

# Lecture Version for An Introduction to the Fourier Transform

By

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This document was specially prepared for use in lecture. It is designed for the instructor or student to change variables and observe their effect on a time domain waveform and a frequency domain spectrum.

# The Test Waveform and Integration

Sample and signal parameters:

$$\omega_{\text{signal}} := 2 \cdot \pi \cdot (2 \cdot \text{Hz})$$

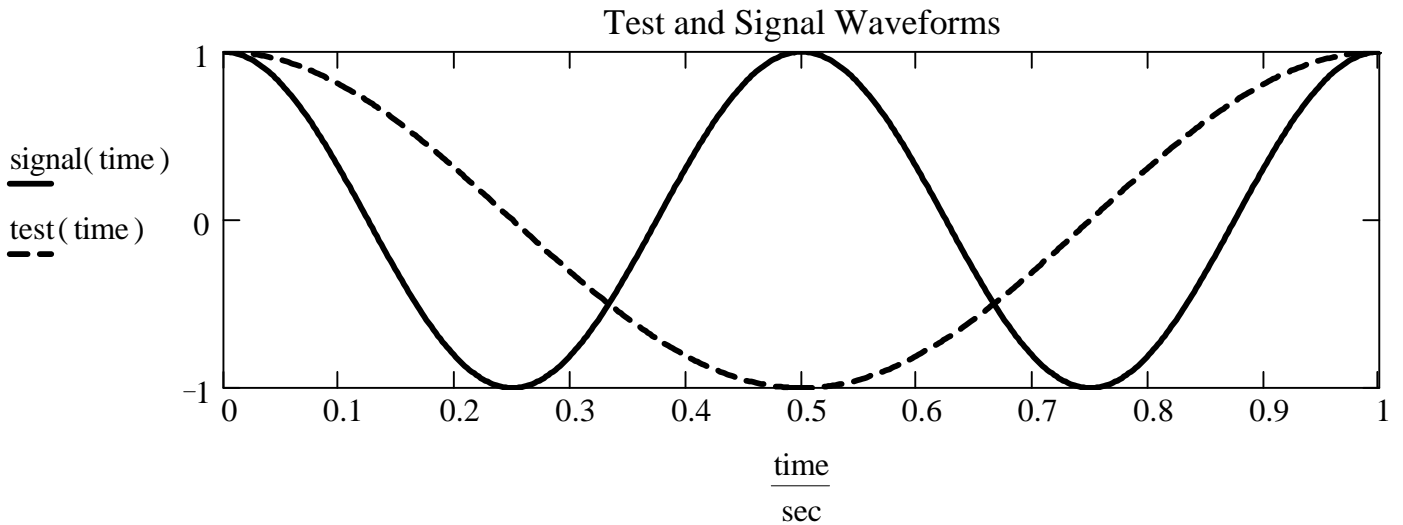
$$\omega_{\text{test}} := 2 \cdot \pi \cdot (1 \cdot \text{Hz})$$

Equation for the signal wave, test wave and time.

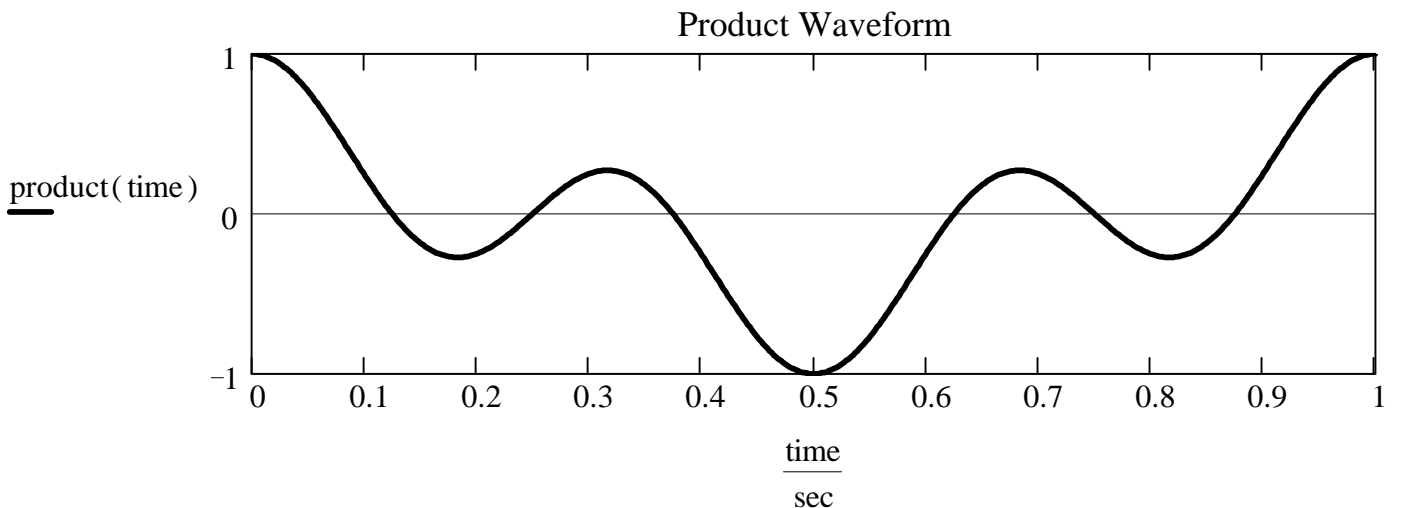
$$\text{time} := 0 \cdot \text{sec}, \frac{1}{512} \cdot 1 \cdot \text{sec} .. 1 \cdot \text{sec}$$

$$\text{signal}(t) := \cos(\omega_{\text{signal}} \cdot t)$$

$$\text{test}(t) := \cos(\omega_{\text{test}} \cdot t)$$



$$\text{product}(t) := \text{test}(t) \cdot \text{signal}(t)$$



Integrate:

$$\int_{0 \cdot \text{sec}}^{1 \cdot \text{sec}} \text{product}(t) dt = 0 \cdot \text{sec}$$

# The Frequency Spectrum

## Setup Calculations

$$N := 1024 \quad t_{\text{acquire}} = 50 \cdot \text{sec} \quad i := 0, 1 \dots N - 1 \quad A := 1$$

$$t_i := \frac{i}{N} \cdot t_{\text{acquire}} \quad j := 0, 1 \dots \frac{N}{2} - 1 \quad \text{frequency}_j := \frac{j}{t_{\text{acquire}}}$$

$$\text{signal}_i := A \cdot \cos(t_i \cdot \omega + \phi) \cdot e^{-\frac{t_i}{T_1}} \quad F := \text{fft}(\text{signal})$$

Variables:	Signal Frequency	$\omega = 2 \cdot \pi \cdot (5 \cdot \text{Hz})$
	Signal Phase	$\phi = 0 \cdot \text{deg}$
	Acquisition Time	$t_{\text{acquire}} = 50 \cdot \text{sec}$
	Relaxation Rate	$T_1 = 5 \cdot \text{sec}$

