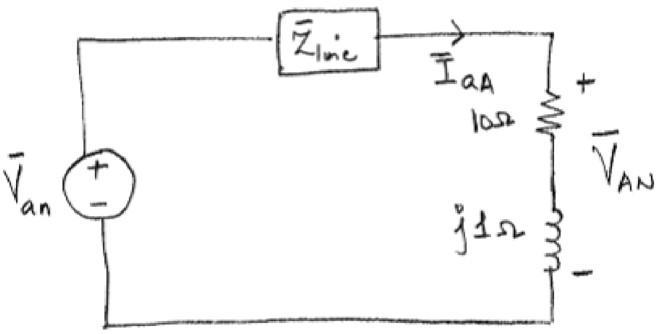
EENG224 HOMEWORK II

1.

In a balanced three phase wye-wye sytem the load impedance is 10 + 1*j* Ω. The source has phase sequence abc and the line voltage $V_{ab} = 220\angle 30^\circ\ V_{rms}$. If the load voltage $V_{AN} = 120\angle 0^\circ\ V_{rms}$, determine the line impedance.

Soln.:



$$\bar{Z}_{load} = 10 + j1\,\Omega$$

$$\bar{V}_{ab} = 220\angle 30^\circ\ V\,rms$$

$$\bar{V}_{AN} = 120\angle 0^\circ\ V\,rms$$

$$\bar{V}_{an} = \frac{220}{\sqrt{3}}\angle 30^\circ - 30^\circ$$

$$\bar{V}_{an} = 127\angle 0^\circ\ V\,rms$$

$$\bar{I}_{aA} = \frac{120\angle 0^\circ}{10+j1} = 11.94\angle -5.71^\circ\ A\,rms$$

$$\text{KVL:}\quad \bar{V}_{an} = \bar{I}_{aA}\bar{Z}_{line} + \bar{V}_{AN}$$

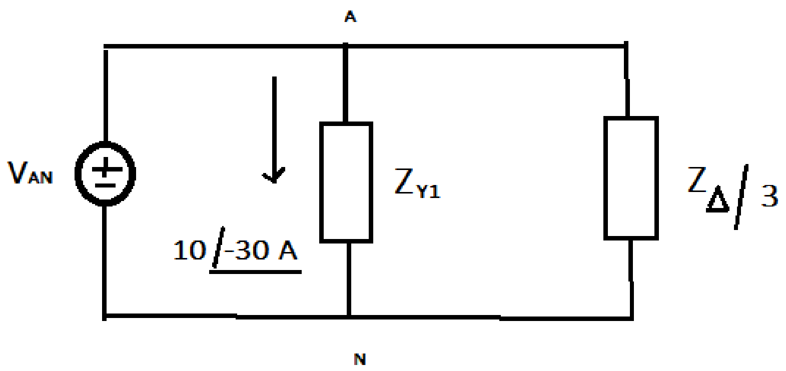
$$\bar{Z}_{line} = \frac{127\angle 0^\circ - 120\angle 0^\circ}{11.94\angle -5.71^\circ}$$

$$\bar{Z}_{line} = 0.59\angle 5.71^\circ\ \Omega$$

2.

A three phase abc sequence wye-connected source supplies 14kVA with a power factor 0.75 lagging to a parallel combination of a wye load and a delta load. If the wye load consumes 9 kVA at a power factor of 0.6 lagging and has a phase current of $10\angle -30^o$ A rms determine the phase impedance of delta load.

Soln.:



Total copmplex power is $S_T = 14000\angle \cos^{-1} 0.75$ VA = $14000\angle 41.41^o$ VA

Wye load complex power is $S_Y = 9000\angle \cos^{-1} 0.6$ VA = $9000\angle 53.13^o$ VA

Delta load complex power is $S_\Delta = S_T - S_Y = 5500\angle 22^0\ VA$

Recall that $S_Y = 3\ V_{AN}\ I_{AN}^*$ for Wye load.

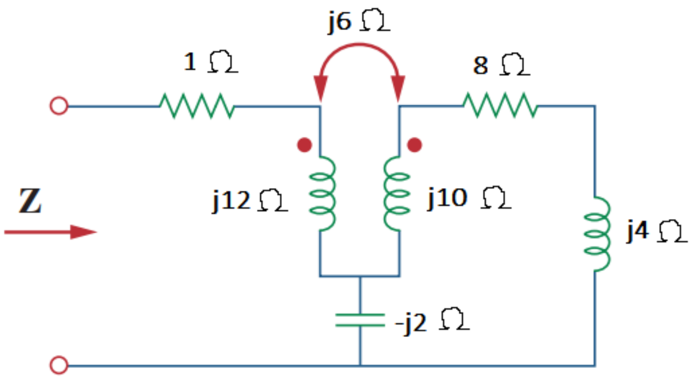
$$V_{AN} = \frac{S_Y}{3\ I_{AN}^*} = \frac{9000\ \angle 53.13^o}{30\ \angle 30^o} = 300\angle 23.13^o \text{ Vrms}$$

Similarly $S_\Delta = 3\ \frac{V_{AN}^2}{(\frac{Z_\Delta}{3})^*} = 9\ \frac{V_{AN}^2}{Z_\Delta^*}$ From this relation, $Z_\Delta = 9\ \frac{300^2}{5500\ \angle -22^0}$

$$Z_\Delta = 147.22\angle 22^o\ \Omega$$

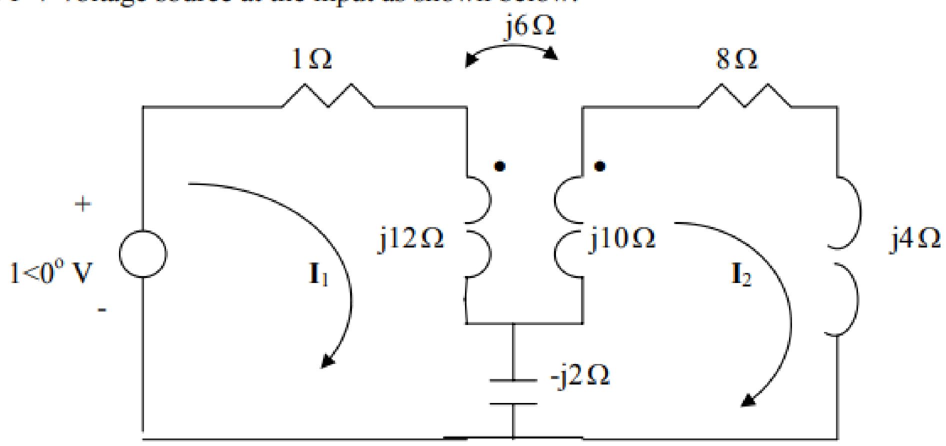
3.

Find the input impedance Z of circuit with transformer shown below.



Soln.:

Insert a 1-V voltage source at the input as shown below.



For loop 1,

$$1 = (1 + j10)I_1 - j4I_2 \qquad (1)$$

For loop 2,

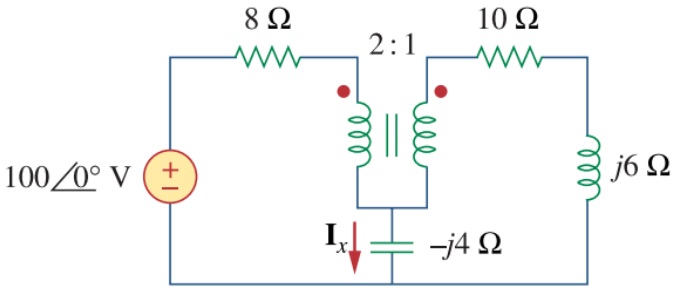
$$0 = (8 + j4 + j10 - j2)I_2 + j2I_1 - j6I_1 \longrightarrow 0 = -jI_1 + (2 + j3)I_2 \qquad (2)$$

Solving (1) and (2) leads to $\mathbf{I}_1$=0.019 –j0.1068

$$Z = \frac{1}{I_1} = 1.6154 + j9.077 = \underline{9.219\angle 79.91^o\,\Omega}$$

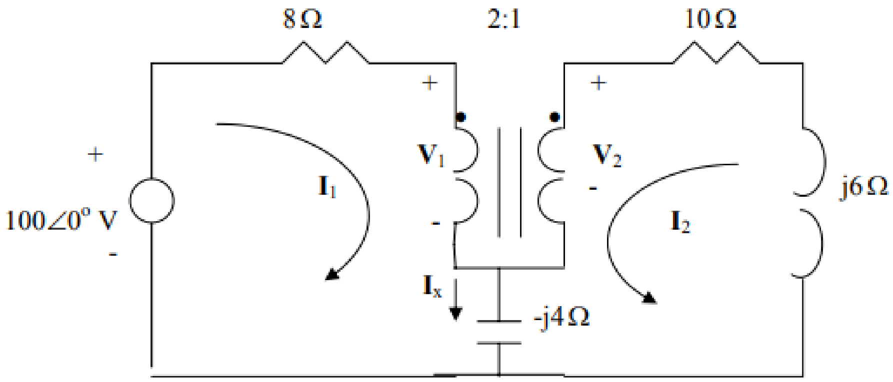
4.

Find I_X in the ideal transformer circuit shown below.



Soln.:

By applying mesh analysis.



$$100 = (8 - j4)I_1 - j4I_2 + V_1 \qquad (1)$$

$$0 = (10 + j2)I_2 - j4I_1 + V_2 \qquad (2)$$

$$\frac{V_2}{V_1} = n = \frac{1}{2} \longrightarrow V_1 = 2V_2 \qquad (3)$$

$$\frac{I_2}{I_1} = -\frac{1}{n} = -2 \longrightarrow I_1 = -0.5I_2 \qquad (4)$$

Substituting (3) and (4) into (1) and (2),

we obtain

$$100 = (-4 - j2)I_2 + 2V_2$$
$$0 = (10 + j4)I_2 + V_2$$

$$\mathbf{I}_2 = -3.5503 + j1.4793$$

$$I_x = I_1 + I_2 = 0.5I_2 = \underline{1.923\angle 157.4^o \ \ \text{A}}$$