

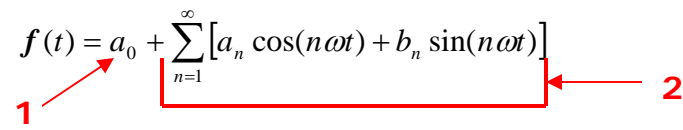
## Supplement to Chapter 4 of *The Science of Digital Media* – Digital Audio Representation

### Worksheet – Digital Audio > Fourier Transform<sup>1</sup>

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Before completing this worksheet, you should view the on-line interactive tutorial “Fourier Transform Introduction.” This tutorial can be accessed at the website for *The Science of Digital Media*.

1. In the following equation for the continuous, periodic Fourier series, indicate which of the parts of the equation represents the AC component and which represents the DC component, and explain what each of these components represents in the waveform.

$$f(t) = a_0 + \sum_{n=1}^{\infty} [a_n \cos(n\omega t) + b_n \sin(n\omega t)]$$


1.

2.

2. Explain what is meant by the term “transform.” When applying the Fourier transform to audio signals, what does the transform do to a waveform in the time domain? How is this useful in the realm of digital audio?

3. From looking at the inverse DFT, whose equation is given below, what can you learn about the relationship between simple sinusoidal waves and a more complex waveform?

$$f_k = \sum_{n=0}^{N-1} \left[ a_n \cos\left(\frac{2\pi nk}{N}\right) + b_n \sin\left(\frac{2\pi nk}{N}\right) \right]$$

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4. In the forward discrete Fourier transform, whose equation is shown below, what does each  $F_n$  indicate as  $n$  varies from 0 to  $N-1$ ? Remember that  $F$  represents the result array after the transform is applied.

$$F_n = \frac{1}{N} \sum_{k=0}^{N-1} f_k \cos\left(\frac{2\pi nk}{N}\right) - i f_k \sin\left(\frac{2\pi nk}{N}\right)$$

5. What does it mean when the  $F_n$  value for a specific  $n$  is a large number? Does this indicate a presence or lack of presence of the specific frequency that the  $F_n$  component represents?
6. Explain how a frequency analysis is created, what role the Fourier transform plays in its formation, and what it indicates about a signal.