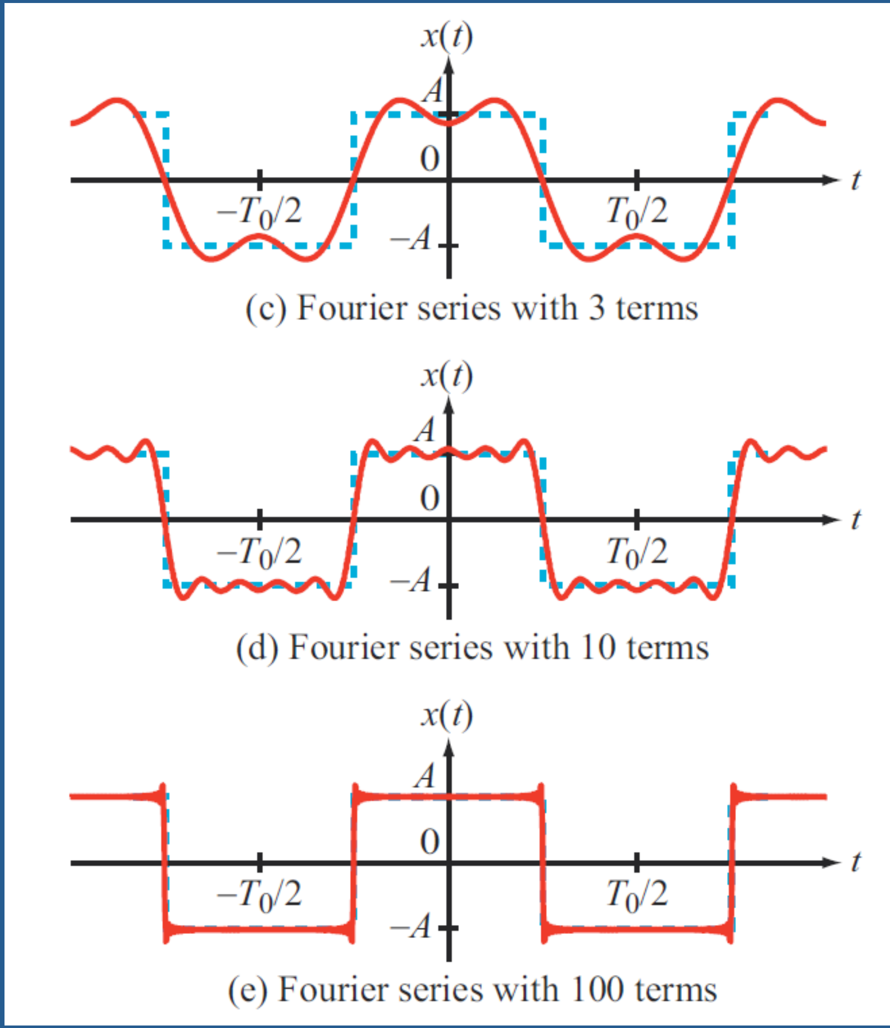

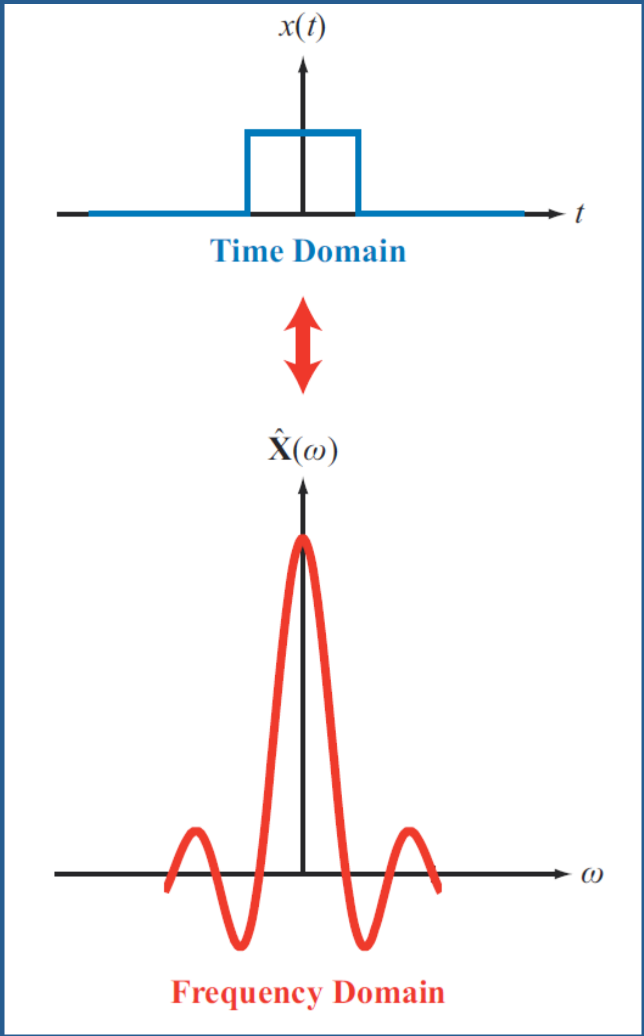

5. FOURIER ANALYSIS TECHNIQUE

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Engineering Signals & Systems by Ulaby & Yagle

Contents

Objectives

Learn to:

- Apply the phasor-domain technique to analyze systems driven by sinusoidal excitations.
- Express periodic signals in terms of Fourier series.
- Use Fourier series to analyze circuits driven by continuous periodic signals.
- Apply Parseval's theorem to compute the power or energy contained in a signal.
- Compute the Fourier transform of nonperiodic signals and use it to analyze the system response to nonperiodic excitations.

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Phasor Analysis: Basics

- If an LTI system is described by a differential equation with an eternal sinusoidal input, then phasor analysis is a simple procedure for computing the system response.
- The system response is also an eternal sinusoidal signal.
- The phasor associated with signal $\upsilon(t) = V_0 \cos(\omega t + \phi)$ is the complex number $\mathbf{V} = V_0 e^{j\phi}$

$$\upsilon(t) = V_0 \cos(\omega t + \phi) \quad \longleftrightarrow \quad \mathbf{V} = V_0 e^{j\phi}$$

- If $\mathbf{X} = |\mathbf{X}|e^{j\phi}$ then $\mathfrak{Re}[|\mathbf{X}|e^{j\phi}e^{j\omega t}] = |\mathbf{X}|\cos(\omega t + \phi)$

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Phasor Analysis: Basics

- The effects of differentiation and integration are:

$x(t)$		$\mathbf{X}$
$A\cos\omega t$	$\leftrightarrow$	A
$A\cos(\omega t+\phi)$	$\leftrightarrow$	$Ae^{j\phi}$
$-A\cos(\omega t+\phi)$	$\leftrightarrow$	$Ae^{j(\phi\pm\pi)}$
$A\sin\omega t$	$\leftrightarrow$	$Ae^{-j\pi/2}=-jA$
$A\sin(\omega t+\phi)$	$\leftrightarrow$	$Ae^{j(\phi-\pi/2)}$
$-A\sin(\omega t+\phi)$	$\leftrightarrow$	$Ae^{j(\phi+\pi/2)}$
$\frac{d}{dt}[A\cos(\omega t+\phi)]$	$\leftrightarrow$	$j\omega Ae^{j\phi}$
$\int A\cos(\omega t'+\phi)\,dt'$	$\leftrightarrow$	$\frac{1}{j\omega}Ae^{j\phi}$

$$i(t)=\Re\mathfrak{e}[\mathbf{I}e^{j\omega t}]$$

$$\frac{di}{dt} \leftrightarrow j\omega\mathbf{I}.$$

$$\int i\,dt' \leftrightarrow \frac{\mathbf{I}}{j\omega}$$

- Use these properties to convert manipulations of sines and cosines into manipulations of complex numbers.

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