EE 102 Week 2, Lecture 1 (Fall 2025)

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1 Goals

- Complex exponentials
- The unit impulse function
- The unit step function

2 Complex exponential signals

Continuous time

$$x(t) = A\, e^{j(\omega_0 t + \phi)} = A\cos(\omega_0 t + \phi) + j\, A\sin(\omega_0 t + \phi).$$

Real and imaginary parts are orthogonal sinusoids. Fundamental period $T_0 = \frac{2\pi}{\omega_0}$.

Discrete time

$$x[n] = A\, e^{j(\Omega_0 n + \phi)}.$$

This is periodic iff $\dfrac{\Omega_0}{2\pi} = \dfrac{M}{N}$ with integers M, N coprime. Then the fundamental period is $N_0 = N$. Otherwise, it is *aperiodic* on $\mathbb{Z}$.

Geometric (phasor) picture

The complex exponential traces a circle of radius A in the complex plane at angular speed ω_0 (continuous) or advances by a fixed angle Ω_0 per sample (discrete). The real part is the projection on the horizontal axis; the imaginary part is the vertical projection.

3 The unit impulse function $\delta(t)$