Phasors

2025-08-04

```
import plotly.io as pio
pio.renderers.default = "plotly_mimetype+notebook_connected"
```

1 Introduction

For many, phasors can feel a bit mystical. Many students may simply memorize the rules associated with them and run calculations without developing a more fundamental understanding. It's not uncommon for this to be the case at both the undergraduate and graduate level.

The goal of this document is to motivate the use of phasors from the ground up, as well as to provide visual representations of complex numbers that make them intuitive to understand. Hopefully by the end, they seem like an obviously good choice for modeling sinusoidal signals.

2 Preliminaries: Complex Numbers and Euler's Equation

Before talking about sinusoids or time domain signals, let's start by coming to grips with Euler's equation. Let's start by asking the question, what does it mean to raise a number to an imaginary power?

$$e^i = ?$$

Exponential notation, e^a, naivly seems to imply a repeated multiplications of e. However, recall that exponents have been extended from natural numbers to whole numbers ($e^0 = 1$), integers ($e^{-a} = 1/e^a$), rational numbers ($e^{1/2} = \sqrt{e}$), and real numbers ($e^\pi - \pi = 20$). None of these hold on to the concept of repeated multiplication. Instead, they use a different property of exponentiation to derive these relationships (namely, $e^a e^b = e^{a+b} \implies \exp(a)\exp(b) = \exp(a+b)$).