SINUSOIDAL WAVE

AC CIRCUITS

prepared by:

Gyro A. Madrona
Electronics Engineer

TOPIC OUTLINE

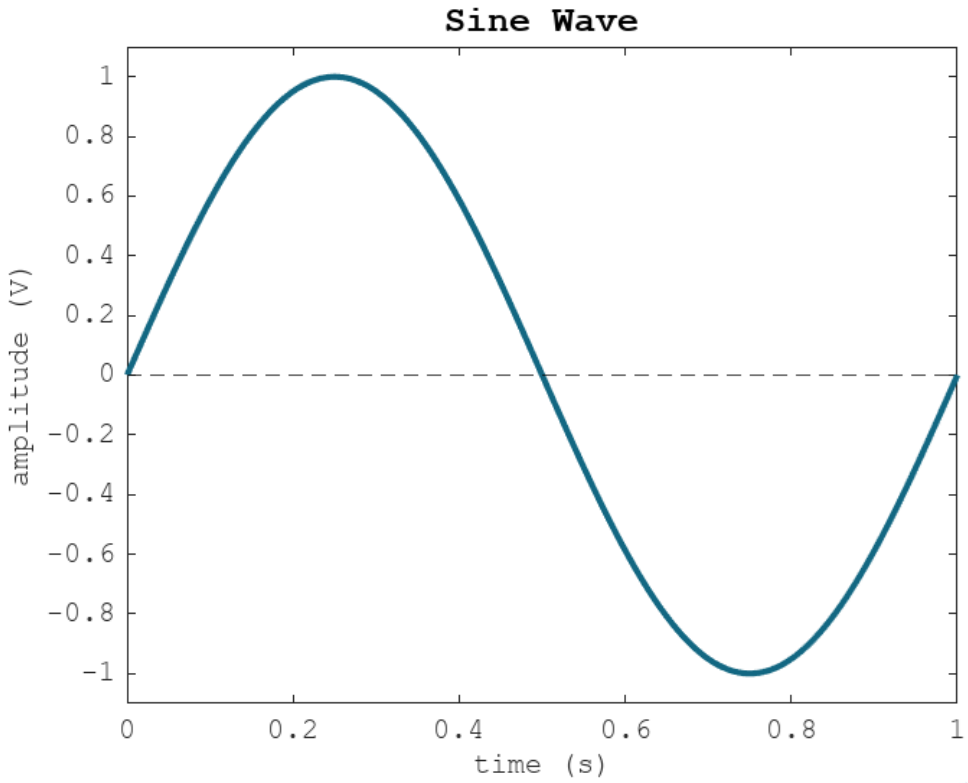
Sinusoidal Wave Parameters

- Instantaneous Voltage
- Peak Voltage
- Root-Mean-Square Voltage
- Period and Frequency

SINUSOIDAL WAVE PARAMETERS

SINUSOIDAL WAVE

A **sinusoidal wave** is a periodic oscillation described mathematically by the **sine** or **cosine function**. It is the foundation for analyzing alternating current (AC) circuits, which are essential in power systems, communication systems, and signal processing.



INSTANTANEOUS VOLTAGE

Instantaneous voltage ($v(t)$) refers to the value of voltage at a specific instant in time during the cycle of a sinusoidal (AC) waveform.

Formula

$$v(t) = v_p \sin \omega t$$

where:

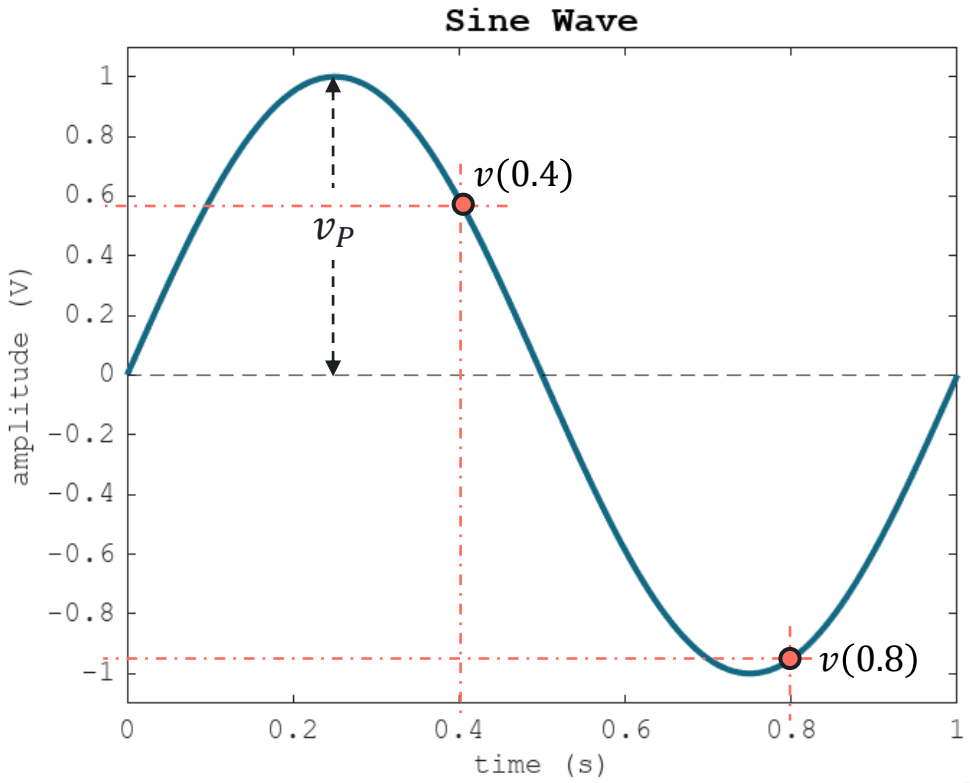
$v(t)$ = instantaneous voltage (V)

v_P = peak/maximum voltage (V)

$\omega = 2\pi f$ = angular speed (rad/s)

f = frequency (Hz)

t = time (s)

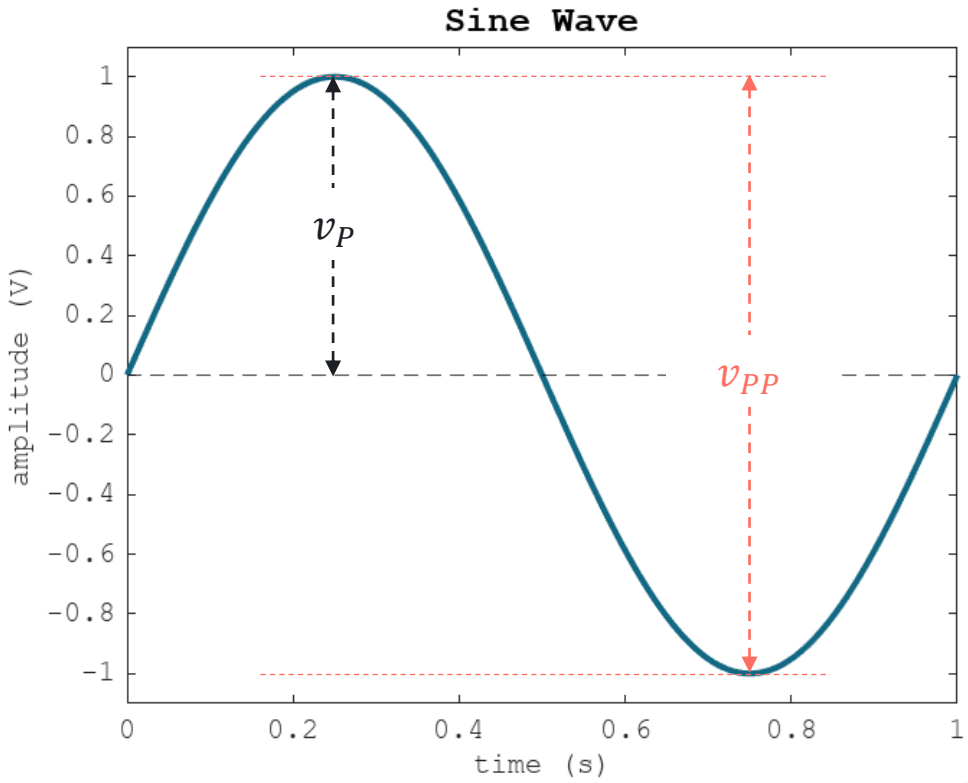


PEAK-TO-PEAK VOLTAGE

Peak-to-peak voltage (v_{PP}) is the total voltage range of an AC waveform. It is the difference between the highest positive point ($+v_P$) and the lowest negative point ($-v_P$) of the wave.

Formula

$$v_{PP} = 2v_P$$

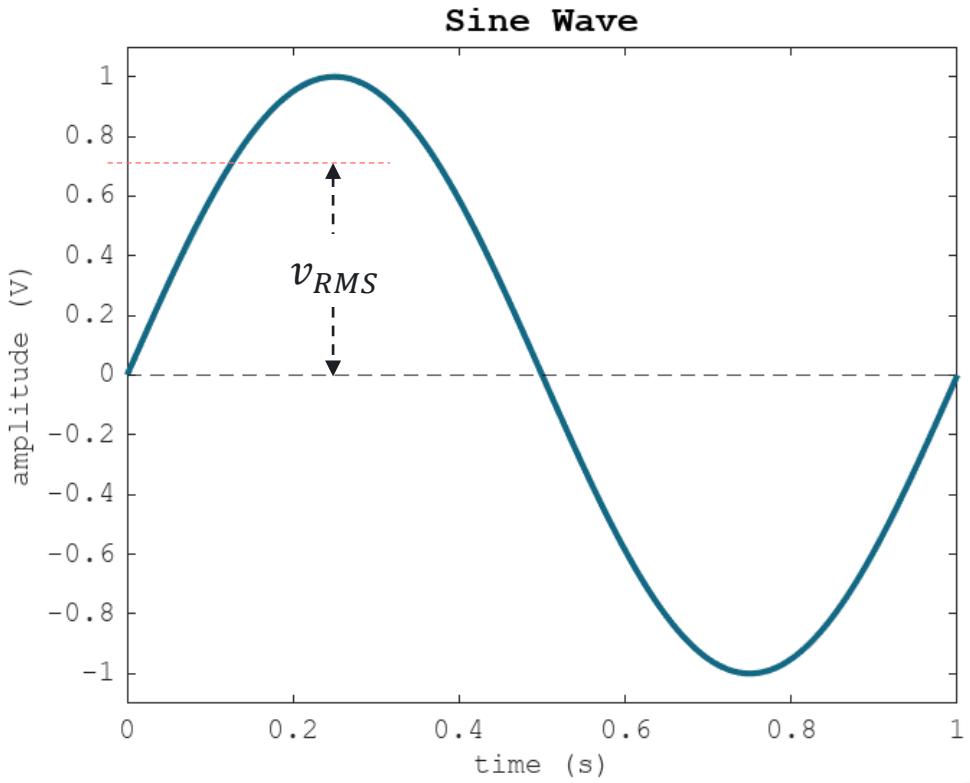


ROOT-MEAN-SQUARE VOLTAGE

The root-mean-square voltage (v_{RMS}) is a measure of the **effective voltage** of an AC signal. When you measure an AC voltage using a multimeter, the displayed value is the RMS voltage.

Formula

$$v_{RMS} = \frac{v_p}{\sqrt{2}}$$

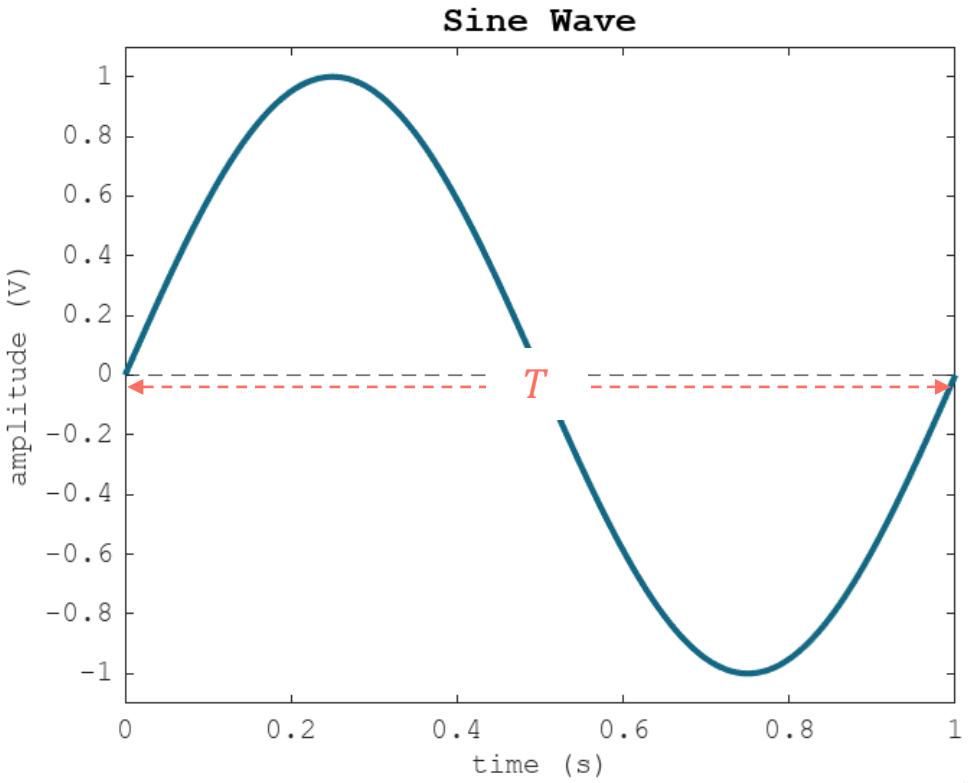


PERIOD AND FREQUENCY

The **period** (***T***) of a waveform describes the time it takes for **one complete cycle** of the waveform to occur. It is the inverse of the **frequency** (***f***), which is the **number of cycles** that the occur per second.

Formula

$$T = \frac{1}{f}$$



EXERCISE

The rms value of the voltage in a 60-cycle circuit is 115 volts. Write the equation for the sinusoidal wave.

V_{rms}

$$V_{rms} = \frac{V_p}{\sqrt{2}}$$

$$V_p = V_{rms}\sqrt{2}$$

$$V_p = 115\sqrt{2}$$

$$V_p = 162.63\ V$$

Solution

$$v(t) = V_p \sin \omega t \qquad \omega = 2\pi f$$

$$v(t) = 162.63 \sin[2\pi(60)t]$$

$$v(t) = 162.63 \sin(120\pi t)$$

ans

EXERCISE

A sinusoidal voltage waveform is described by the equation:

$$v(t) = 120 \sin 377t$$

Determine the following:

a. Frequency (f)

b. Period (T)

c. RMS voltage (v_{RMS})

d. Peak-to-peak voltage (v_{PP})

e. If this voltage is applied across a 10Ω resistor, what is the average power dissipated in the resistor?

Solution

a. $2\pi f t = 377t$

$$f = \frac{377}{2\pi}$$

$$f = 60\,\text{Hz}$$

ans

b. $\text{period} = \frac{1}{f}$

$$\text{period} = \frac{1}{60}$$

$$\text{period} = 16.67\,\text{ms}$$

ans

EXERCISE

A sinusoidal voltage waveform is described by the equation:

$$v(t) = 120 \sin 377t$$

Determine the following:

a. Frequency (f)

b. Period (T)

c. RMS voltage (v_{RMS})

d. Peak-to-peak voltage (v_{PP})

e. If this voltage is applied across a 10Ω resistor, what is the average power dissipated in the resistor?

Solution

c. $V_{rms} = \frac{V_p}{\sqrt{2}}$

$V_{rms} = \frac{120}{\sqrt{2}}$

$V_{rms} = 84.85\,V$

ans

d. $V_{pp} = 2V_p$

$V_{pp} = 2(120)$

$V_{pp} = 240\,V$

ans

EXERCISE

A sinusoidal voltage waveform is described by the equation:

$$v(t) = \mathbf{120}\,\mathbf{sin}\,\mathbf{377}t$$

Determine the following:

a. Frequency (f)

b. Period (T)

c. RMS voltage (v_{RMS})

d. Peak-to-peak voltage (v_{PP})

e. If this voltage is applied across a 10Ω resistor, what is the average power dissipated in the resistor?

Solution

$V_{rms} = 84.85\,V$

$$P = \frac{V^2}{R}$$

$$P = \frac{(84.85)^2}{10}$$

$$P = 719.95\,W$$

ans

LABORATORY