EEE1024: Fundamentals of Electrical and Electronics Engineering

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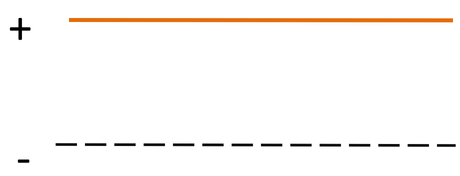
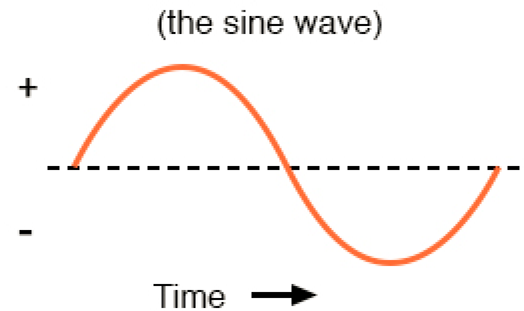
Direct Current Vs Alternating Current

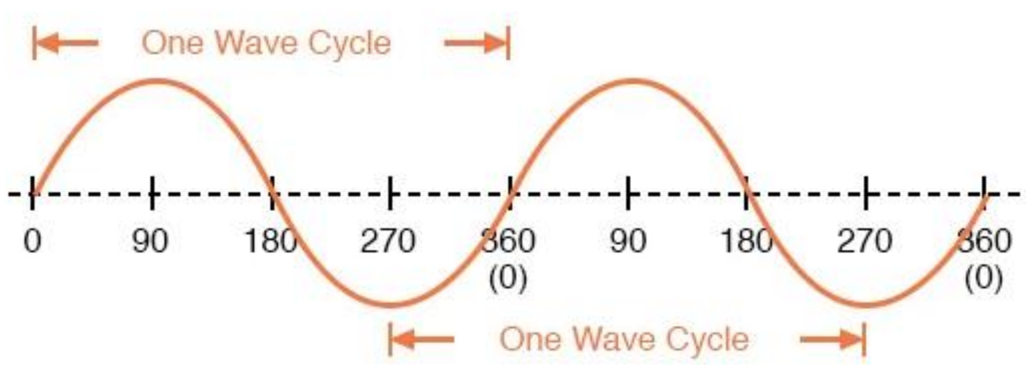
DC voltage



AC voltage



Periodic Motion

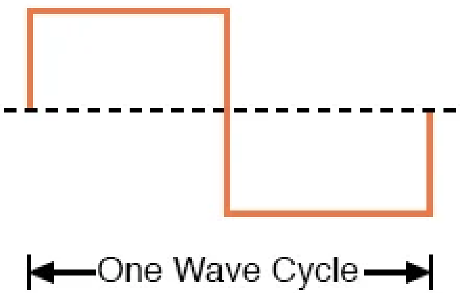


$$Frequency(Hz) = \frac{1}{Period(s)}$$

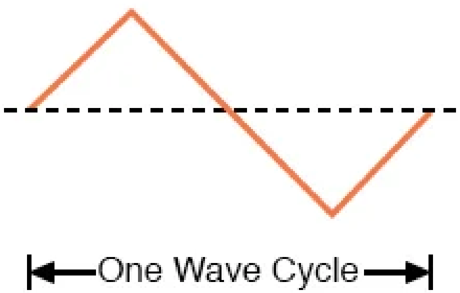
Types of AC waveforms

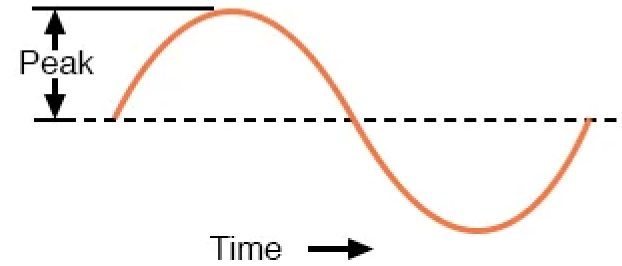
Types of waves

Square Wave



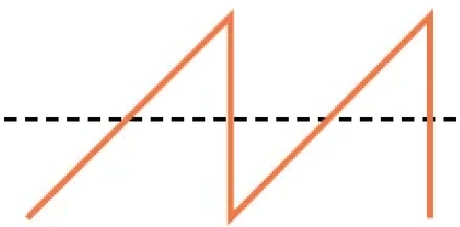
Triangle Wave

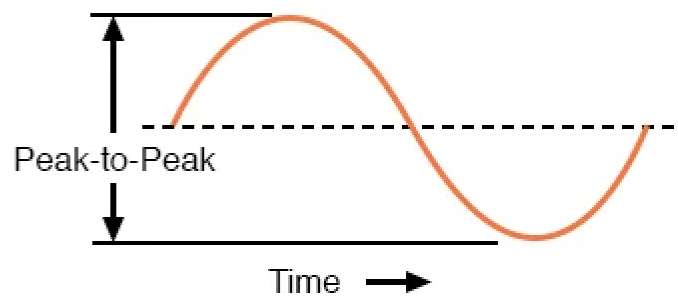




Peak voltage of a waveform.

Sawtooth Wave

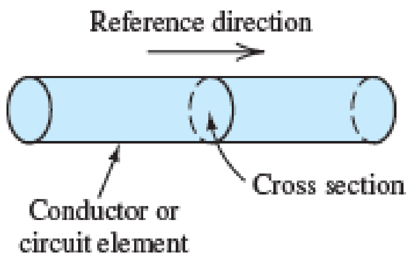




Current = f (time)

$$I(t) = \frac{dq(t)}{dt}$$

$$1A = \frac{1C}{1s}$$



To find charge *q(t)*

$$q(t) = \int_{t_0}^{t} i(t)\,dt + q(t_0)$$

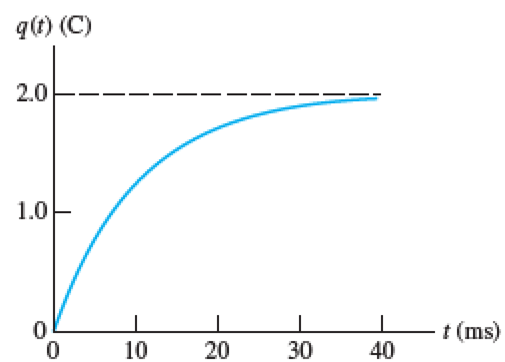
For a given circuit element,

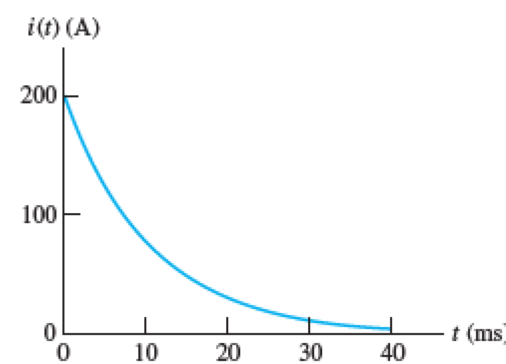
$$q(t) = 0 \qquad \text{for } t < 0$$

$$q(t) = 2 - 2e^{-100t}\ \text{C} \qquad \text{for } t > 0$$

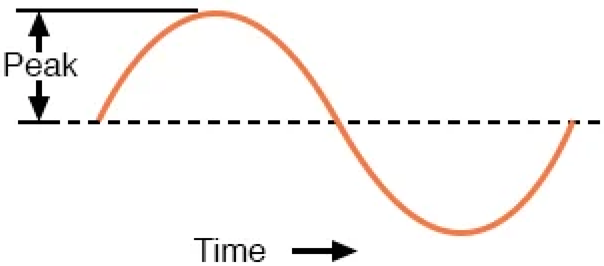
$$\begin{aligned} i(t) &= \frac{dq(t)}{dt} \\ &= 0 \qquad \text{for } t < 0 \\ &= 0 - 2(-100)e^{-100t} \\ &= 200e^{-100t}\ \text{A} \qquad \text{for } t > 0 \end{aligned}$$

Sketch, *q(t)* and *i(t)*

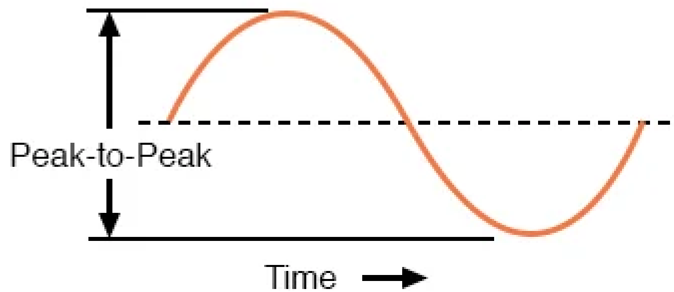




Sinusoidal wave – Average & RMS



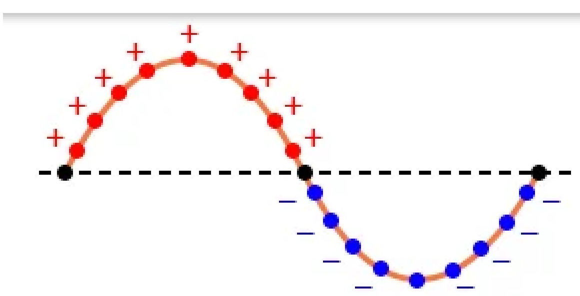
Peak voltage of a waveform.



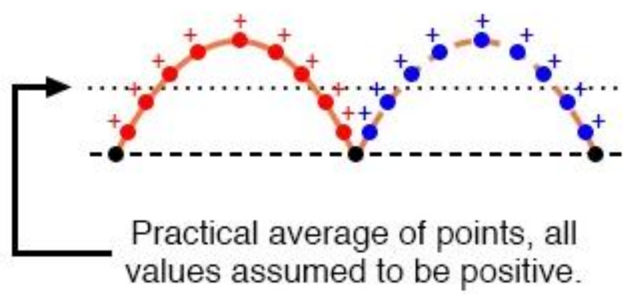
AC

RMS –
Root Mean Square

DC

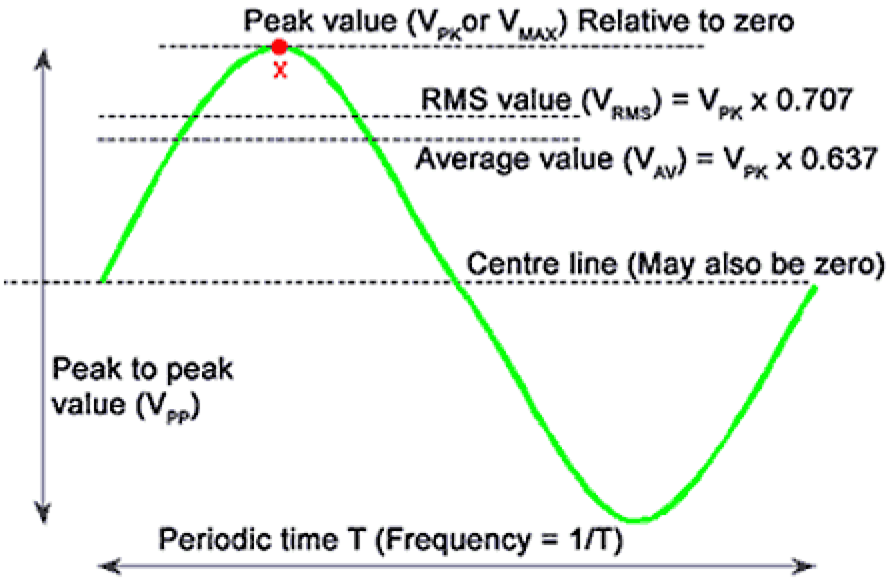


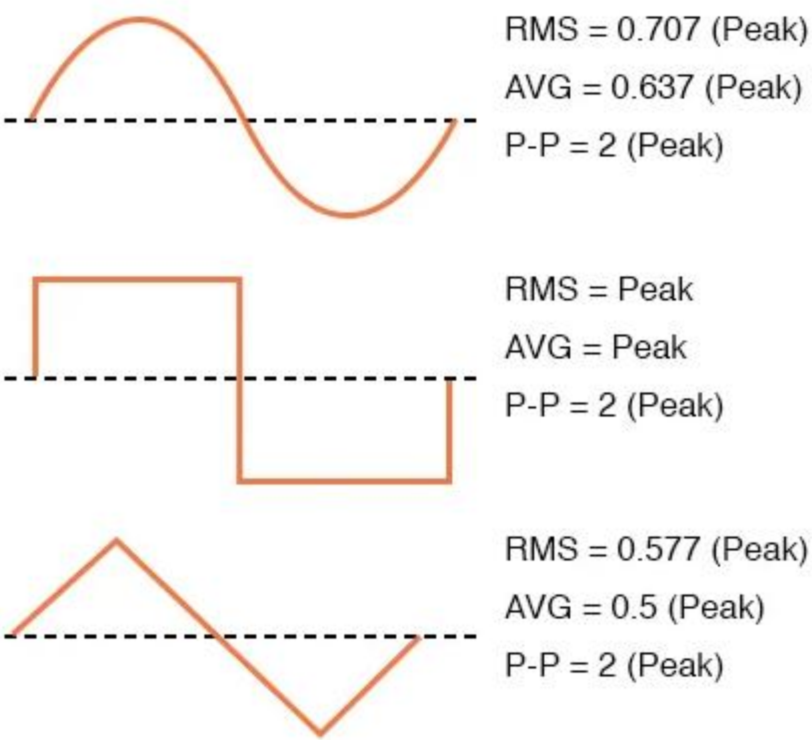
True Average



Practical Average –
Measured by meter

Values of different waveforms



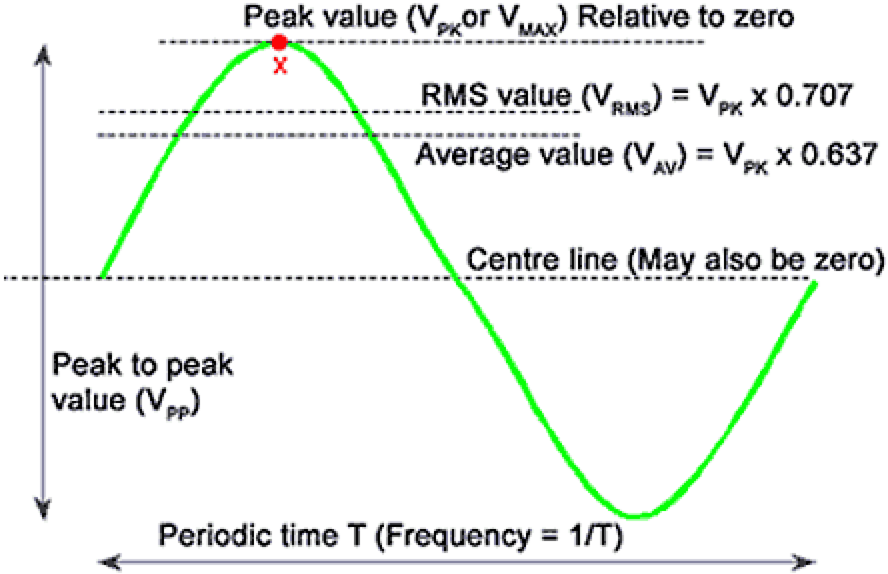


$$V_{AV} = V_{PK} \times 0.637$$

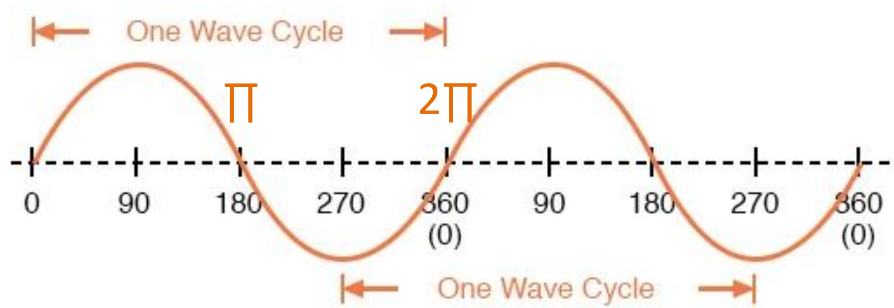
$$V_{RMS} = V_{PK} \times 0.707$$

$$V_{PP} = V_{PK} \times 2$$

Basic Quantities



At any time instant 't' ???



$$v(t) = V_m \sin(\omega t + \theta)$$ ……….. $V_{pk} = V_m$

$$\omega T = 2\pi$$

$$\omega = \frac{2\pi}{T}$$

$$\omega = 2\pi f$$ …………………………… $f = \frac{1}{T}$

$V_{AV} = V_{PK}$ x 0.637

$V_{RMS} = V_{PK}$ x 0.707

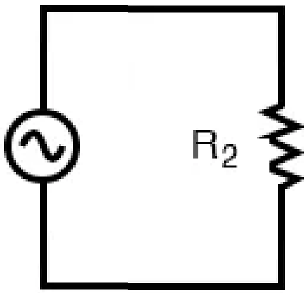
$V_{PP} = V_{PK}$ x 2

$$\pi^c = 180^o$$

$$\sin(\theta) = \cos(\theta - 90^o)$$

Root Mean Square (RMS) - I

A periodic voltage v(t) is applied to a resistor R,



The power delivered to R is $$p(t) = \frac{v^2(t)}{R}$$

Energy delivered in 1 period is $$E_T = \int_0^T p(t)\,dt \quad\cdots\cdots\cdots\cdots\cdots 1W = \frac{1J}{1s}$$

Avg. power delivered to load in 1 period is $$P_{\text{avg}} = \frac{E_T}{T} = \frac{1}{T}\int_0^T p(t)\,dt$$

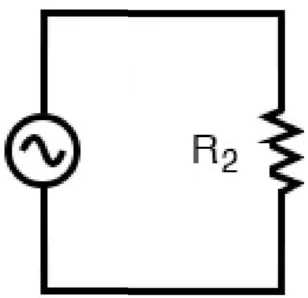
$$P_{\text{avg}} = \frac{1}{T}\int_0^T \frac{v^2(t)}{R}\,dt$$

RMS value is defined as $$V_{\text{rms}} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

$\pi^c = 180^o$

$\sin(\theta) = \cos(\theta - 90^o)$

Root Mean Square (RMS) Voltage related to P_{avg}



Average power

$$P_{\text{avg}} = \frac{1}{T}\int_0^T \frac{v^2(t)}{R}\,dt$$

RMS voltage value is defined as

$$V_{\text{rms}} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

$$P_{\text{avg}} = \frac{\left[\sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}\right]^2}{R}$$

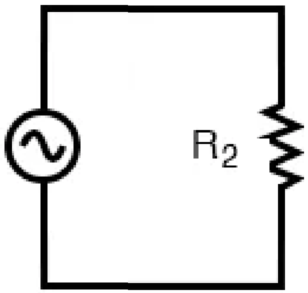
RMS value of VOLTAGE -

$$P_{\text{avg}} = \frac{V_{\text{rms}}^2}{R}$$

$\pi^c = 180^o$

$\sin(\theta) = \cos(\theta - 90^o)$

RMS Current related to P_{avg}



$$P_{\text{avg}} = \frac{1}{T}\int_0^T \frac{v^2(t)}{R}\,dt$$

$$P_{\text{avg}} = \frac{\left[\sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}\,\right]^2}{R}$$

RMS voltage value is defined as

$$V_{\text{rms}} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

RMS current value is defined as

$$I_{\text{rms}} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt}$$

RMS value of CURRENT -

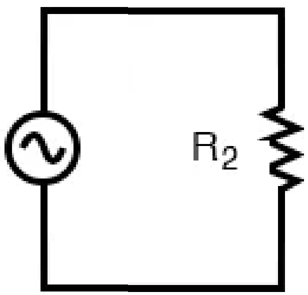
$$P_{\text{avg}} = I_{\text{rms}}^2 R$$

$\pi^c = 180^o$

$\sin(\theta) = \cos(\theta - 90^o)$

RMS values related *Peak* values

$$v(t) = V_m \sin(\omega t + \theta)$$



$$V_{rms} = \frac{V_m}{\sqrt{2}} \qquad I_{rms} = \frac{I_m}{\sqrt{2}}$$

SINUSOIDAL STEADY STATE ANALYSIS

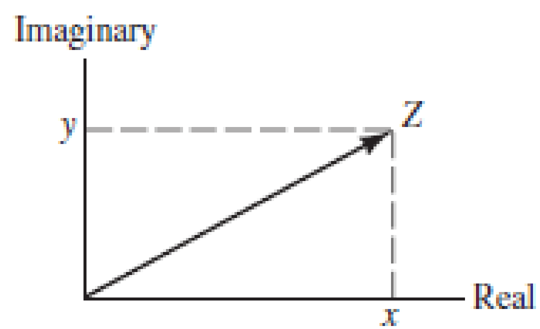
3 sinusoidal voltage sources

$$v(t) = 10\cos(\omega t) + 5\sin(\omega t + 60^\circ) + 5\cos(\omega t + 90^\circ)$$

PHASORS

Voltages and Currents

As vectors



Acknowledgements

1. https://www.allaboutcircuits.com
2. https://learnabout-electronics.org
3. Allan R. Hambley, ‘Electrical Engineering - Principles & Applications, Pearson Education, First Impression, 6/e, 2013