EN1060 Signals and Systems: Discrete-Time Fourier Series

Ranga Rodrigo
ranga@uom.lk

The University of Moratuwa, Sri Lanka

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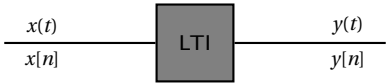
- Now, we have studied Fourier series and Fourier transform for CT signals.
- In this lesson we will develop similar tool for discrete time.
- Specifically, we consider the representation of discrete-time signals though a decomposition as a linear combination of complex exponentials.
  - DT periodic signals → DT Fourier series
  - DT aperiodic signals → DT Fourier transform



Decompose the input as

$$x = a_1\phi_1 + a_2\phi_2 + \cdots \quad \text{linear combination of basic inputs}$$

Then

$$y = a_1\psi_1 + a_2\psi_2 + \cdots \quad \text{linear combination of corresponding outputs}$$

Choose $\phi_k(t)$ or $\phi_k[n]$ such that

- Broad class of signals can be constructed, and
- Response to ϕ_ks easy to compute.

Continuous-Time:
$\phi_k(t) = e^{j\omega_k t}$:

$$e^{j\omega_k t} \longrightarrow H(\omega_k) e^{j\omega_k t} \quad \text{(a scaled-version of the input)}$$

"Discrete-Time":

Example

Determine and sketch the DTFT of

$$x[n] = 1 + \sin\omega_0 n + 3\cos\omega_0 n + \cos\left(2\omega_0 n + \frac{\pi}{2}\right).$$

Example

Determine and sketch the DTFT of $x[n]$ of which is shown in the figure.