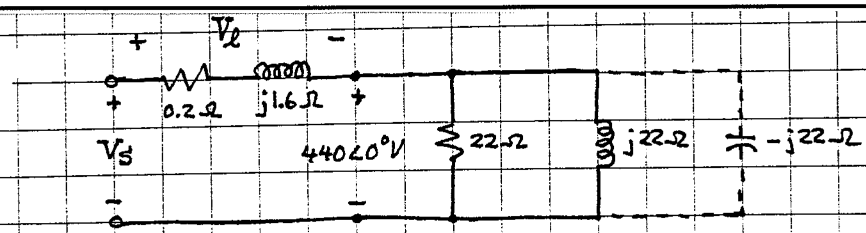
ex:



a) Compute V_s and V_ℓ

b) Construct phasor diagram showing V_s, V_ℓ, and $440\angle 0°$ V.

c) Repeat (a) and (b) with added capacitive load (and with $440\angle 0°$ V still).

a) soln: Use V-divider formula $440\angle 0° \text{ V} = V_s \dfrac{22\,\Omega \| j22\,\Omega}{22\,\Omega \| j22\,\Omega + 0.2\,\Omega + j1.6\,\Omega}$

$$22\,\Omega \| j22\,\Omega = 22\,\Omega \cdot 1 \| j = 22\,\Omega \frac{j}{1+j} = 22\,\Omega \frac{j}{1+j}\frac{1-j}{1-j} = 22\,\Omega \frac{1+j}{2}$$

$$= 11\,\Omega \cdot (1+j)$$

$$\therefore\ 440\angle 0° \text{ V} = V_s \frac{11\,\Omega \cdot (1+j)}{11\,\Omega \cdot (1+j) + 0.2 + j1.6\,\Omega} = V_s \frac{11\,\Omega\ (1+j)}{11.2\,\Omega + j12.6\,\Omega}$$

$$\text{or } V_s = 440 \text{ V} \cdot \frac{11.2 + j12.6}{11\ (1+j)} \frac{\Omega}{\Omega} = \frac{440}{11} \frac{(11.2 + j12.6)}{1+j} \frac{(1-j)}{(1-j)}$$

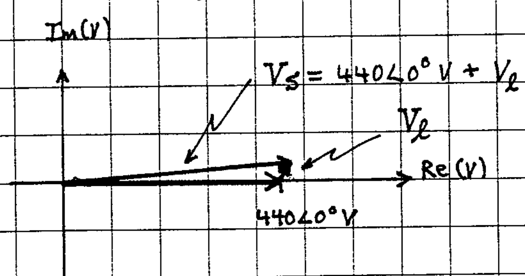
$$= 40\ \frac{11.2 + 12.6 + j(-11.2 + 12.6)}{2} = 20\ (23.8 + j1.4) \text{ V}$$

$$= 476 + j28 \text{ V} = 476.8 \angle 3.37° \text{ V}$$

$$V_\ell = V_s - 440\angle 0° \text{ V} = 476 + j28 - 440 \text{ V} = 36 + j28 \text{ V}$$

$$= 36 + j28 \text{ V} = 45.6 \angle 37.87° \text{ V}$$

b) soln:



The phasor diagram shows $440\angle 0°$ V, V_ℓ, and V_s as vectors, and it shows that $440\angle 0°\text{V} + V_\ell = V_s$.

c) sol'n: With added load we have $22\,\Omega \,\|\, j22\,\Omega \,\|\, (-j22)\,\Omega$.

In situations like this, we avoid a divide by zero if we use $R_1 \| R_2 = \dfrac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$ instead of $R_1 \| R_2 = \dfrac{R_1 R_2}{R_1 + R_2}$.

$$22\,\Omega \,\|\, j22\,\Omega \,\|\, -j22\,\Omega = 22\,\Omega \cdot \frac{1}{\frac{1}{1} + \cancel{\frac{1}{j}} + \cancel{\frac{1}{-j}}} = 22\,\Omega$$

The L and the C cancel each other...

For sake of illustration, we take a different approach than previou sol'n. (Previous approach would still work.)

Define $I = \dfrac{440\angle 0°\,V}{22\,\Omega}$. $V_s = 440\angle 0°\,V + I \cdot (0.2 + j1.6)\,\Omega$

$$\therefore\ V_s = 440\left(1 + \frac{1}{22}(0.2 + j1.6)\right)V = 440 \cdot \frac{22.2 + j1.6}{22}\ V$$

$$V_s = 20\,(22.2 + j1.6)\,V = 444 + j\,32\ V = 445.15\angle 4.12°\ V$$

$$V_s = 440\angle 0°\,V + V_\ell \Rightarrow V_\ell = 4 + j32\,V = 32.25\angle 82.87°\ V$$