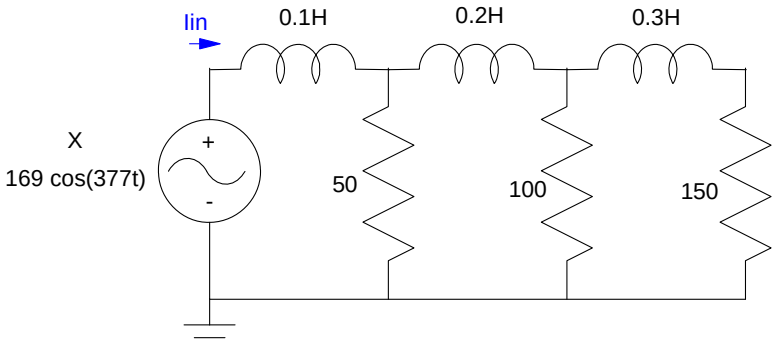
ECE 331 - Homework #2

Phasors, RL Circuits, Power Factor - Due Monday, Jan 27th

1a) Determine the current, Iin:
1b) Determine the power factor:
1c) Determine the power consumed by this circuit



Step 1: Convert to impedance

$0.1H \rightarrow j\omega L = j37.7\Omega$
$0.2H \rightarrow j75.4\Omega$
$0.3H \rightarrow j113.1\Omega$

Step 2: Combine in series and parallel:

$150 + j113.1 || 100 = 66.79 + j15.02$ parallel
$(66.79 + j15.02) + (j75.4) = 66.79 + j90.42$ series
$(66.79 + j90.42) || (50) = 36.51 + j10.36$ parallel
$(36.51 + j10.36) + (j37.7) = 36.61 + j48.06$

$$Z_{in} = 36.61 + j48.06$$

1a): Compute the current

$$I_{in} = \frac{169/\sqrt{2}\ V_{rms}}{36.61+j48.06\Omega} = 1.2036 - j1.5798$$

$$\boxed{\begin{aligned} I_{in} &= 1.2036 - j1.5798 \\ &= 1.9861\angle -52.69^0 \end{aligned}} \text{ Amps rms}$$

1b) The power factor is

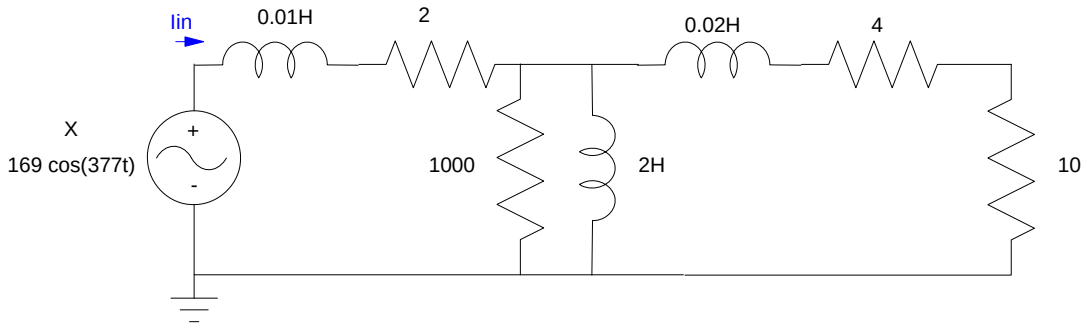
$$\boxed{pf = \cos(-52.69^0) = 0.6060}$$

1c) The power consumed is

$P = V_{rms} \cdot I_{rms} \cdot pf$
$P = (120V_{rms})(1.9861A_{rms})(0.6060)$

$$\boxed{P = 144.43W}$$

2a) Determine the current, Iin:
2b) Determine the power factor:
2c) Determine the power consumed by this circuit



Step 1: Convert to impedance:

$0.02H \rightarrow j7.54$

$2H \rightarrow j754$

$0.01H \rightarrow j3.77$

Step 2: Combine:

$(10)+(4)+(j7.54)=14+j7.54$

$(14+j7.54)||(j754)||(1000)=(13.5910+j7.5096)$

$(13.5910+j7.5096)+(2)+(j3.77)=15.5910+j11.2796$

$Zin=15.5910+j11.2796$

Step 3: Determine the current

$I=\frac{V}{Z}=\frac{120V_{rms}}{15.5910+j11.2796\Omega}$

2a) $\begin{aligned} I &= 5.5023-j3.6552 \\ &= 6.2359\angle -35.88^0 \end{aligned}$ A rms

$pf=\cos(-35.88^0)$

2b) $pf=0.8102$

$P=V_{rms}\cdot I_{rms}\cdot pf$

$P=(120V)(6.2359A)(0.8102)$

2c) $P=606W$

3) The following data is measured for a RL circuit:

- Vin = 120V rms
- Iin = 35A rms
- Pin = 3000 Watts
- f = 60Hz (377 rad/sec)

Determine the impedance and power factor.

$$|Z| = \frac{120V}{35A} = 3.4286\Omega$$

$$pf = \frac{P}{V \cdot I} = \frac{3000W}{(120V)(35A)}$$

$$\boxed{pf = 0.7143}$$

$$\theta = \arccos(0.7143) = 44.41^0$$

$$\boxed{Z = 3.4286 \angle 44.41^0}$$

4) Determine an RL series and RL parallel circuit to implement the impedance for problem #3 (at 60Hz):

In rectangular form

$$Z = 2.4490 + j2.3995$$

Series Model:

$$\boxed{\begin{aligned} R_s &= 2.4490 \\ jX_s &= j2.3995 \end{aligned}}$$

Taking the inverse to find the parallel form

$$\frac{1}{Z} = \frac{1}{R_p} + \frac{1}{jX_p}$$

$$\frac{1}{Z} = 0.2083 - j0.2041$$

Parallel Model:

$$\boxed{\begin{aligned} R_p &= 4.8008 \\ jX_p &= j4.8996 \end{aligned}}$$