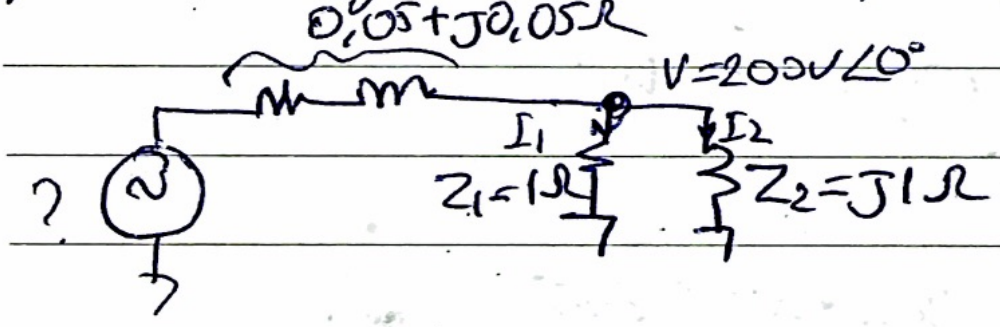
Exercises

AC Systems

Two loads $Z_1 = 1\,\Omega$ (purely resistive) and $Z_2 = (J1\,\Omega)$ purely inductive are connected across a source through a transmission line with an impedance of $Z_{line} = 0{,}05 + J0{,}05\,\Omega$

If the voltage of the loads is 200Vrms, find the voltage, current and complex power of the source.



$\vec{I}_1 = 200A\angle 0°$

$\vec{I}_2 = 200A\angle -90°$

$\vec{I}_1 + \vec{I}_2 = 200\sqrt{2}\angle -45°$

or $Z_1 // Z_2 = 1 // J1 = 0{,}5 + J0{,}5 \Rightarrow \dot{I}_L = \frac{200}{0{,}5 + J0{,}5} = 200\sqrt{2}\angle -45°$

$\frac{J1}{(1+J)(1-J)} = \frac{J+1}{2}$

$\Rightarrow 200 - J200A$

Real power is only consumed by resistive elements $\Rightarrow P_{Z1} = \frac{V^2}{R} = \frac{200^2}{1} = 40kW$

Reactive power is ~~"exchanged"~~ "consumed" by inductive elements $Q_{Z1} = \frac{V^2}{X(Z)} = 40kVAR$

formal way

$S_L = V_L \cdot I_L^* = 200(200 + J200) = 40kW + J\,40kVAR$

consumed by Z_1 — exchanged by Z_2

Source voltage:

$$V_S = \vec{V}_L + Z_{line} \cdot \vec{I}_L$$

$$= 200\angle 0^\circ + \underbrace{(0{,}05 + j0{,}05)}_{\sqrt{2}\cdot 0{,}05\angle 45^\circ} \cdot 200\sqrt{2}\angle -45^\circ$$

$$= 200 + 20 = 220\,V$$

$$200 + (0{,}05 + j0{,}05) \cdot (200 - 200j)$$

$$200 + 10 - 10j + 10j + 0$$

$$= 220\,V$$

$$S_{source} = V_S I_S^* = 200 \times 200\sqrt{2}\angle 45^\circ$$

$$= \underbrace{4kW + j4kVAR}$$

$+4kW$
$+4kVAR$ } for the transmission line.