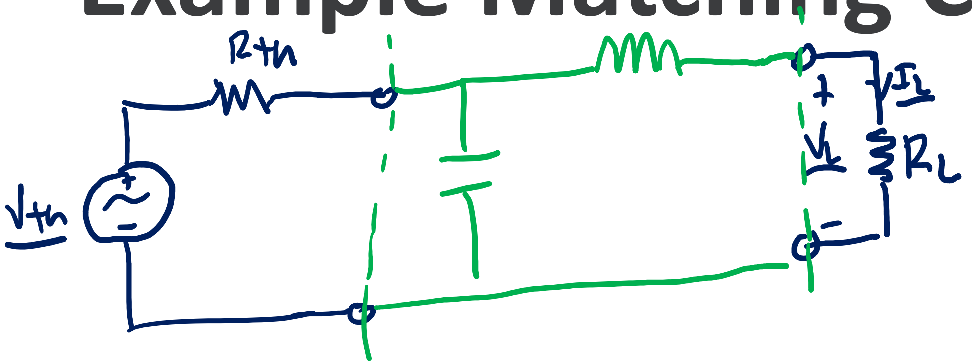




Impedance Matching Goals

- Maximize power to Z_L $\left(Z_L = Z_{th,eq}^*\right)$
- Minimize distortion $\left(Z_L = Z_{th,eq}\right)$
- Maximize efficiency $\left(Re\{Z_L\} >> Re\{Z_{th,eq}\}\right)$
- Minimize Q $\left(Im\{Z_{L,eq}\} = \emptyset\right)$

Example Matching Circuits



$R_{th} > R_L$

with no matching network

$P_L < P_{L,max}$