

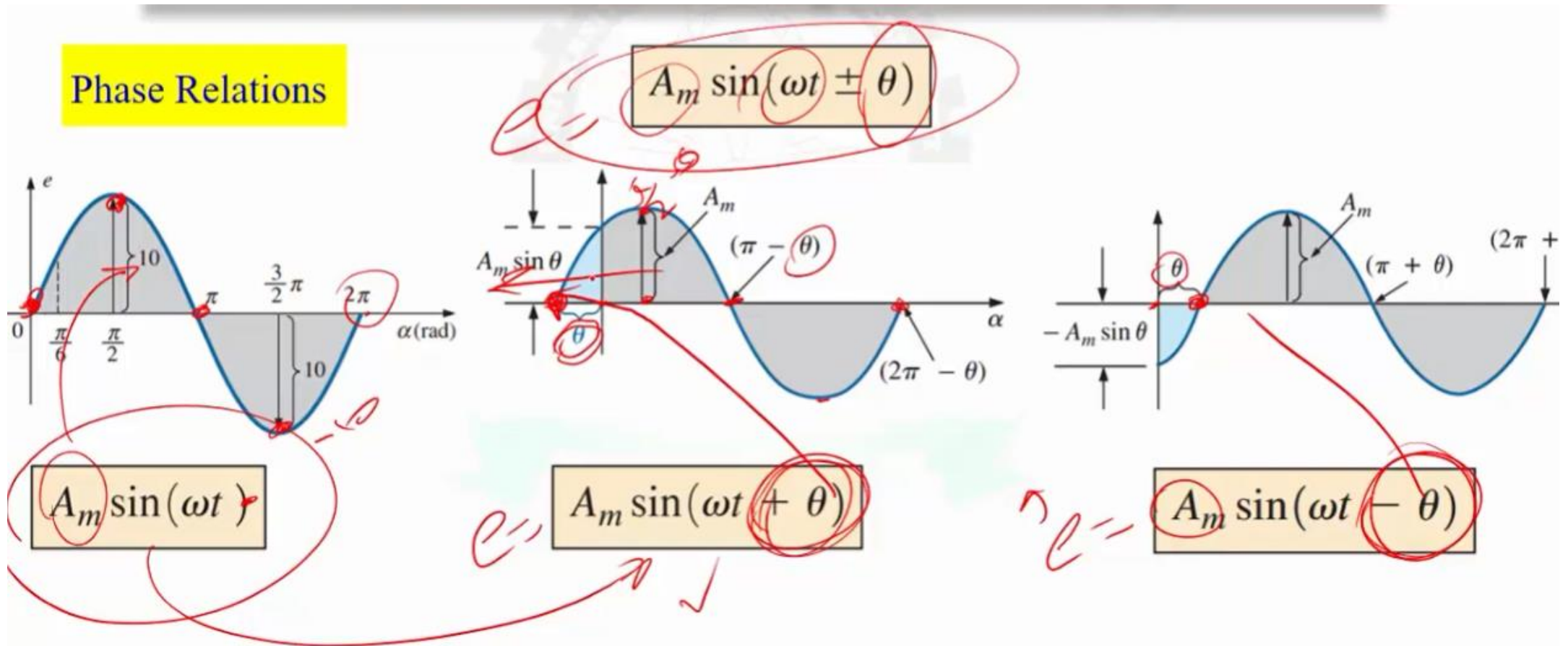
Sinusoidal alternating current-2

Phase relation

Average value

Effective value

Phase relation



Example

EXAMPLE What is the phase relationship between the sinusoidal waveforms of each of the following sets?

a. $v = 10 \sin(\omega t + 30^\circ)$
 $i = 5 \sin(\omega t + 70^\circ)$

b. $i = 15 \sin(\omega t + 60^\circ)$
 $v = 10 \sin(\omega t - 20^\circ)$

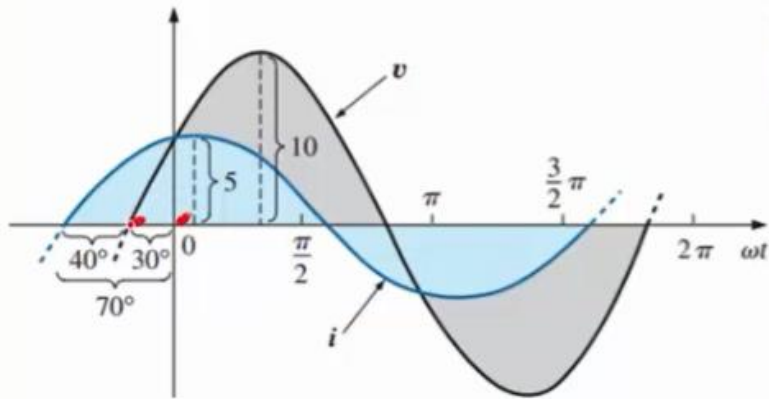
Solution

Phase Relations

a. $v = 10 \sin(\omega t + 30^\circ)$
 $i = 5 \sin(\omega t + 70^\circ)$

Solution:

i leads v by 40° , or v lags i by 40° .



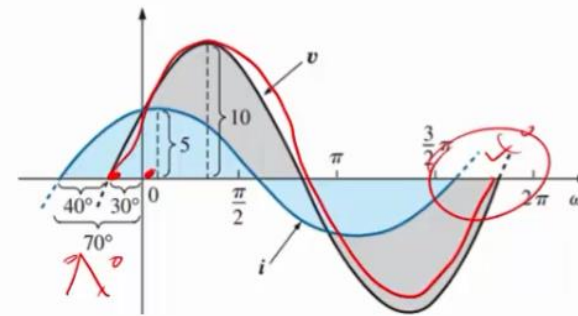
a

Phase Relations

a. $v = 10 \sin(\omega t + 30^\circ)$
 $i = 5 \sin(\omega t + 70^\circ)$

Solution:

i leads v by 40° , or v lags i by 40° .

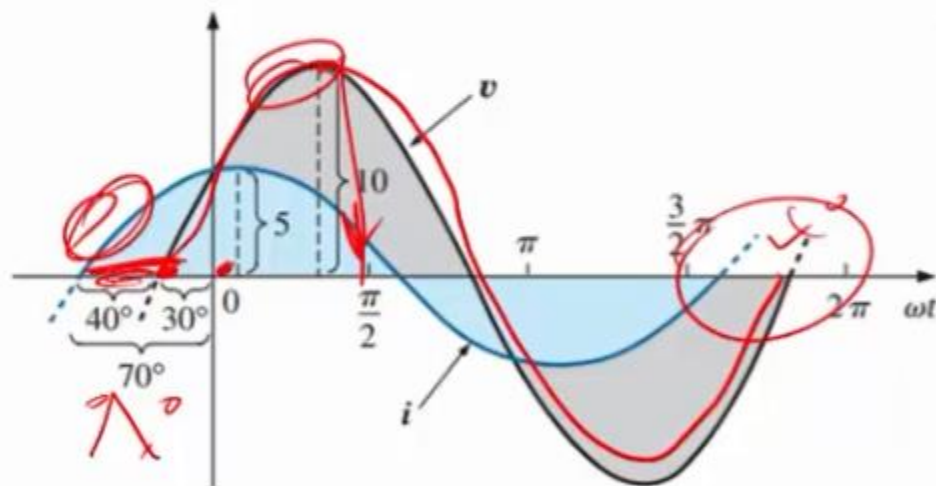


a

Phase Relations

Solution:

i leads v by 40° , or v lags i by 40° .

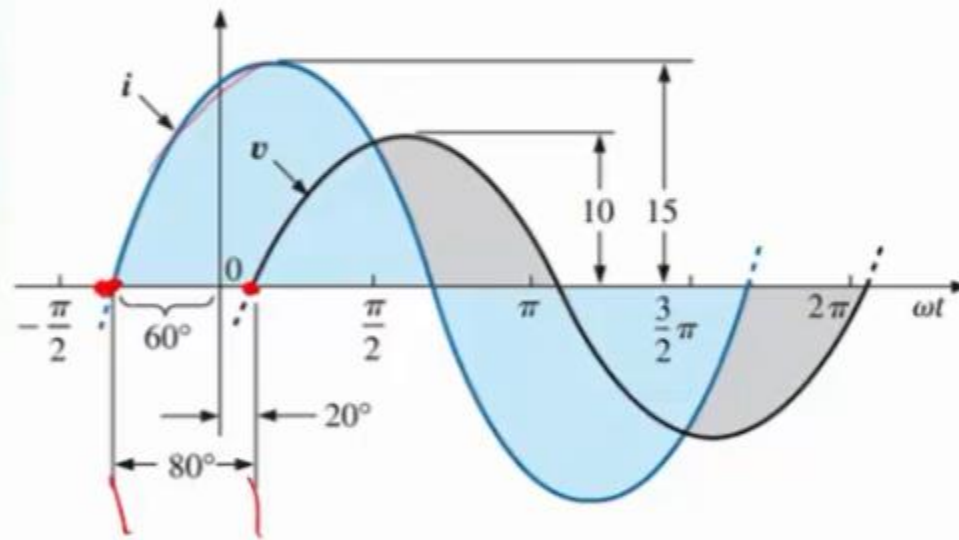


a

a. $v = 10 \sin(\omega t + 30^\circ)$
 $i = 5 \sin(\omega t + 70^\circ)$

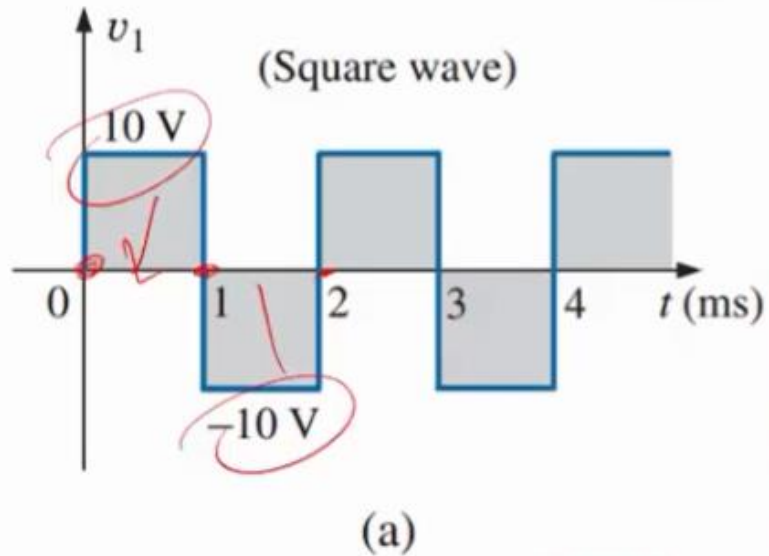
b. $i = 15 \sin(\omega t + 60^\circ)$
 $v = 10 \sin(\omega t - 20^\circ)$

i leads v by 80° , or v lags i by 80° .

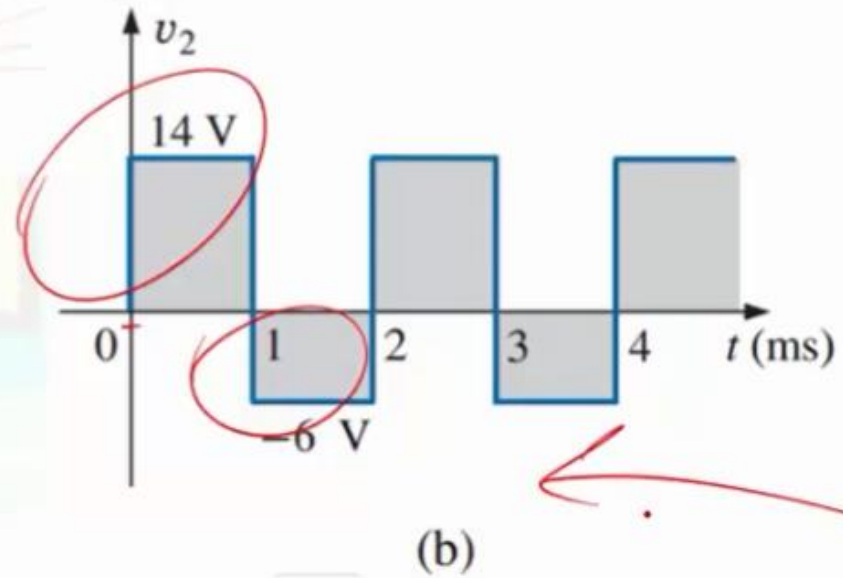


b

Average value



$$G = \frac{(10 \text{ V})(1 \text{ ms}) - (10 \text{ V})(1 \text{ ms})}{2 \text{ ms}} = \frac{0}{2 \text{ ms}} = 0 \text{ V}$$



$$G = \frac{(14 \text{ V})(1 \text{ ms}) - (6 \text{ V})(1 \text{ ms})}{2 \text{ ms}} = \frac{14 \text{ V} - 6 \text{ V}}{2} = \frac{8 \text{ V}}{2} = 4 \text{ V}$$

Effective or rms value

Effective (rms) Values:

The relationship between the peak value and the rms value is the same for voltages, resulting in the following set of relationships for the examples and text material to follow:

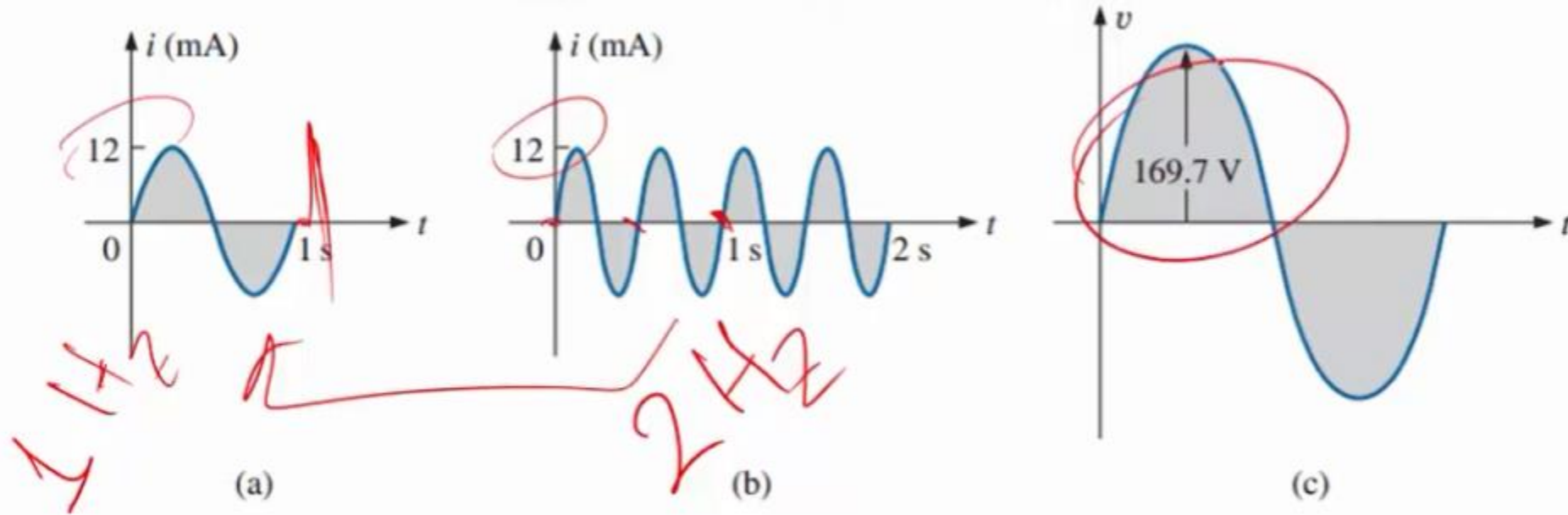
$$I_{\text{rms}} = \frac{1}{\sqrt{2}} I_m = 0.707 I_m$$
$$E_{\text{rms}} = \frac{1}{\sqrt{2}} E_m = 0.707 E_m$$

$$I_m = \sqrt{2} I_{\text{rms}} = 1.414 I_{\text{rms}}$$
$$E_m = \sqrt{2} E_{\text{rms}} = 1.414 E_{\text{rms}}$$

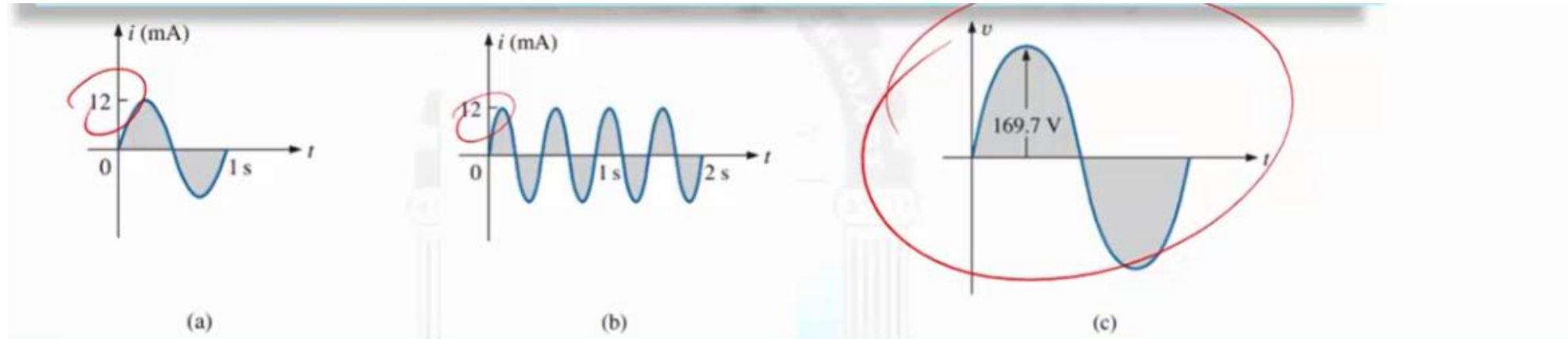


Example

EXAMPLE Find the rms values of the sinusoidal waveform in each part in Fig.



Solution



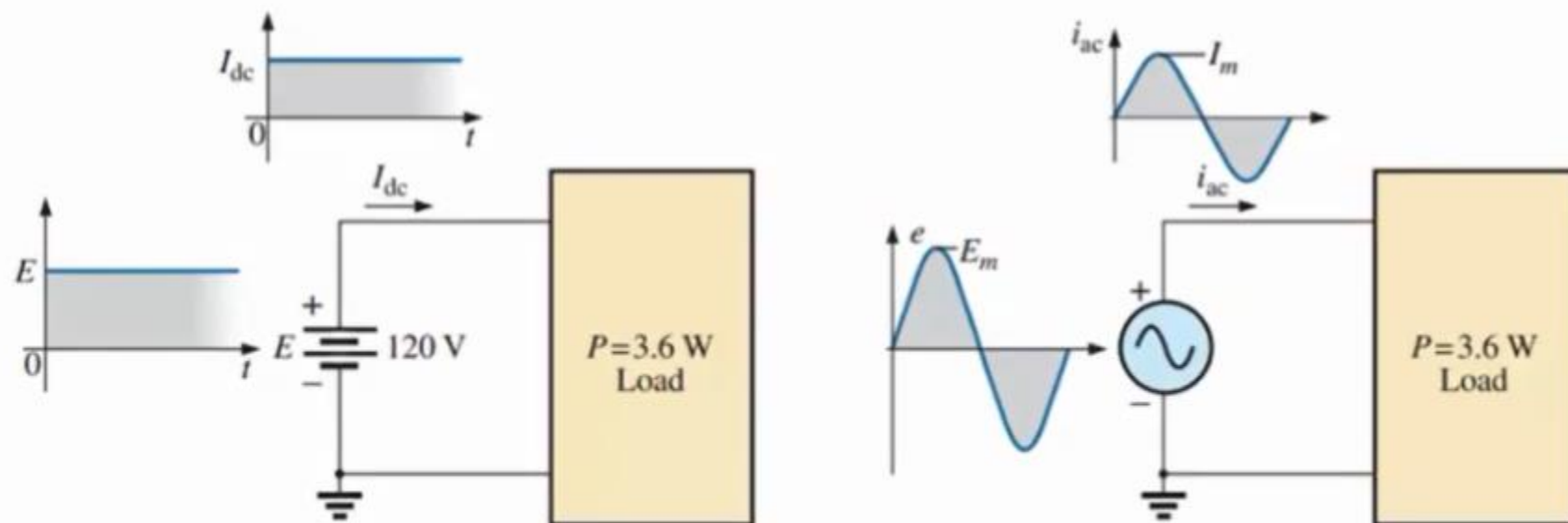
Solution:

For part (a), $I_{\text{rms}} = 0.707(12 \text{ mA}) = 8.48 \text{ mA}$.

For part (b), again $I_{\text{rms}} = 8.48 \text{ mA}$. Note that frequency did not change the effective value in (b) compared to (a).

For part (c), $V_{\text{rms}} = 0.707(169.73 \text{ V}) = 120 \text{ V}$, the same as available from a home outlet.

EXAMPLE The 120 V dc source in Fig. 61(a) delivers 3.6 W to the load. Determine the peak value of the applied voltage (E_m) and the current (I_m) if the ac source [Fig. 61(b)] is to deliver the same power to the load.



Solution:

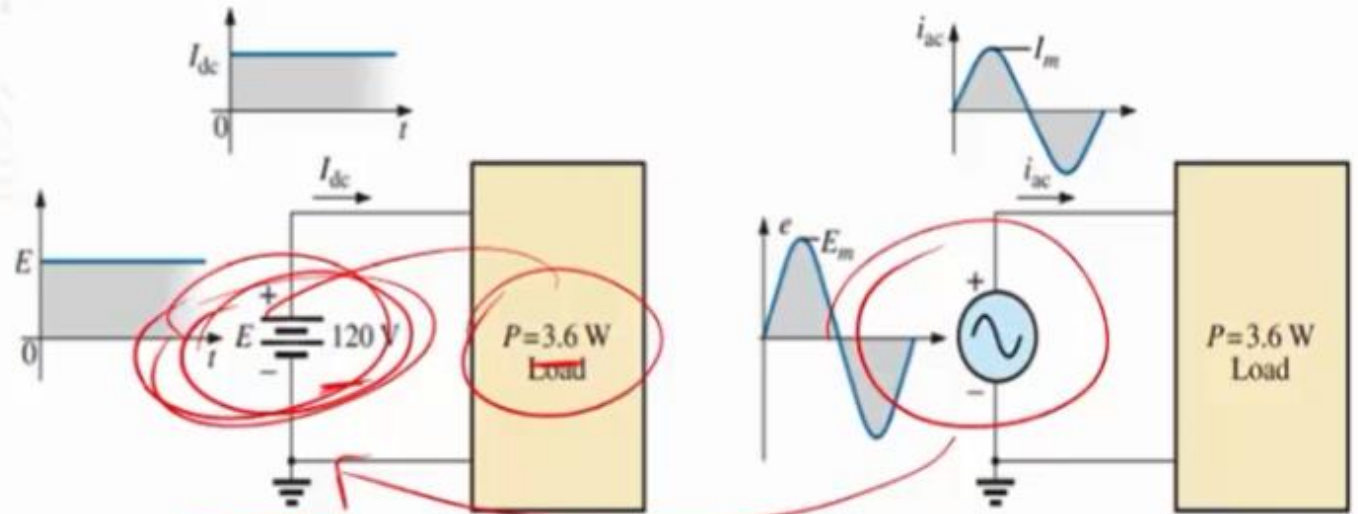
$$P_{dc} = V_{dc} I_{dc}$$

and

$$I_{dc} = \frac{P_{dc}}{V_{dc}} = \frac{3.6 \text{ W}}{120 \text{ V}} = 30 \text{ mA}$$

$$I_m = \sqrt{2} I_{dc} = (1.414)(30 \text{ mA}) = 42.42 \text{ mA}$$

$$E_m = \sqrt{2} E_{dc} = (1.414)(120 \text{ V}) = 169.68 \text{ V}$$



Conclusion

Sinusoidal Alternating Waveforms

Characteristics of a sinusoidal waveform

Phase relations

Average value

Effective value
(V_{rms})