10

8.48

Use the power information given for the circuit to determine:

Load $\mathbf{Z}_1$: $24kW@pf = 0.66$ leading
Load $\mathbf{Z}_2$: $18kW@pf = 0.82$ lagging

a

$\mathbf{Z}_1$ and $\mathbf{Z}_2$

✓ Answer

$S = \frac{P_{av}}{pf} = 21.95\ kW$
$\phi_z = \cos^{-1}(0.82) = 34.92^\circ$
$\mathbf{S} = 27\angle 34.92^\circ\ kW$
$\mathbf{Z} = \frac{\mathbf{V}\mathbf{V}^*}{\mathbf{S}} = \frac{|\mathbf{V}|^2}{\mathbf{S}}$
$\mathbf{Z}_2 = 8.82\angle 34.92^\circ \Omega = 7.232 + 5.048i \Omega$

$\mathbf{I}_2 = \frac{\mathbf{V}_2}{\mathbf{Z}_2} = 49.89\angle -34.92^\circ\ A$
$V_1 = I_2(Z_2 + 1.2 + 0.4i) = 500.833\angle -2.05^\circ\ V = 500.5 - 17.9i\ V$

$S = 36\ kW$
$\phi_z = -48.70^\circ$
$\mathbf{S} = 36\angle -48.70^\circ$

$Z_1 = 4.599 + 5.235i\ \Omega$

b

The rms value of $\mathbf{V}_s$

✓ Answer

$I_1 = \frac{V_1}{Z_1} = 63.93 + 67.72i\ \Omega$
$V_s = 0.6I_1 + V_1 = 538.87 + 22.73i\ V = 539.35\angle 2.42^\circ\ V$

8.51

For the circuit, choose the load impedance $\mathbf{Z}_L$ so that the power dissipated in it is a maximum. How much power will that be?

✓ **Answer**

With Z_L as an open circuit,

All the resistors simplify to $Z_{eq} = 6 - 2j\ \Omega$

$I = 0.9 + 0.3j\ A$

The below current will be $\frac{(4-2j)I}{1+2j} = 0.6 - 1.8j$

This means the voltage across $V_L = 5.4 + 1.8j$

$P_{max} = \frac{V_L^2}{8(6)} = 0.54 + 0.405j = 0.675\ W$

8.55

✓ **Answer**

With Z_L as open,

$I_x = 0.001667\ A$

This makes $V_L = 4000I_x = 6.67\ V$

$6000I_x + 2000I_x + 4000jI_L - 3000(I_x + I_L) - 15 = 0$

$5000I_x + (4000j - 3000)I_L = 15$

$I_x = I_L j$

$I_x = \frac{15}{9000+3000j}$

$I_L = 0.0005 + 0.0015j$

$Z_{Th} = 1.3 - 4j\ k\Omega$

$P_{max} = 4.278\ mW$

9.2

Determine the resonant frequency of the circuit shown given that

$R = 100\ \Omega$

$L = 5\ mH$

$C = 1\ \mu F$

✓ **Answer**

$Z_{eq} = \omega Li + \frac{1}{\frac{1}{R}+i\omega C} = \frac{R+\omega Li-\omega^2 LRC}{1+i\omega RC}$

$= \frac{R+\omega Li-\omega^2 LRC-\omega R^2 Ci+\omega^2 LRC+\omega^3 LR^2C^2 i}{1+(\omega RC)^2}$

$\mathscr{I}(Z_{eq}) = 0$

$= \frac{\omega L-\omega R^2 C+\omega^3 LR^2C^2}{1+(\omega RC)^2}$

$= L - R^2C + \omega^2 LR^2C^2$

$\frac{R^2C-L}{LR^2C^2} = \omega^2$

$\sqrt{\frac{1}{LC} - \frac{1}{R^2C^2}} = \omega$
$= 10000\ rad/s$

9.6

✓ **Answer**

By KVL and KCL,

$H = -\frac{iCL_1R\omega^2}{CL_1L_2\omega^3 - iCL_1R\omega^2 - L_1\omega - L_2\omega + iR}$