- Linear Circuits and Systems

Review of Sinusoids

Course: Linear Circuits and Systems
Dr. Ahmed Dallal
Electrical and Computer Engineering
University of Pittsburgh

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Nominal form of a sinusoid

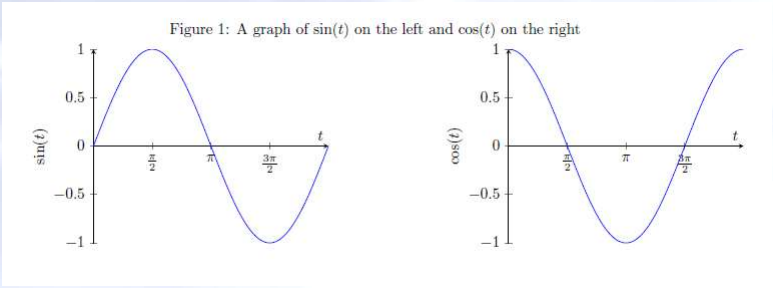
- A typical sinusoid is represented as

$$A\cos(\omega t + \phi) \text{ or}$$
$$A\sin(\omega t + \phi)$$

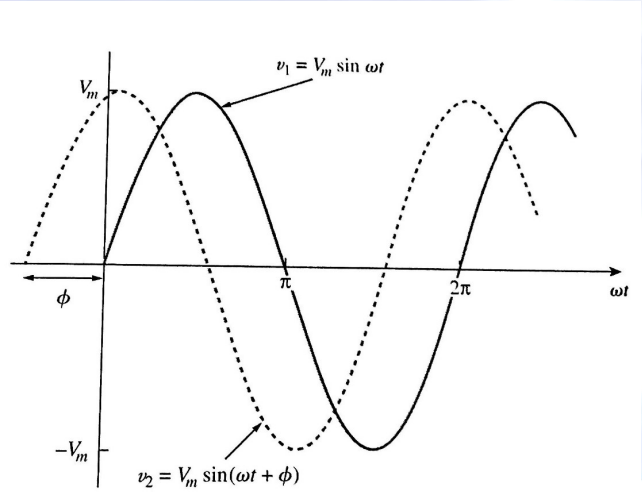
A: Amplitude

ω: Angular frequency

ϕ: Phase shift



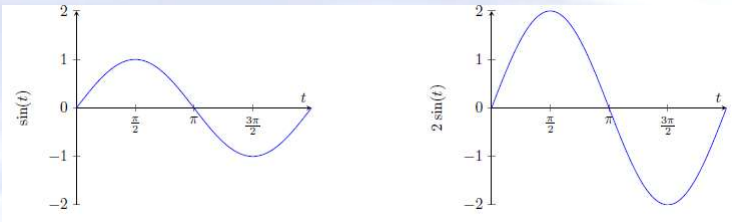
Sinusoidally alternating voltage



Two voltage sinusoids with same frequency and amplitude, but different phases

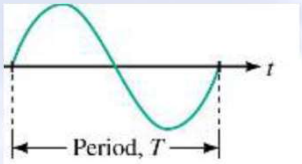
Amplitude

- The **amplitude** of a sinusoid wave is the distance from its average value to its peak



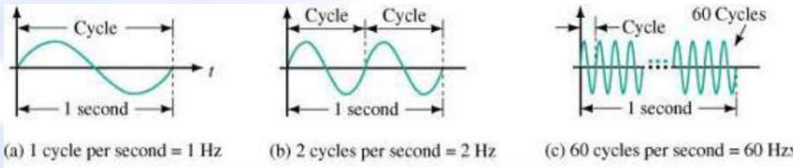
Period

- The period (T) is the time taken to complete one full cycle.



Period and Frequency

- The frequency (f) is the number of cycles per second.
  - The unit of frequency is **hertz** (Hz).
  - 1 Hz = 1 cycle per second.



(a) 1 cycle per second = 1 Hz (b) 2 cycles per second = 2 Hz (c) 60 cycles per second = 60 Hz

Period and Frequency

- The period and the frequency are related by the formula

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

Angular Frequency, ω

- ω is a measure of the angular velocity of the sinusoid.
  - It has units of rad/sec
  - Changes to ω affect sinusoids in the same way changes to f

$$\omega = 2\pi f \quad \text{(rad/s)}$$

$$\omega = 2\pi f = \frac{2\pi}{T} \quad \text{(rad/s)}$$

Phase shift, ϕ

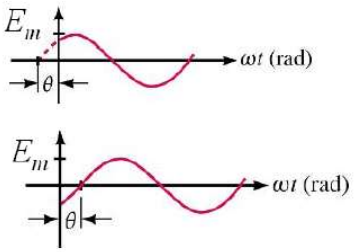
- Phase shift encodes the time shift in sinusoids
- Changing ϕ shifts a sinusoid to the left or the right.

If e is shifted left (Leading), then

$e = E_m \sin(\omega t + \theta)$

If e is shifted right (Lagging), then

$e = E_m \sin(\omega t - \theta)$



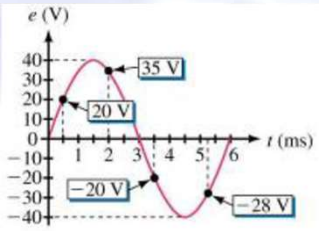
Phase shift, ϕ

- Phase shift ϕ corresponds to shifting the signal T_0 seconds.
- The time shift, T_0, is related to ϕ as follows:

$$T_0 = \frac{\phi}{\omega} = \frac{\phi}{2\pi f} = \frac{\phi T}{2\pi}$$

Instantaneous value

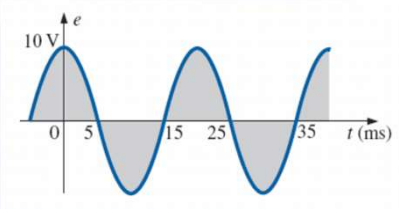
- The **instantaneous value** of a sinusoid is the value of the sinusoid at a particular instant in time.



- We obtain the instantaneous value by at a particular time t_0 by substituting t_0 for t in the sinusoid equation

Example 1

- The signal on the right is defined as $A\sin(\omega t + \phi)$
- Determine the value of A, ω, and ϕ.



Example 2

- A sine wave has a frequency of 100 Hz, phase shift of 0, and an instantaneous value of 100 V at 1.25 msec. What is the voltage at 2.5 msec?

Conclusion

Acknowledgement

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