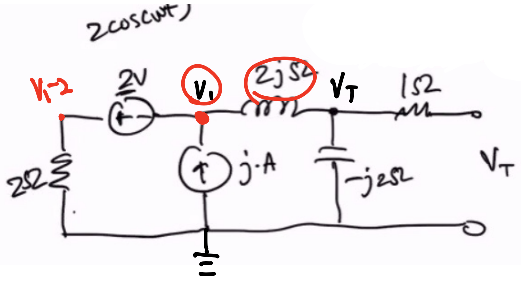
for impedance Network.

Node voltage and loop current method to find open-ckt voltage and short-ckt current



apply KCL to the V_1 node

$$\frac{V_1+2}{2}+\frac{V_1-V_T}{2j}=j$$

apply KCL to V_T node

$$\frac{V_T}{-2j}+\frac{V_T-V_1}{2j}=0$$

$V_1 = 0$ ↳ virtual gnd

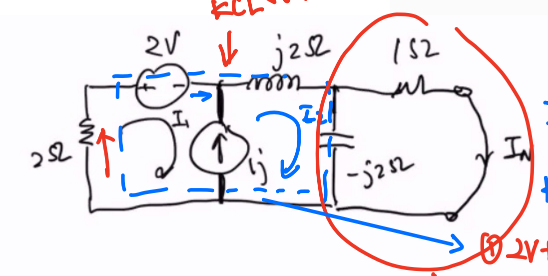
$$1+\frac{V_T}{2j}=1j$$

$$\Rightarrow 1-j=\frac{V_T}{2j}$$

$$V_T = 2j(1-j)$$

$$= 2+2j\ V$$

KCL to this node



$I_2 = I_1 + 1j$

KVL for superloop

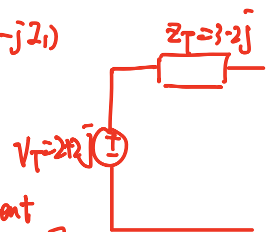
① $2V + 2j(I_1+j) + (-2j)\cdot(I_1+j-I_N) + 2I_1 = 0$

② $1\cdot I_N + (-2j)[I_N-(I_1+j)] = 0$

↳ $I_N(1-2j) = 2(1-jI_1)$

$$I_N = \frac{2+j2}{3-j2}\ A$$

$$Z_T = \frac{V_T}{I_N} = 3-2j\ \Omega$$



Thevein equivalent

Average power

$P = V \cdot I$

$p(t) = v(t) \cdot i(t)$ → function of t

Instantaneous power

power at a particular time

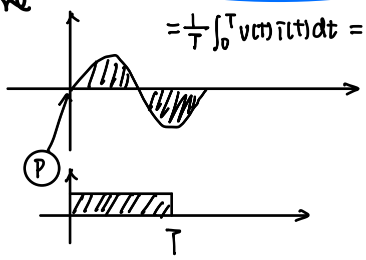
co-sinusoidal → steady-state

power absorbed by a ckt element

by -average.

$$P = \frac{1}{T}\int_0^T v(t)\cdot i(t)\,dt$$

$$= \frac{1}{T}\int_0^T v(t)\,i(t)\,dt = \frac{1}{T}\int_0^T |V|\cos(wt+\theta)\times|I|\cdot\cos(wt+\phi)\,dt$$



$p(t) = v(t)\cdot i(t)$

$= Re\{Ve^{jwt}\}\cdot Re\{Ie^{jwt}\}$

$= \frac{Ve^{jwt}+V^*e^{-jwt}}{2}\;\frac{Ie^{jwt}+I^*e^{-jwt}}{2}$

$= \frac{VIe^{j2wt}+V^*I^*e^{-j2wt}+V^*I+VI^*}{4}$

$= \frac{VI^*+V^*I}{4} + \frac{VIe^{j2wt}+V^*I^*e^{-j2wt}}{4}$

$= \frac{C+C^*}{4} + \frac{D+D^*}{4}$

$\boxed{= \frac{1}{2}Re\{C\} + \frac{1}{2}Re\{D\}}$

* $(C\cdot D)^* = C^*\cdot D^*$

$(VI^*)^* = V^*I$

$C = VI^*$
$D = VIe^{j2wt}$

$p(t) = \frac{1}{2}Re\{V\cdot I^*\} + \frac{1}{2}\{V\cdot I\cdot e^{j2wt}\}$

$T = \frac{1}{2}T \quad w = 2w$

Part 2

$p(t) = v(t)\cdot i(t) = \frac{1}{2}Re\{V\cdot I^*\} + \frac{1}{2}Re\{V\cdot I\,e^{j2wt}\}$

average pwr over time:

$$P = \frac{1}{T}\int_0^T p(t)\,dt = \frac{1}{T}\int_0^T \underbrace{\frac{1}{2}Re\{V\cdot I^*\}}_{\text{const.}}dt + \frac{1}{T}\int_0^T Re\{VI\,e^{j2wt}\}\,dt$$

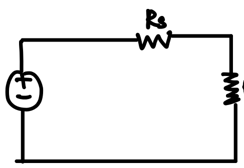
$\Leftrightarrow \frac{1}{2}Re\{V\cdot I^*\}$

$|V|\cdot|I|\cos(2wt+\theta+\phi)$ → 0

* $\Rightarrow P = \frac{1}{2}Re\{V\cdot I^*\}$

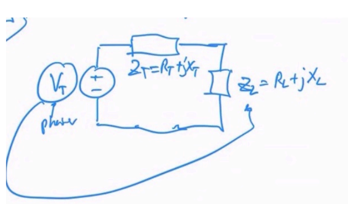
Average power.

Availible Power



$R_L = R_S$

$R_L \Rightarrow$ Resistor only



$V_L = I_L \cdot Z_L$

$= \frac{V_T}{Z_T+Z_L}\cdot Z_L$

* $c\cdot c^* = |c|^2$

$Z_L = R_L + jX_L$

$P = \frac{1}{2}Re\{V_L\cdot I_L^*\}$

$$= \frac{1}{2}Re\left\{\frac{V_T Z_L}{Z_L+Z_T}\cdot\frac{V_T^*}{(Z_L+Z_T)^*}\right\} = \frac{1}{2}Re\left\{\frac{|V_T|^2\cdot Z_L}{|Z_L+Z_T|^2}\right\} = \frac{1}{2}Re\left\{\frac{|V_T|^2 R_L + j|V_T|^2 X_L}{|Z_L+Z_T|^2}\right\}$$

$|a+jb|^2 = a^2+b^2$ *

$$P=\frac{1}{2}\frac{|V_T|^2 R_L}{|(R_T+R_L)+j(X_T+X_L)|^2}$$

$\Downarrow 0 \Rightarrow X_T=-X_L$

$$\Leftrightarrow P=\frac{1}{2}\frac{|V_T|^2 R_L}{(R_T+R_L)^2} \Rightarrow R_T=R_L$$

$$\Rightarrow P_{avm}=\frac{|V_T|^2 R_L}{4R_L^2}=\frac{V_T^2}{4R}$$

$$=\frac{1}{2}\frac{|V_T|^2 R_L}{|Z_L+Z_T|^2}$$

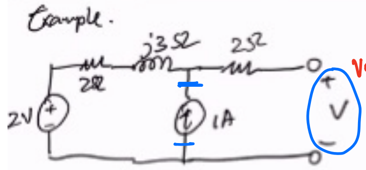
$$P=\frac{1}{2}\frac{|V_T|^2 R_L}{|Z_L+Z_T|^2}$$

Find the condition under which pwr of the load maximized.

... and load.

$$\begin{cases} R_T=R_L \\ X_T=-X_L \end{cases} \Rightarrow Z_T=Z_L^*$$

Example.



Open ckt V_T

Voltage convert.

$V_T = 2+1(2+3j)$ → Norton

$= 4+3j\,V$

super position by turning on sources one at a time.

$Z_T = 2+2+3j = 4+3j$

$\Rightarrow Z_L = 4-3j \quad P_{avai}=\frac{|V_T|^2}{8R_T}=\frac{4^2+3^2}{8\cdot 4}$

$=\frac{25}{32}W$