AC power 002

Unlimited Attempts.

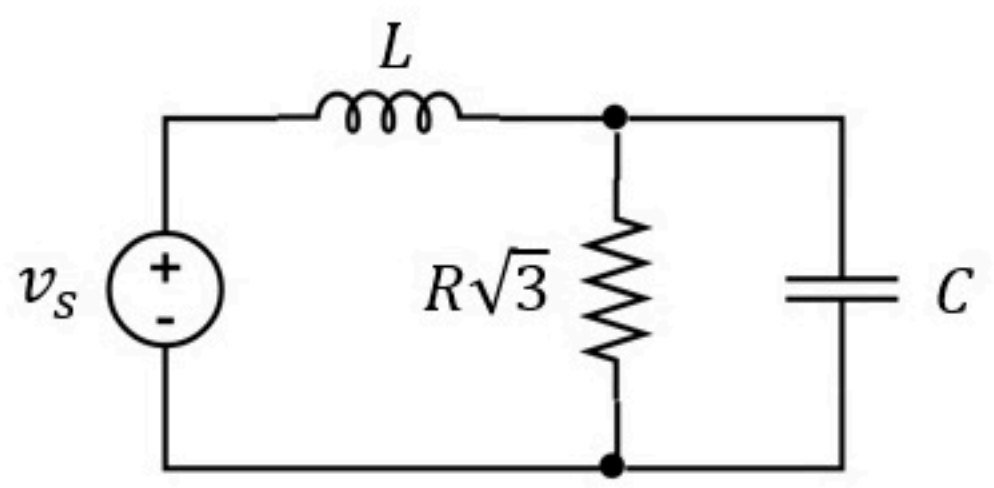
$$v_s(t) = A_1 \cos(1000t + B_1)$$

(a) Find the instantaneous power supplied by the power supply

$$p = A_2\sqrt{3} + A_3 \cos(2000t + B_3) \quad \text{with } -180° < B_3 \leq 180$$

(b) Find the instantaneous power received by the inductor

$$p = A_4\sqrt{3} + A_5 \cos(2000t + B_5) \quad \text{with } -180° < B_5 \leq 180$$



Given Variables:

A1 : 6 V

B1 : 45 degrees

R : 2 ohm

C : 500 uF

L : 1 mH

Calculate the following:

A2 (W) :

9

A3 (W) :

18

B3 (degrees) :

120

A4 (W) :

0

A5 (W) :

18

B5 (degrees) :

-120

Hint: Find the v(t) and i(t), or use the equations (video lecture)

$v_s(t) = A_1 \cos(1000t + B_1)$

A1 : 8 V

B1 : 135 degrees

R : 2 ohm

C : 500 uF

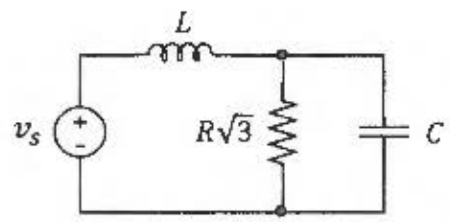
L : 1 mH

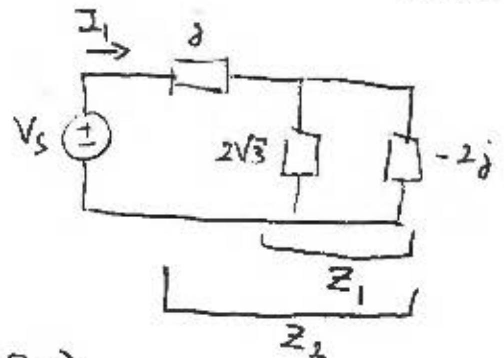
(a) Find the <u>instantaneous</u> power supplied by the power supply

$$p = A_2\sqrt{3} + A_3 \cos(2000t + B_3)$$

(b) Find the <u>instantaneous</u> power received by the inductor

$$p = A_4\sqrt{3} + A_5 \cos(2000t + B_5)$$





$$V_s = 8\,e^{j135°}$$

$$Z_1 = \frac{1}{\frac{1}{2\sqrt{3}} + \frac{j}{2}} = \frac{2\sqrt{3}}{1+\sqrt{3}j} = \frac{\sqrt{3}}{2}\left(1 - \sqrt{3}j\right)$$

$$Z_2 = Z_1 + j = \frac{\sqrt{3}}{2} - \frac{j}{2} = 1 \cdot e^{-30°} \qquad I_1 = \frac{V_s}{Z_2} = 8\,e^{j165°}$$

<u>INSTANTANEOUS POWER</u>

$$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m \cos(2\omega t + \theta_v + \theta_i)$$

(a) $V = V_s \Rightarrow V_m = 8\,V \quad \theta_v = 135°$

$I = I_1 \Rightarrow I_m = 8\,A \quad \theta_i = 165°$

$$A_2\sqrt{3} = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) = \frac{1}{2}\cdot 8 \cdot 8 \cdot \cos(-30°) = 16\sqrt{3} \Rightarrow \boxed{A_2 = 16\,W}$$

$$A_3 = \frac{1}{2} V_m I_m = \frac{1}{2}\cdot 8 \cdot 8 \Rightarrow \boxed{A_3 = 32\,W} \qquad B_3 = \theta_v + \theta_i = 300° \quad \boxed{B_3 = -60°}$$

(b) $I = I_1 \Rightarrow I_m = 8\,A \quad \theta_i = 165°$

$V = j I_1 \Rightarrow V_m = 8\,V \quad \theta_v = 165° + 90° = 255°$

$$A_4\sqrt{3} = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) = \frac{1}{2}\cdot 8 \cdot 8 \cos(90°) = 0 \Rightarrow \boxed{A_4 = 0\,W}$$

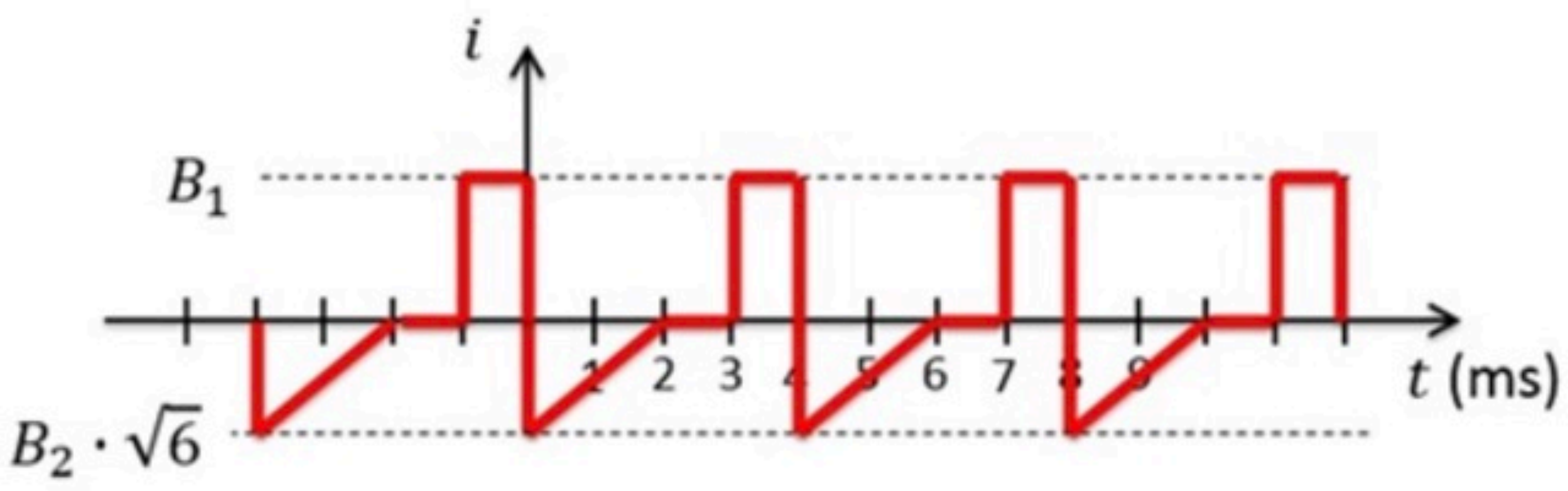
$$A_5 = \frac{1}{2} V_m I_m = \frac{1}{2}\cdot 8 \cdot 8 \Rightarrow \boxed{A_5 = 32\,W} \qquad B_5 = \theta_v + \theta_i = 420°$$

$$\boxed{B_5 = 60°}$$

AC power 003

Problem has been graded.

Find I_{rms} for this waveform.



Given Variables:

B1 : 6 A

B2 : -4 A

Calculate the following:

Irms (A) :

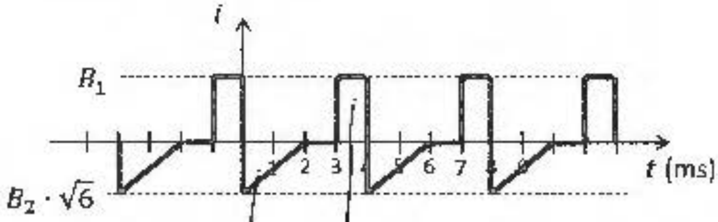
5

Hint: Square the time waveform, integrate, average and take sqrt()

Find I_{rms} for this waveform.

B1 : 6 A

B2 : -4 A



$i(t) = 6 \Rightarrow i(t)^2 = 36$

$i(t) = 2\sqrt{6}(t-2) \Rightarrow i(t)^2 = 24(t-2)^2$

$$\int_0^4 i^2 dt = \int_0^2 24(t-2)^2 dt + \int_3^4 36\,dt$$

$$= 24 \left.\frac{(t-2)^3}{3}\right|_0^2 + 36$$

$$= 8 \cdot (0 - (-2)^3) + 36$$

$$= 64 + 36$$

$$= 100$$

$$\sqrt{\frac{1}{4}\int_0^4 i^2 dt} = \sqrt{\frac{1}{4} \cdot 100} = 5 \Rightarrow \boxed{I_{rms} = 5A}$$

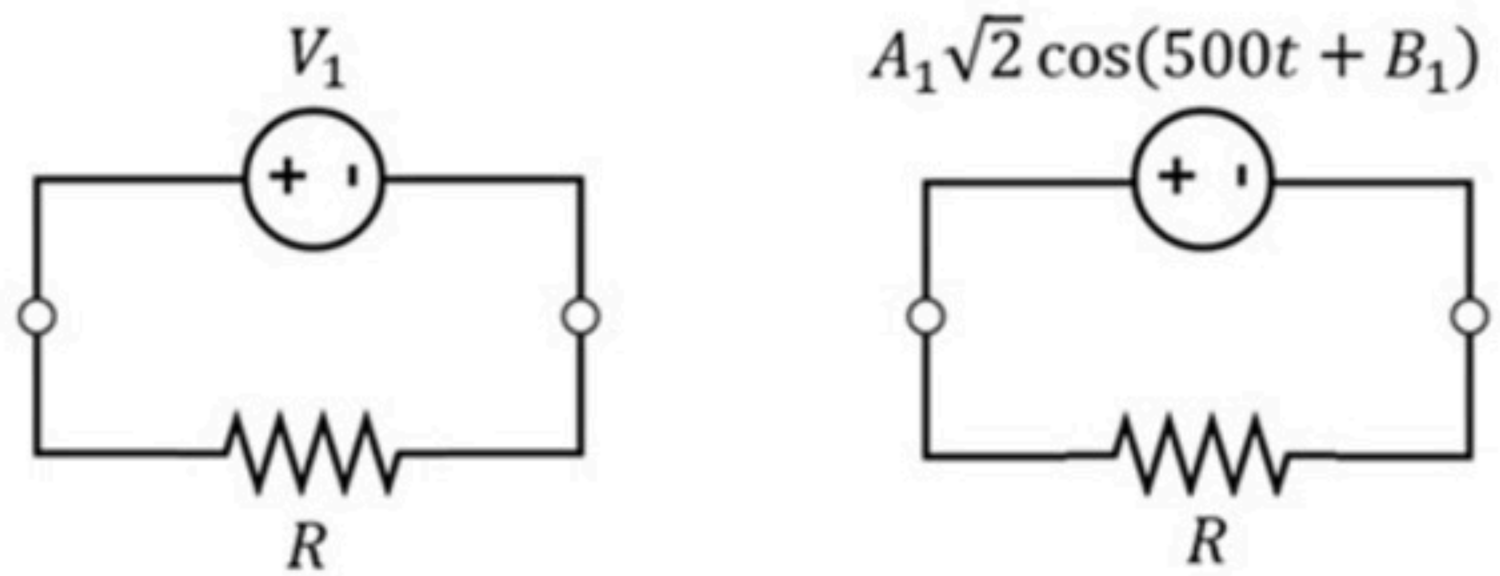
AC power 004

Problem has been graded.

You are told that the sources in the two circuits below supply the same average power.

(a) Find the average power P supplied.

(b) Find A_1.



Given Variables:

V1 : 10 V

R : 5 ohm

B1 : 135 degrees

Calculate the following:

P (W) :

20

A1 (V) :

10

Hint: What is the definition of Vrms?

You are told that the sources in the two circuits below supply the same average power.

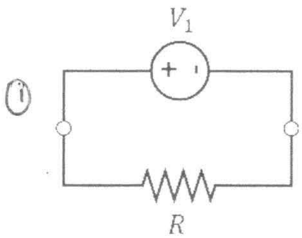
(a) Find the average power P supplied.

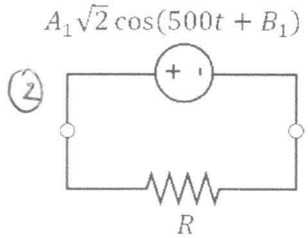
(b) Find A_1.

V1 : 6 V

R : 2 ohm

B1 : 60 degrees





(a) CIRCUIT 1 : $P = \frac{V_1^2}{R} = \frac{36}{2} \Rightarrow \boxed{P = 18\,W}$

(b) FOR THE SAME AVERAGE POWER

$$V_{RMS} = V_1 = 6\,V$$

$$V_{RMS} = \frac{V_m}{\sqrt{2}} = \frac{A_1 \cancel{\sqrt{2}}}{\cancel{\sqrt{2}}}$$

$$\Rightarrow \boxed{A_1 = 6\,V}$$

AC power 005

0 of 5 attempts made

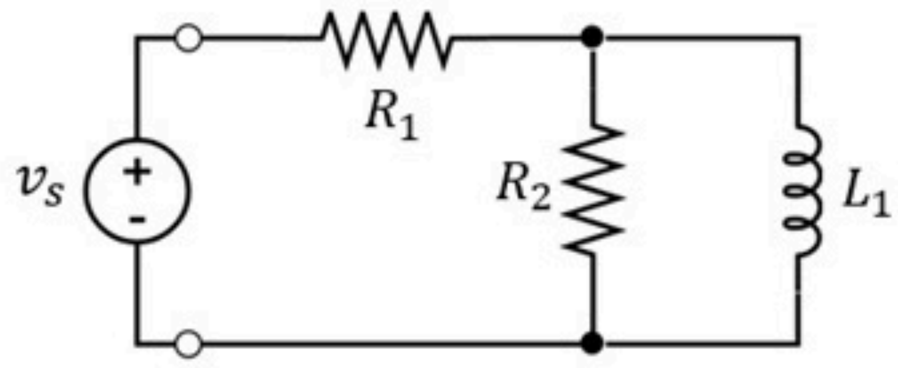
$v_s(t) = A_1 \cos(500t + B_1)$

Find the complex power $\mathbf{S_1} = a_1 + b_1 j$ received by the source v_S.

Find the complex power $\mathbf{S_2} = a_2 + b_2 j$ received by the resistor R_1.

Find the complex power $\mathbf{S_3} = a_3 + b_3 j$ received by the resistor R_2.

Find the complex power $\mathbf{S_4} = a_4 + b_4 j$ received by the inductor L_1.



Given Variables:

A1 : 6 V

B1 : 45 degrees

R1 : 4 ohm

R2 : 4 ohm

L1 : 8 mH

Calculate the following:

a1 (W) :

-2.7

b1 (VAR) :

-0.9

a2 (W) :

1.8

b2 (VAR) :

0

a3 (W) :

0.9

b3 (VAR) :

0

a4 (W) :

0

b4 (VAR) :

0.9

$v_s(t) = A_1 \cos(500t + B_1)$

Find the complex power $\mathbf{S_1} = a_1 + b_1 j$ received by the source v_S.

Find the complex power $\mathbf{S_2} = a_2 + b_2 j$ received by the resistor R_1.

Find the complex power $\mathbf{S_3} = a_3 + b_3 j$ received by the resistor R_2.

Find the complex power $\mathbf{S_4} = a_4 + b_4 j$ received by the inductor L_1.

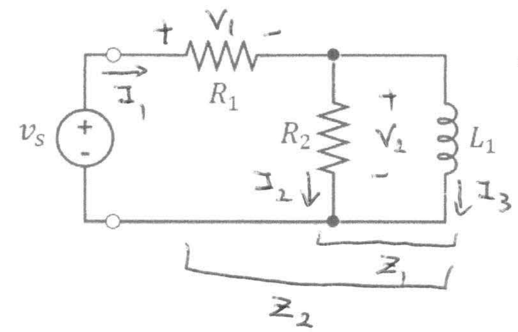
A1 : 3 V

B1 : 30 degrees

R1 : 1 ohm

R2 : 2 ohm

L1 : 4 mH



$Z_L = 2j$

$Z_1 = \dfrac{1}{\frac{1}{2} - \frac{j}{2}} = \dfrac{2}{1-j} = 1 + j$

$Z_2 = Z_1 + 1 = 2 + j$

$V_s = 3e^{j30°}$ $\quad I_1 = \dfrac{V_s}{Z_2}$ $\quad V_1 = 1 \cdot I_1$ $\quad V_2 = Z_1 I_1$ $\quad I_2 = \dfrac{V_1}{2}$ $\quad I_3 = \dfrac{V_1}{2j}$

(a) $S_1 = \frac{1}{2} V_s(-I_1^*) = -\frac{1}{2} \dfrac{V_s \cdot V_s^*}{Z_2^*} = -\dfrac{|V_s|^2}{2} \dfrac{Z_2}{|Z_2|^2} = -\dfrac{9}{2} \dfrac{(2+j)}{5}$

$\boxed{a_1 = -1.8\,W}$ $\boxed{b_1 = -0.9\,VAR}$

(b) $S_2 = \frac{1}{2} V_1 I_1^* = \dfrac{I_1 I_1^*}{2} = \dfrac{|I_1|^2}{2} = \dfrac{|V_s|^2}{2|Z_2|^2} = \dfrac{9}{2 \cdot 5}$

$\boxed{a_2 = 0.9\,W}$ $\boxed{b_2 = 0\,VAR}$

(c) $S_3 = \frac{1}{2} V_2 I_2^* = \frac{1}{2} V_2 \dfrac{V_2^*}{2} = \dfrac{|V_2|^2}{4} = \dfrac{|Z_1|^2 |I_1|^2}{4} = \dfrac{|Z_1|^2}{4} \cdot \dfrac{|V_s|^2}{|Z_2|^2} = \dfrac{2 \cdot 9}{4 \cdot 5}$

$\boxed{a_3 = 0.9\,W}$ $\boxed{b_3 = 0\,VAR}$

(d) $S_4 = \frac{1}{2} V_2 I_3^* = \frac{1}{2} \dfrac{V_2 V_2^*}{(2j)^*} = j\dfrac{|V_2|^2}{4} = j\dfrac{|Z_1|^2}{4} \cdot \dfrac{|V_s|^2}{|Z_2|^2} = j \dfrac{2 \cdot 9}{4 \cdot 5}$

$\boxed{a_4 = 0\,W}$ $\boxed{b_4 = 0.9\,VAR}$

CHECK: $S_1 + S_2 + S_3 + S_4 = \begin{array}{cccc} -1.8 & +0.9 & +0.9 & +0 \\ -0.9j & +0j & +0j & +0.9j \end{array} = 0$

$(\sum \text{REC.} = \sum \text{SUPPL.})$

AC power 006

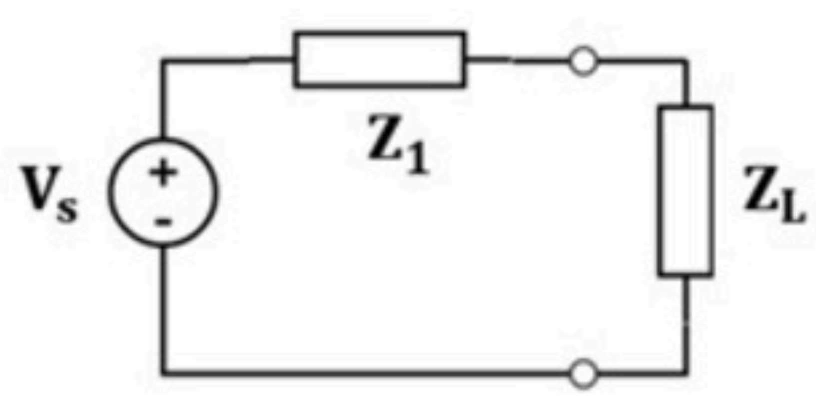
No more attempts left.

For the system below, the source is represented in phasor-notation as:

$$\mathbf{Z_1} = A_1 + jB_1 \qquad \mathbf{V_S} = A_2 \cdot e^{jB_2}$$

(a) Find the load impedance $\mathbf{Z_L} = A_3 + jB_3$ that results in the maximum power being received by this load.

(b) Find the maximum average power P received by the load.



Source Load

Given Variables:

A1 : 5 ohm

B1 : 4 ohm

A2 : 2 V

B2 : 75 degrees

Calculate the following:

A3 (ohm) :

5

B3 (ohm) :

-4

P (W) :

0.1

Hint: Keep your calculations algebraic as long as you can.

For the system below, the source is represented in phasor-notation as:

A1 : 1 ohm

B1 : -8 ohm

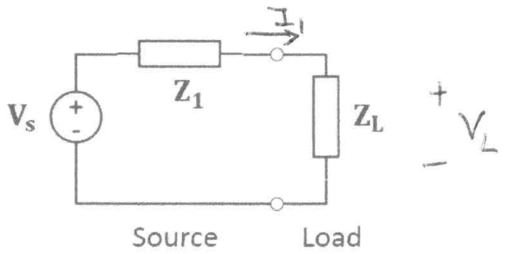
A2 : 4 V

B2 : 65 degrees

$$\mathbf{Z_1} = A_1 + jB_1 \qquad \mathbf{V_S} = A_2 \cdot e^{jB_2}$$

(a) Find the load impedance $\mathbf{Z_L} = A_3 + jB_3$ that results in the maximum power being received by this load.

(b) Find the maximum average power P received by the load.



(a) $Z_L = Z_1^* \Rightarrow Z_L = 1 + j8$

$\boxed{A_3 = 1\Omega}$
$\boxed{B_3 = 8\Omega}$

(b) $I_1 = \dfrac{V_S}{Z_1 + Z_L}$ $\qquad Z_1 + Z_L = 2$

$V_S = 4e^{j65°}$ $\qquad V_L = Z_L \cdot I_1$

$$S_L = \frac{1}{2} V_L \cdot I_1^* = \frac{1}{2} Z_L \cdot I_1 \cdot I_1^* = \frac{Z_L}{2} |I_1|^2 = \frac{Z_L}{2} \frac{|V_S|^2}{|Z_1 + Z_L|^2}$$

$$= \frac{(1+j8)}{2} \cdot \frac{4^2}{2^2} = (1+j8) \cdot 2 = \underbrace{2}_{P} + \underbrace{16j}_{Q}$$

$\boxed{P = 2\,W}$

AC power 008

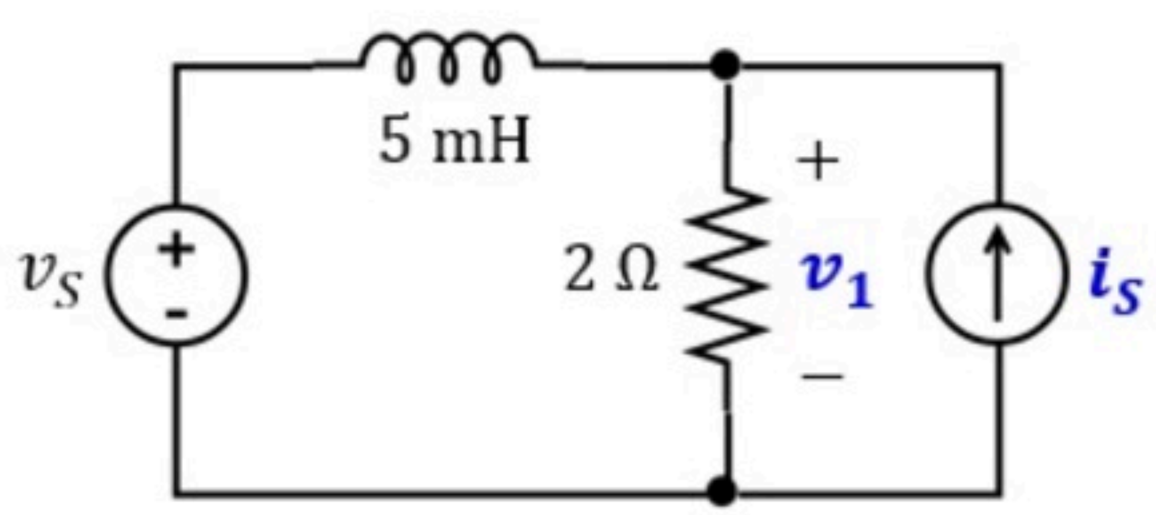
Problem has been graded.

Both v_S and i_S are AC sources with $\omega = 400$ rad/s. Someone did two measurements on the circuit and found:

$$v_1(t) = A_1 \cos(400t + B_1)$$ *(this is v_1, not v_S !)*

$$i_S(t) = 2\cos\left(400t + \frac{\pi}{6}\right)$$

(a) Find the average power P_1 received by the resistor
(b) Find the average power P_2 supplied by current source i_S
(c) Find the average power P_3 received by the inductor



Given Variables:

A1 : 8 V

B1 : 90 degrees

Calculate the following:

P1 (W) :

16

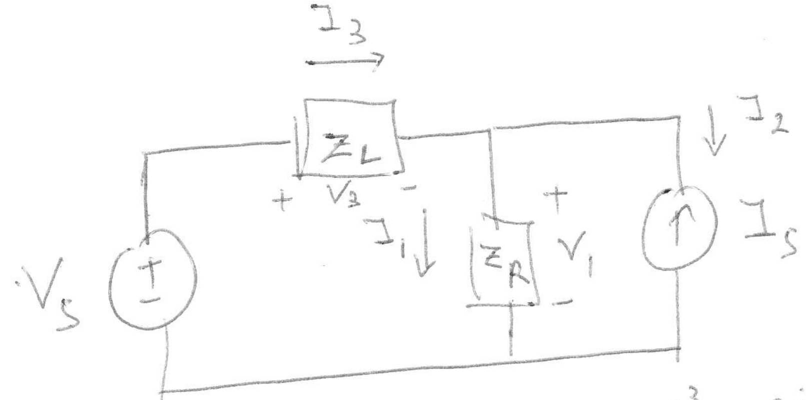
P2 (W) :

4

P3 (W) :

0

Hint: Find S symbolically first. Find phasors and plug in. For c, what do you know about the element?



$A_1 : 10\,V$

$B_1 : -90^\circ$

$$Z_L = j\omega L = j \cdot 400 \cdot 5 \cdot 10^{-3} = 2j \qquad Z_R = 2$$

(a) $S_1 = \frac{1}{2} V_1 \cdot I_1^* \qquad I_1 = \frac{V_1}{Z_R}$

$$= \frac{1}{2} V_1 \left(\frac{V_1}{Z_R}\right)^* = \frac{1}{2}\frac{V_1 V_1^*}{Z_R} = \frac{|V_1|^2}{2} \cdot \frac{1}{Z_R} = \frac{A_1^2}{2} \cdot \frac{1}{Z_R} = \frac{100}{2 \cdot 2} = 25$$

$P_1 = \mathrm{Re}[S_1] \qquad \boxed{P_1 = 25\,W}$ received

(b) $S_2 = \frac{1}{2} V_1 I_2^*$ ⇝ PASSIVE SIGN CONVENTION (POWER RECEIVED)

$$= \frac{1}{2} V_1 (-I_s)^* \qquad \left(\begin{array}{l} V_1 = A_1 e^{jB_1} = 10\, e^{-j\frac{\pi}{2}} \\ I_s = 2\, e^{j\frac{\pi}{6}} \end{array} \right.$$

$$= -\frac{1}{2} V_1 I_s^*$$

$$= -\frac{1}{2} \cdot 10 e^{-j\frac{\pi}{2}} \cdot 2 e^{-j\frac{\pi}{6}} = -10\, e^{-j\frac{4\pi}{6}} = -10\, e^{-j\frac{2\pi}{3}}$$

$P_2 = \mathrm{Re}[S_2] = -10 \cos\left(-\frac{2\pi}{3}\right) = -10\left(\frac{-1}{2}\right) = +5$ ⇝ received

$\boxed{P_2 = -5\,W}$ supplied

(c) $\boxed{P_3 = 0\,W}$ inductor always has $P = 0$

we can check: $S_3 = \frac{1}{2} V_3 I_3^* \qquad V_3 = Z_L \cdot I_3$

$$= \frac{1}{2} Z_L I_3 \cdot I_3^* = \frac{Z_L |I_3|^2}{2} = \underbrace{\frac{|I_3|^2 \cdot (2j)}{2}}$$

no real part $\Rightarrow P = \mathrm{Re}[S] = 0$