ANALOG ASSIGNMENT

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Question

1. The peak voltage of an AC supply is 300 V. What is the rms voltage?
2. The rms value of current in an AC circuit is 10 A. What is the peak current?

(NCERT)

Solution: Theory

parameter	value	description
$V(t)$	$V_0 \cdot \sin(2\pi ft + \phi)$	voltage in terms of time
$I(t)$	$I_0 \cdot \sin(2\pi ft + \phi)$	current in terms of time
V_0	$300\,\text{V}$	peak voltage
V_{rms}	$\sqrt{\frac{1}{T}\int_0^T [V(t)]^2\,dt}$	rms value of Voltage
I_{rms}	$10\,\text{A}$	rms value of current
I_0	$\sqrt{2} \times I_{\text{rms}}$	peak current
f	$50\,\text{Hz}$	frequence of the sinosoidal wave.
T	$0.02\,\text{s}$	time period of sinosoidal wave.

Table: Input Parameter Table

Theory

$$V_{rms}^2 = \frac{1}{T}\int_0^T [V(t)]^2\,dt \tag{1}$$

$$= f\int_0^{\frac{1}{f}} V_0^2 \cdot \sin^2(2\pi ft + \phi)\,dt \tag{2}$$

$$= \frac{1}{2}V_0^2\left(1 - \frac{1}{f}\int_0^{\frac{1}{f}} \cos(4\pi ft + 2\phi)\,dt\right) \tag{3}$$

$$= \frac{1}{2}V_0^2\left(1 - \frac{1}{f}\left[\frac{\sin(4\pi ft + 2\phi)}{4\pi f}\right]_0^{\frac{1}{f}}\right) \tag{4}$$

$$= \frac{1}{2}V_0^2\left(1 - \frac{1}{f}\cdot\frac{\sin(4\pi + 2\phi) - \sin(0 + 2\phi)}{4\pi f}\right) \tag{5}$$

$$V_{rms} = \frac{V_0}{\sqrt{2}} \tag{6}$$

Theory

To find the RMS voltage (V_{rms}) when the peak voltage (V_0) is 300V, you can use equation (6)

$$V_{\text{rms}} = \frac{300V}{\sqrt{2}} \approx 212.13V \tag{7}$$

Theory

$$I_{rms}^2 = \frac{1}{T}\int_0^T [I(t)]^2\,dt \tag{8}$$

$$= f\int_0^{\frac{1}{f}} I_0^2 \cdot \sin^2(2\pi ft + \phi)\,dt \tag{9}$$

$$= \frac{1}{2}I_0^2\left(1 - \frac{1}{f}\left[\frac{\sin(4\pi ft + 2\phi)}{4\pi f}\right]_0^{\frac{1}{f}}\right) \tag{10}$$

$$= \frac{1}{2}I_0^2\left(1 - \frac{1}{f}\cdot\frac{\sin(4\pi + 2\phi) - \sin(0 + 2\phi)}{4\pi f}\right) \tag{11}$$

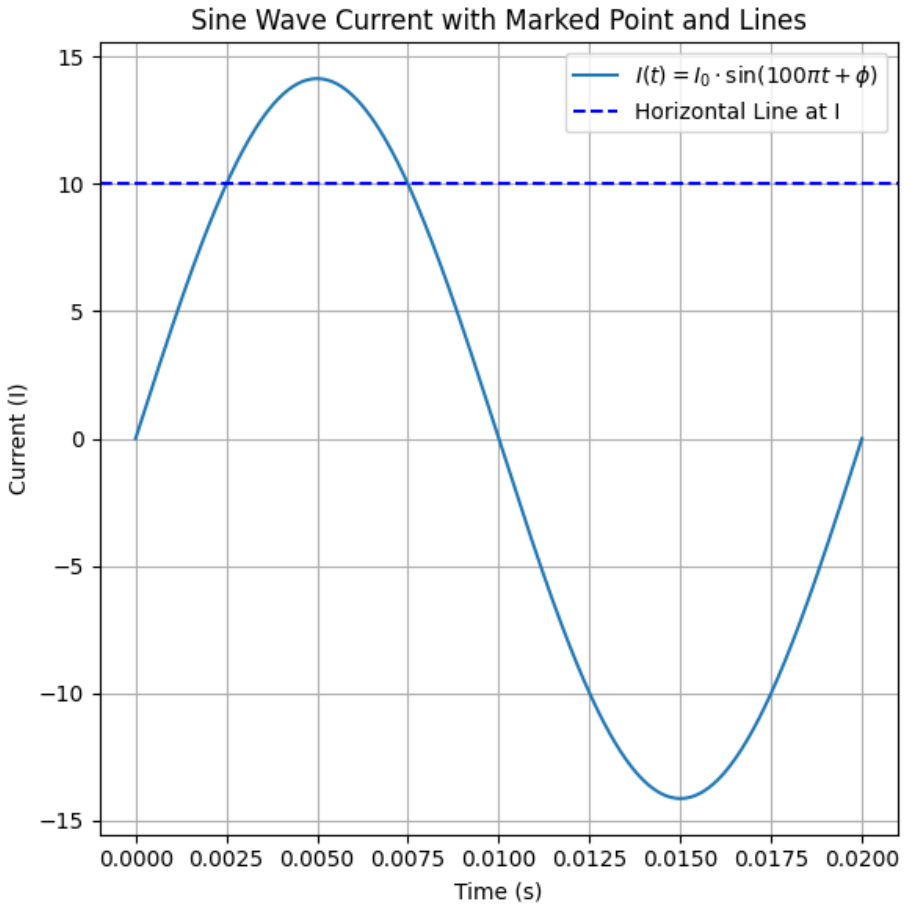
$$I_{rms} = \frac{I_0}{\sqrt{2}} \tag{12}$$

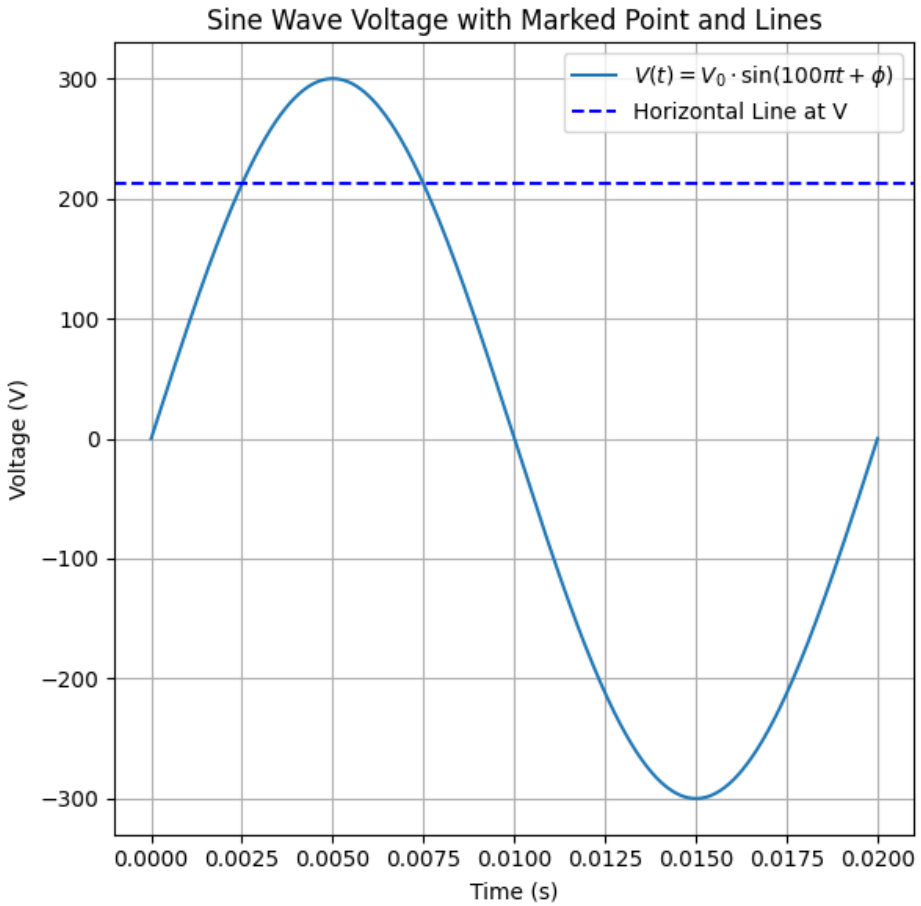
Theory

To find the peak current (I_0) when the RMS current (I_{rms}) is given, you can use equation (12)

$$I_0 \approx 10\,\text{A} \times 1.414 \approx 14.14\,\text{A} \tag{13}$$

Theory


Sine Wave Current with Marked Point and Lines
$I(t) = I_0 \cdot \sin(100\pi t + \phi)$
Horizontal Line at I
Current (I)
Time (s)
15
10
5
0
−5
−10
−15
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200


Sine Wave Voltage with Marked Point and Lines
$V(t) = V_0 \cdot \sin(100\pi t + \phi)$
Horizontal Line at V
Voltage (V)
Time (s)
300
200
100
0
−100
−200
−300
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200