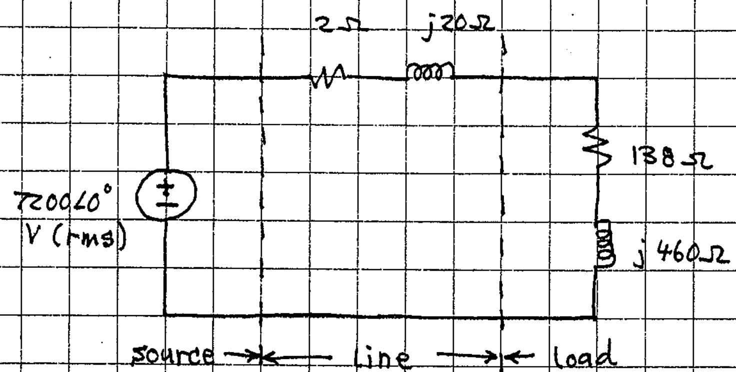
Neil E Cotter

Use circuit in problem, but only calculate:

i) complex power $S = P + jQ$ for both line & load

ii) ave power " " " "

iii) apparent power " " " "



ans: i) $S_{line} = 415 + j4.15k$ VA ii) $P_{line} = 415$ W iii) $|S_{line}| = 4.17$ kVA

$S_{load} = 28.6k + j95.4k$ VA $P_{load} = 28.6k$ W $|S_{load}| = 99.6k$ VA

sol'n: i) S is the phasor for the sinusoidal component of the power, $p(t)$. $S = P + jQ$

$$p(t) = P + P\cos(2\omega t) - Q\sin(2\omega t)$$

$$\text{or } p(t) = P + |S|\cos\left(2\omega t + \tan^{-1}\frac{Q}{P}\right)$$

We also have $S = Z\left|\mathbb{I}_{rms}\right|^2$ for impedance Z

$$\text{Here, } \mathbb{I}_{rms} = \frac{7200\angle 0^\circ \text{ V rms}}{Z_{Tot}} = \frac{7200\angle 0^\circ \text{ V rms}}{(2\,\Omega + 138\,\Omega) + j(20\,\Omega + 460\,\Omega)}$$

$$= \frac{7200\angle 0^\circ \text{ V rms}}{140\,\Omega + j\,480\,\Omega} = \frac{7200\angle 0^\circ \text{ V rms}}{20\,(7 + j24)\,\Omega}$$

$$\left|\mathbb{I}_{rms}\right|^2 = \left|\frac{7200\angle 0^\circ \text{ V rms}}{20\,(7 + j24)\,\Omega}\right|^2 = \frac{360^2}{7^2 + 24^2}\frac{(\text{V rms})^2}{\Omega^2}$$

$$'' = \frac{360^2}{25^2}\frac{(\text{V rms})^2}{\Omega^2} = \frac{72^2}{5^2}(\text{V rms})^2/\Omega$$

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$$|I_{rms}|^2 = 14.4^2 \ (V\,rms)^2/\Omega^2 = 207.36 \ (A\,rms)^2$$

$$S_{line} = \overbrace{(2+j20)}^{z_{line}}\, 207.36 \ VA$$

$$S_{line} = 414.72 + j\,4.1472k \ VA \doteq 415 + j\,4.15k \ VA$$

$$S_{load} = \overbrace{(138+j460)}^{z_{load}}\, 207.36 \ VA$$

$$S_{load} = 28.6k + j\,95.4k \ VA$$

ii) $P = \text{Re}[S]$ By serendipity, the ave DC pwr and the magnitude of the $\cos(2\omega t)$ term of the AC pwr are the same.

$$P_{line} = \text{Re}[415 + j4.15k]\ VA = 415 \ W$$

$$P_{load} = \text{Re}[28.6k + j95.4k]\ VA = 28.6k \ W$$

iii) $|S_{line}| = |415 + j4.15k|\ VA = 415\,|1+j10|\ VA = 4.17k\,VA$

$$|S_{load}| = |28.6k + j95.4k|\ VA = 99.6 \ kVA$$

Note: $p(t)$ waveforms