Basic Electrical Technology

[ELE 1051]

SINGLE PHASE AC CIRCUITS

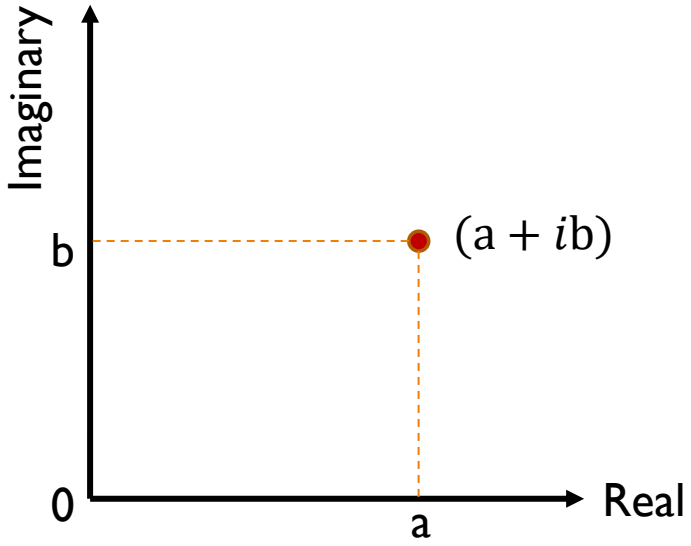
Topics covered…

- Complex numbers
- Comparison of DC & AC
- How is AC generated?
- Terminologies of AC

Complex Number

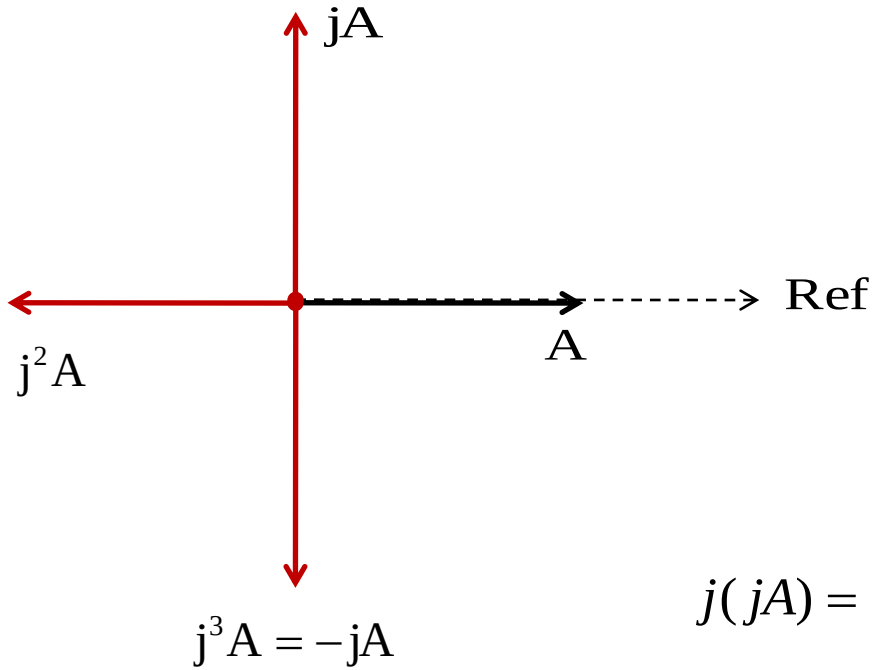
- A **complex number** is of the form **a + *i* b**

- Represented on complex plane as:



The operator 'j'

$j = 1\angle 90°$



$$j(jA) = j^2A = -A$$

Therefore, $j^2 = -1; \quad j = \sqrt{-1}$

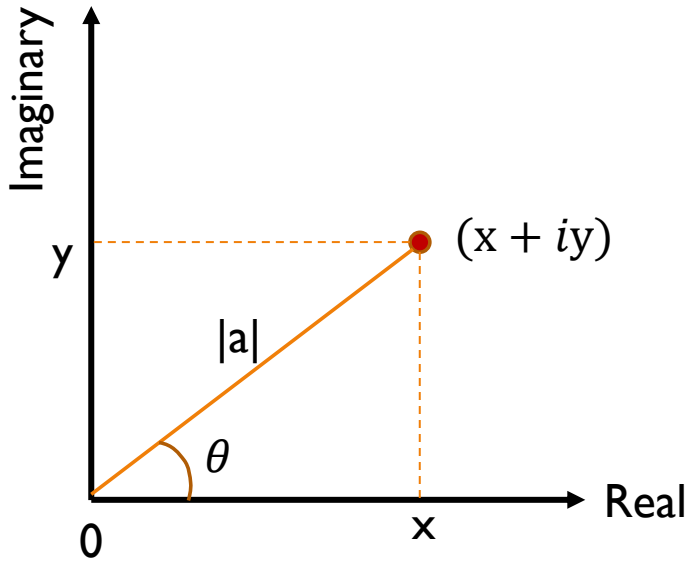
The operator 'j' rotates the given vector by 90 degrees in anti-clockwise direction

Rectangular ↔ Polar conversion

- **Rectangular to polar:**

$$|a| = \sqrt{x^2 + y^2}$$

$$\theta = \tan^{-1}\frac{y}{x}$$



- **Polar to Rectangular:**

$$x = |a|\cos\theta$$

$$y = |a|\sin\theta$$

Representation of a complex number

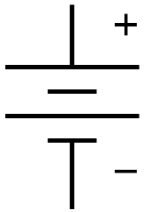
- **Rectangular form:** $\mathbf{a = x \pm jy}$
- **Polar form:** $\mathbf{a = |a| \angle \pm \theta}$
- **Exponential form:** $\mathbf{a = |a| e^{\pm j\theta}}$
- **Trigonometric form:** $\mathbf{a = |a|(\cos\theta \pm j\sin\theta)}$

Rectangular ↔ Polar conversion

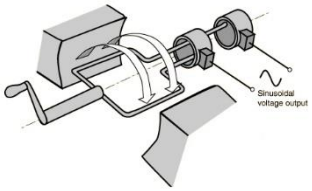
- Convert the following into polar form
  1) $3 + j\,4$ $= 5 \angle 53.13°$
  2) $8 + j\,6$ $= 10 \angle 36.87°$
  3) $8 - j\,6$ $= 10 \angle -36.87°$

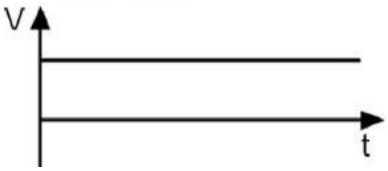
- Convert the following into rectangular form
  1) $5 \angle 30°$ $= 4.33 + j\,2.5$
  2) $3 \angle -60°$ $= 1.5 - j\,2.59$
  3) $-(10 \angle 45°)$ $= -7.07 - j\,7.07$

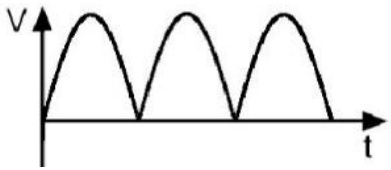
DC vs. AC

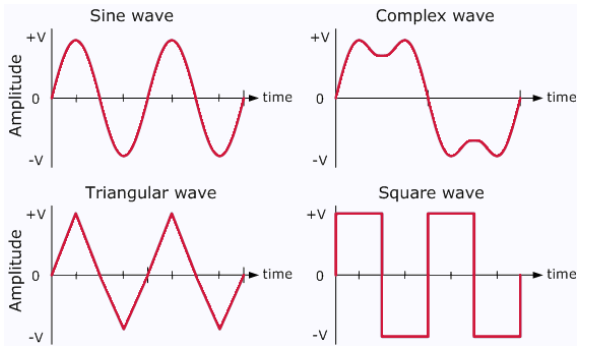


	DC	AC
Obtained from	Battery / cell / derived from AC	AC Generator
Polarity	Positive and Negative	Oscillatory
Frequency	Zero	50Hz or 60Hz
Types	Constant or pulsating	**Sinusoidal**, Trapezoidal, Triangular, Square

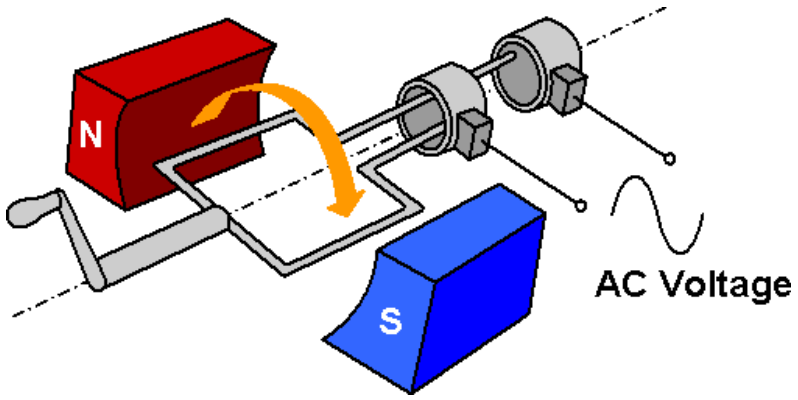




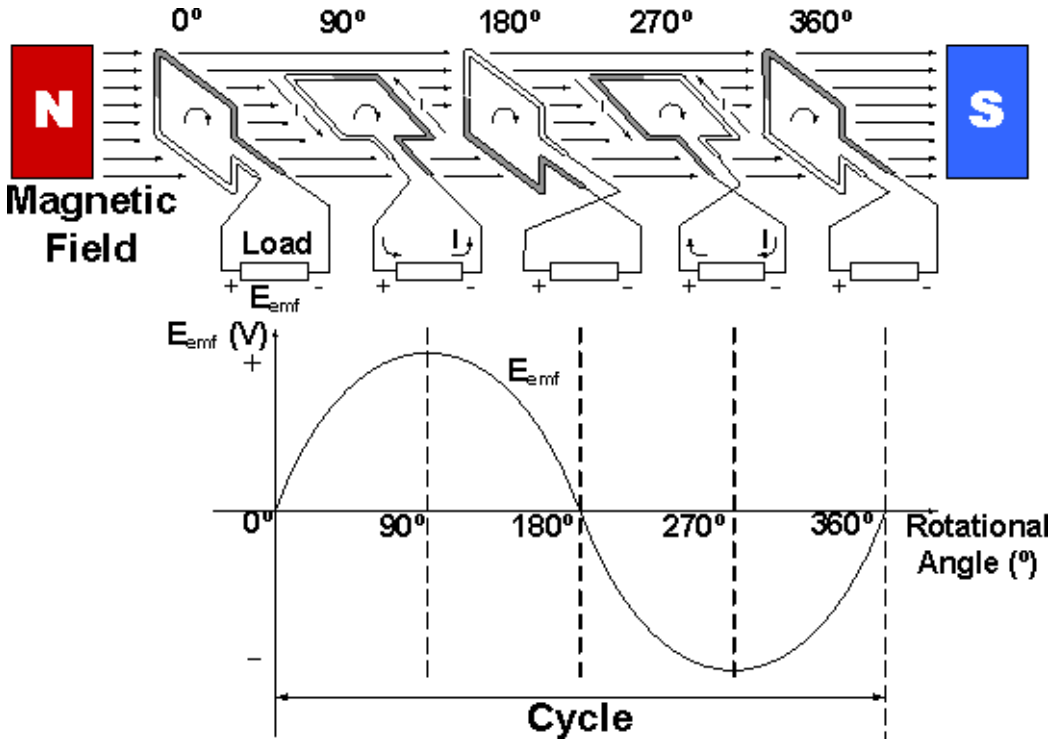




Generation of Alternating EMF



Generator working principle



EMF Equation

EMF induced per conductor is

$$e = B\,l\,v\,\sin\theta$$

EMF Induced in one turn of a coil is

$$e = 2\,B\,l\,v\,\sin\theta$$

If, b = width of the coil,

$$v = \pi\,b\,n$$ *'n' is the speed in revolutions per sec.*

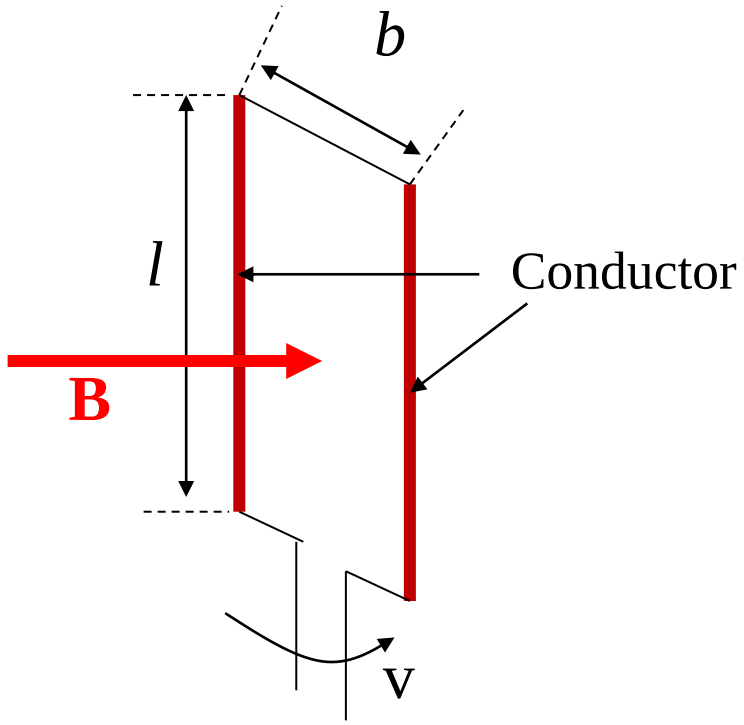
$$e = 2\,B\,l\,b\,\pi\,n\,\sin\theta$$

$$= 2\,B\,A\,\pi\,n\,\sin\theta$$

If there are N turns in the coil, the emf induced is,

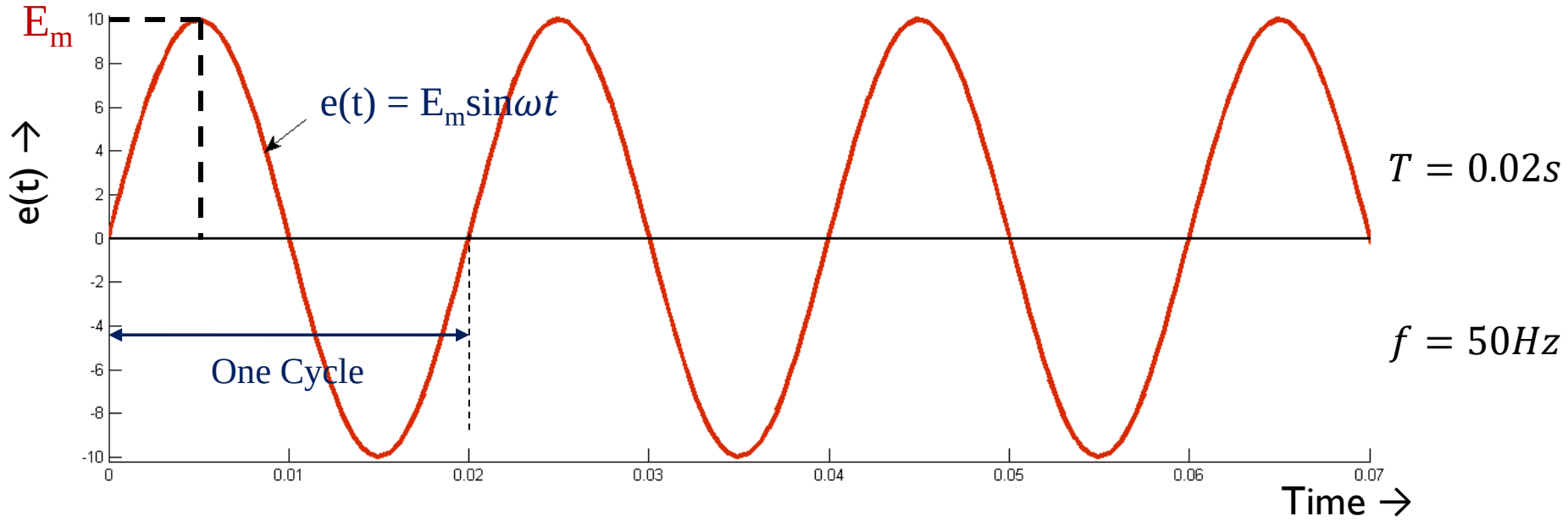
$$e = 2\,\pi\,n\,B\,A\,N\,\sin\theta$$

$$\boxed{e = E_m \sin\theta}$$



Turn of a coil

Terminologies in AC waveform



Cycle: Each repetition of the alternating quantity, recurring at equal intervals

Period (T): Duration of one cycle

Instantaneous Value (e(t)): The magnitude of a waveform at any instant in time

Peak Amplitude: Maximum value or peak value of alternating quantity

Frequency (f): Number of cycles in one second (Hz) $f = \frac{1}{T}$