- **Steady-State Complex Sinusoid**
- **Phase**
- **Decay Time Constant**
- **Generalized Complex Sinusoid**

• Steady-State Complex Sinusoid

a complex sinusoid can be written as:

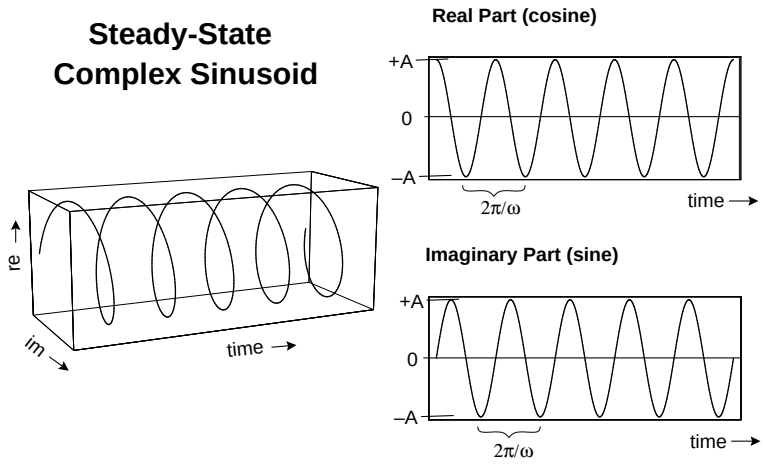
$$A\, e^{j\omega t} = A\cos\,\omega t + j\,A\,\sin\,\omega t$$

where

$$A = \text{amplitude}$$

$$\omega = \text{angular frequency} = 2\pi f$$

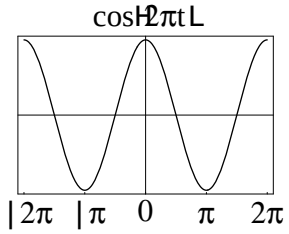
$$t = \text{time variable} = nT \text{ if discrete}$$



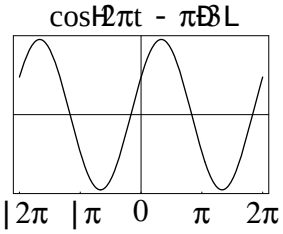
• Phase

$$A\, e^{j(\omega t+\phi)} \;=\; A\cos(\omega t+\phi)+j\,A\,\sin(\omega t+\phi) \;=\; A\, e^{j\phi}\, e^{j\omega t}$$

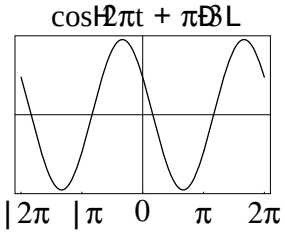
no phase: $e^{j\omega t}$



phase advance: $e^{j(\omega t-\phi)}$

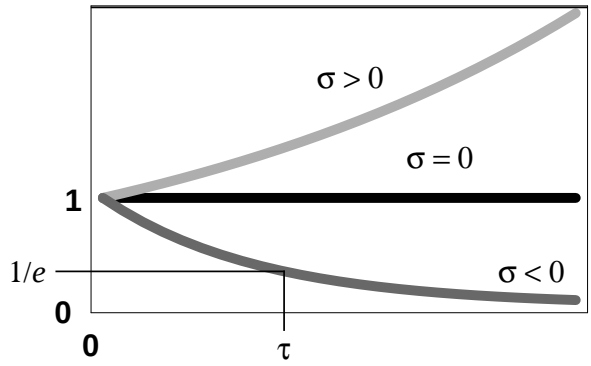


phase delay: $e^{j(\omega t+\phi)}$



• Decay Time Constant

exponential amplitude envelope: $e^{\sigma t}$



Also written as $e^{-t/\tau}$ **: where τ is called the** *"time constant"*.
This is the time it takes for the envelope to decay by 1/e = 0.37

$T_{60} \approx 7\,\tau$, where T_{60} is the time it takes a sound to decay by 60 dB.

• Generalized Complex Sinusoid

$$A\ e^{-t/\tau}\ e^{j\phi}\ e^{j\omega t} = A\, e^{j\omega t + j\phi - t\tau}$$

Amplitude Term

Decay Term

Phase Term

Frequency Term