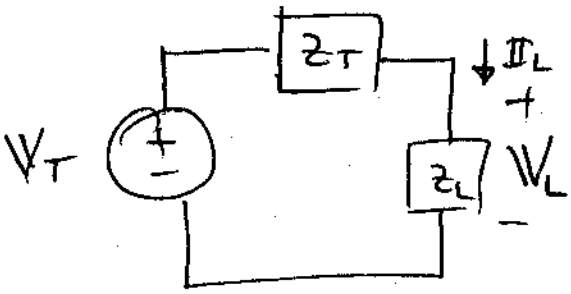
# Max power in AC steady state:




$$\mathbb{I}_L = \frac{\mathbb{V}_T}{Z_T + Z_T^*} = \frac{\mathbb{V}_T}{2\,\mathrm{Re}\{Z_T\}}$$

$$\mathbb{V}_L = \frac{Z_T^*}{Z_T^* + Z_T}\,\mathbb{V}_T = \frac{Z_T^*}{2\,\mathrm{Re}\{Z_T\}}\,\mathbb{V}_T$$

Set $Z_L = Z_T^*$

(NOTE: $\mathbb{V}_L$, $\mathbb{I}_L$ are RMS quantities)

$$S_{max} = \mathbb{V}_L\,\mathbb{I}_L^* = \left[\frac{Z_T^*}{2\,\mathrm{Re}\{Z_T\}}\,\mathbb{V}_T\right]\cdot\left[\frac{\mathbb{V}_T}{2\,\mathrm{Re}\{Z_T\}}\right]^*$$

$$S_{max} = \frac{Z_T^*\,|\mathbb{V}_T|^2}{4\,\mathrm{Re}\{Z_T\}^2} = \frac{\left(\mathrm{Re}\{Z_T\} - j\,\mathrm{Im}\{Z_T\}\right)|\mathbb{V}_T|^2}{4\,\mathrm{Re}\{Z_T\}^2}$$

$$P_{max} = \mathrm{Re}\{S_{max}\}$$

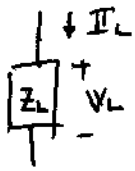
$$= \frac{\mathrm{Re}\{Z_T\}\,|\mathbb{V}_T|^2}{4\,\mathrm{Re}\{Z_T\}^2}$$

$$P_{max} = \frac{|\mathbb{V}_T|^2}{4\,\mathrm{Re}\{Z_T\}} = \frac{\left|\frac{\mathbb{V}_T}{\sqrt{2}}\right|^2}{4\,\mathrm{Re}\{Z_T\}} = \frac{|\mathbb{V}_T|^2}{8\,\mathrm{Re}\{Z_T\}}$$

($|\mathbb{V}_T|$: RMS; $\left|\frac{\mathbb{V}_T}{\sqrt{2}}\right|$: peak; $|\mathbb{V}_T|$: peak)

OVER

* In general:

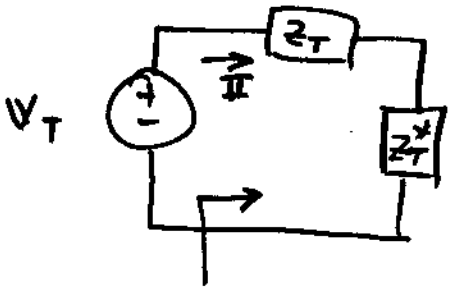



$$P = |\mathbb{V}_L| \cdot |\mathbb{I}_L| \cos\theta$$

($|\mathbb{V}_L|$, $|\mathbb{I}_L|$: RMS)

$\theta$: phase of voltage waveform minus phase of current waveform (phase difference)

# Max power (easier way!)




① Find impedance seen by source $(= 2\mathrm{Re}\{Z_T\})$

② Observe that ½ the power delivered by $V_T$ makes it to the load

③ Write expression for power delivered by $V_T$ & ÷ by 2:

$$S_{max} = \frac{V_T I^*}{2} = \frac{V_T}{2}\left(\frac{V_T}{2\mathrm{Re}\{Z_T\}}\right)^*$$

$$\Rightarrow S_{max} = \frac{|V_T|^2}{4\mathrm{Re}\{Z_T\}}$$

this is always a pure real #, so it must be $P_{max}$

$$\Rightarrow \boxed{P_{max} = \frac{|V_{T_{RMS}}|^2}{4\mathrm{Re}\{Z_T\}}}$$