Bangladesh Army University of Engineering & Technology

CSE-3215
Data Communication

Lecture-10

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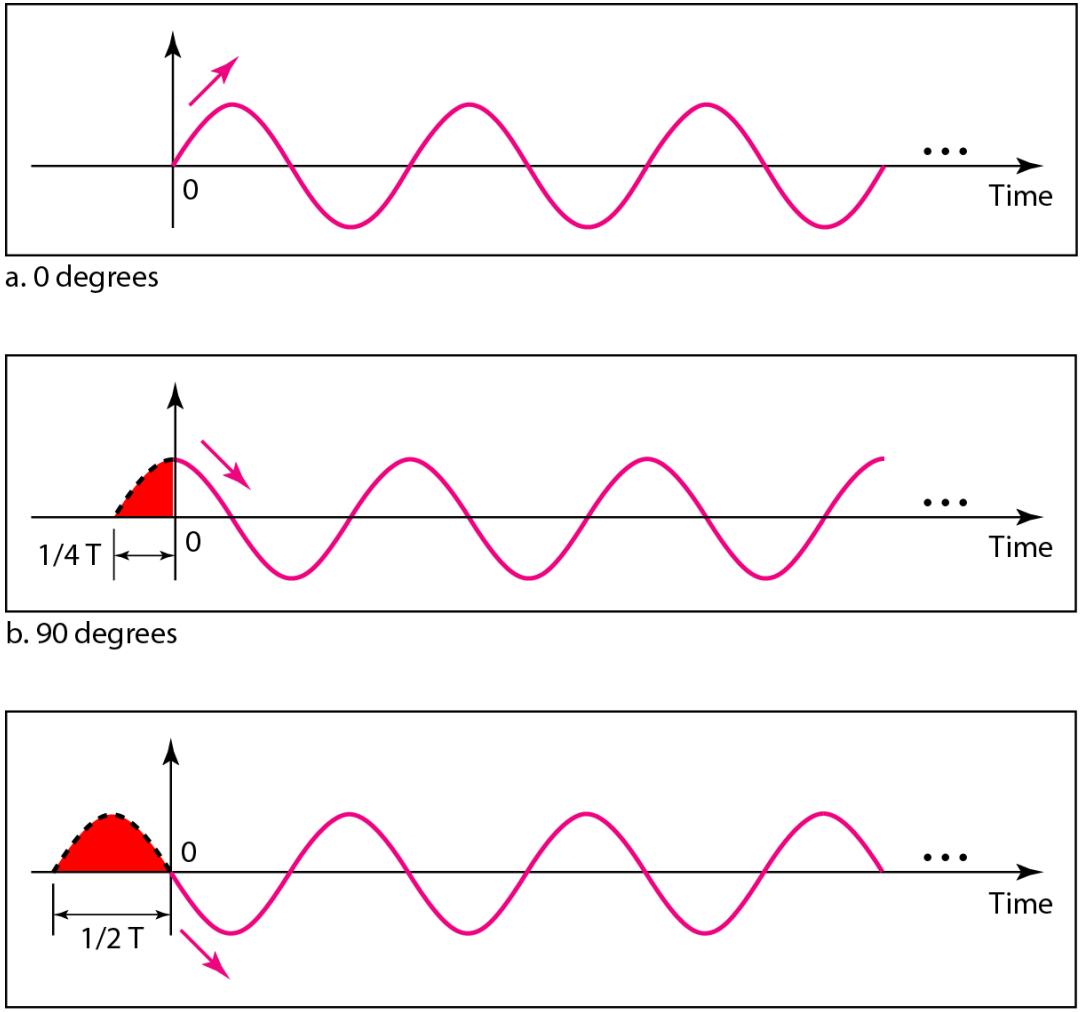


Figure-1: Three sine waves with the same amplitude and frequency, but different phases

Note

If a signal does not change at all, its frequency is zero.
If a signal changes instantaneously, its frequency is infinite.

Note

Phase describes the position of the waveform relative to time 0.

A sine wave is offset 1/6 cycle with respect to time 0. What is its phase in degrees and radians?

Solution

We know that 1 complete cycle is 360°. Therefore, 1/6 cycle is

$$\frac{1}{6} \times 360 = 60° = 60 \times \frac{2\pi}{360} \text{ rad} = \frac{\pi}{3} \text{ rad} = 1.046 \text{ rad}$$

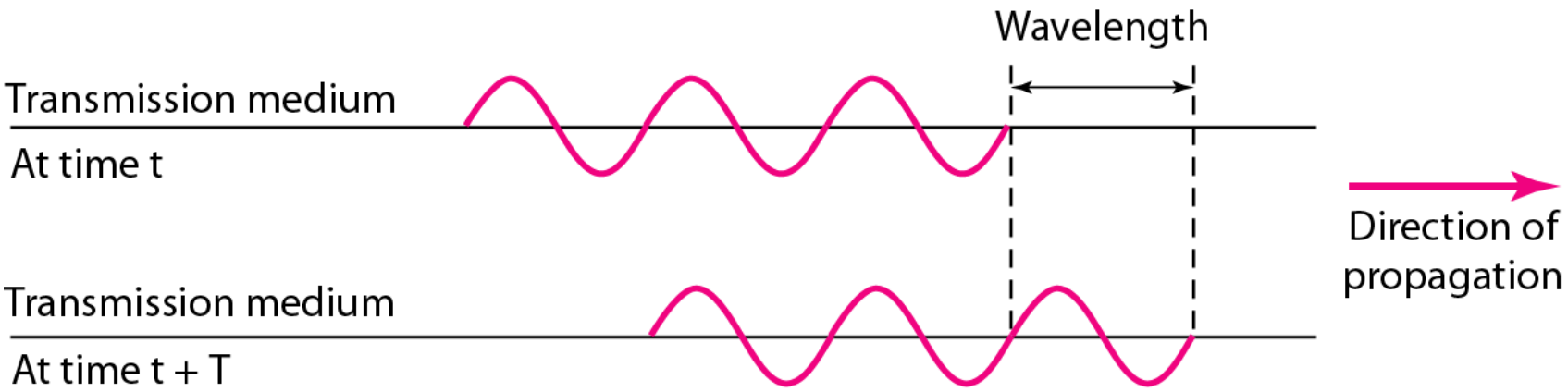
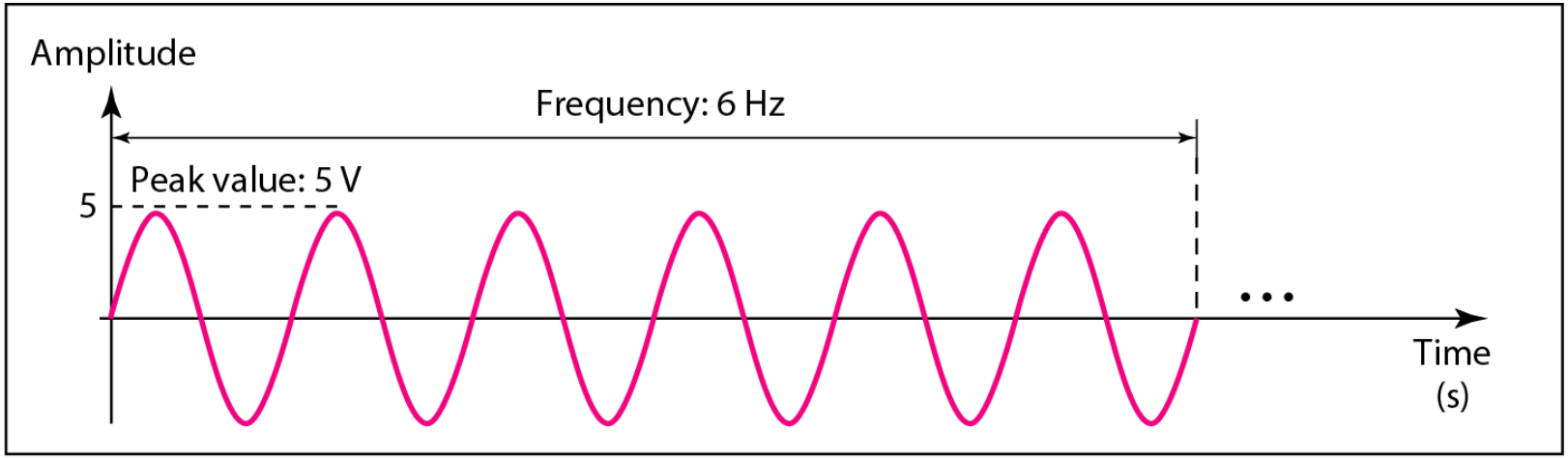
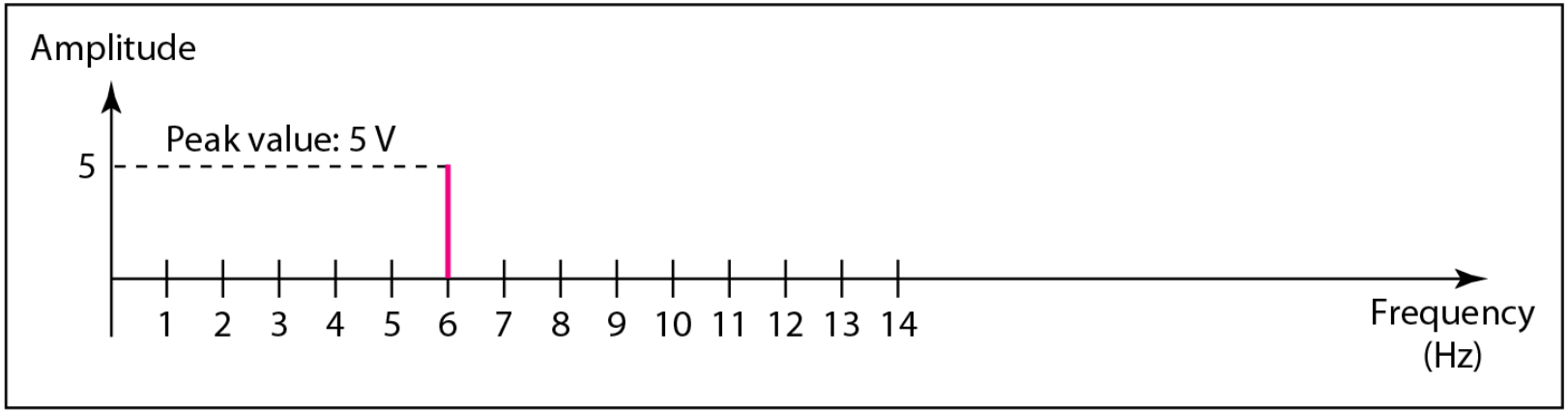


Figure-2: Wavelength and period



a. A sine wave in the time domain (peak value: 5 V, frequency: 6 Hz)



b. The same sine wave in the frequency domain (peak value: 5 V, frequency: 6 Hz)

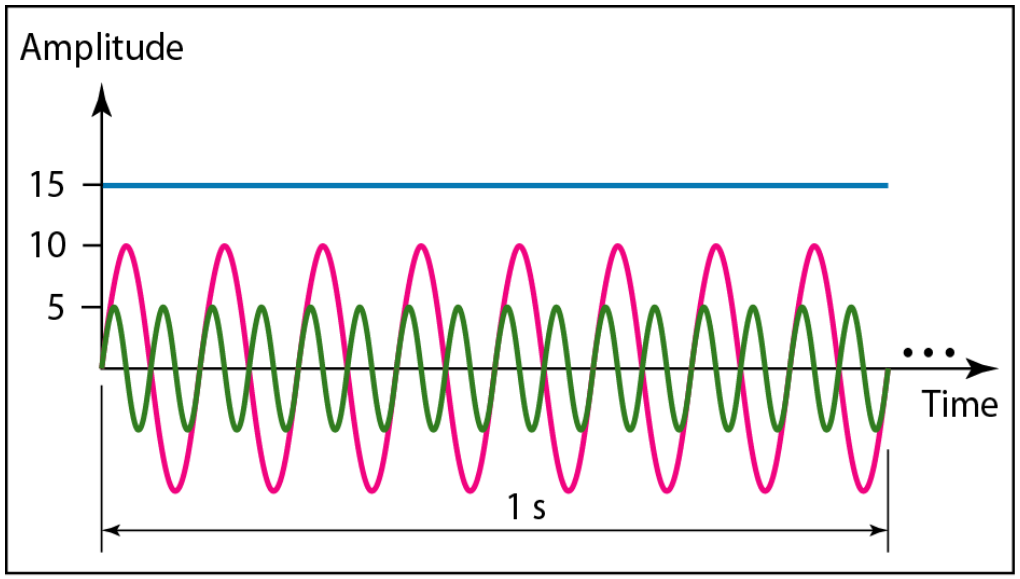
Figure-3: The time-domain and frequency-domain plots of a sine wave

Note

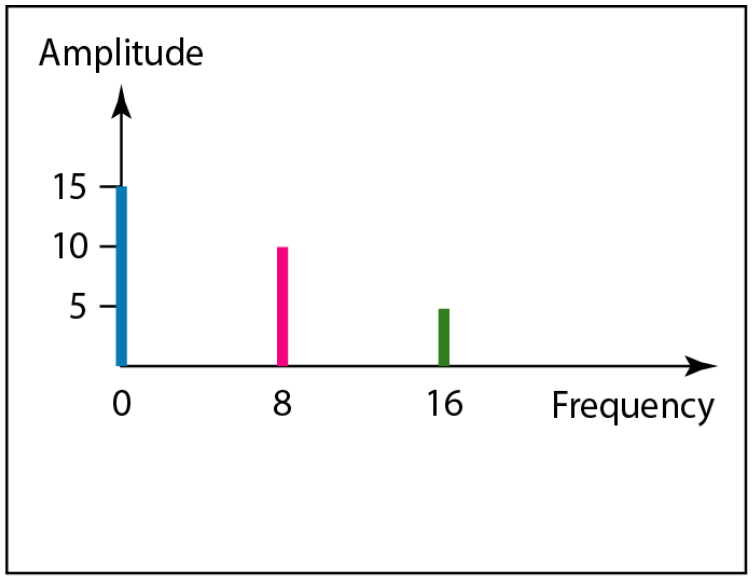
A complete sine wave in the time domain can be represented by one single spike in the frequency domain.

An Example

The frequency domain is more compact and useful when we are dealing with more than one sine wave. For example, *Figure 4* shows three sine waves, each with different amplitude and frequency. All can be represented by three spikes in the frequency domain.



a. Time-domain representation of three sine waves with frequencies 0, 8, and 16



b. Frequency-domain representation of the same three signals

Figure-4: The time domain and frequency domain of three sine waves

Note

A single-frequency sine wave is not useful in data communications; we need to send a composite signal, a signal made of many simple sine waves.

Composite Signal

Figure 5 shows a periodic composite signal with frequency f. We can consider it to be three alarm systems, each with a different frequency. The analysis of this signal can give us a good understanding of how to decompose signals.

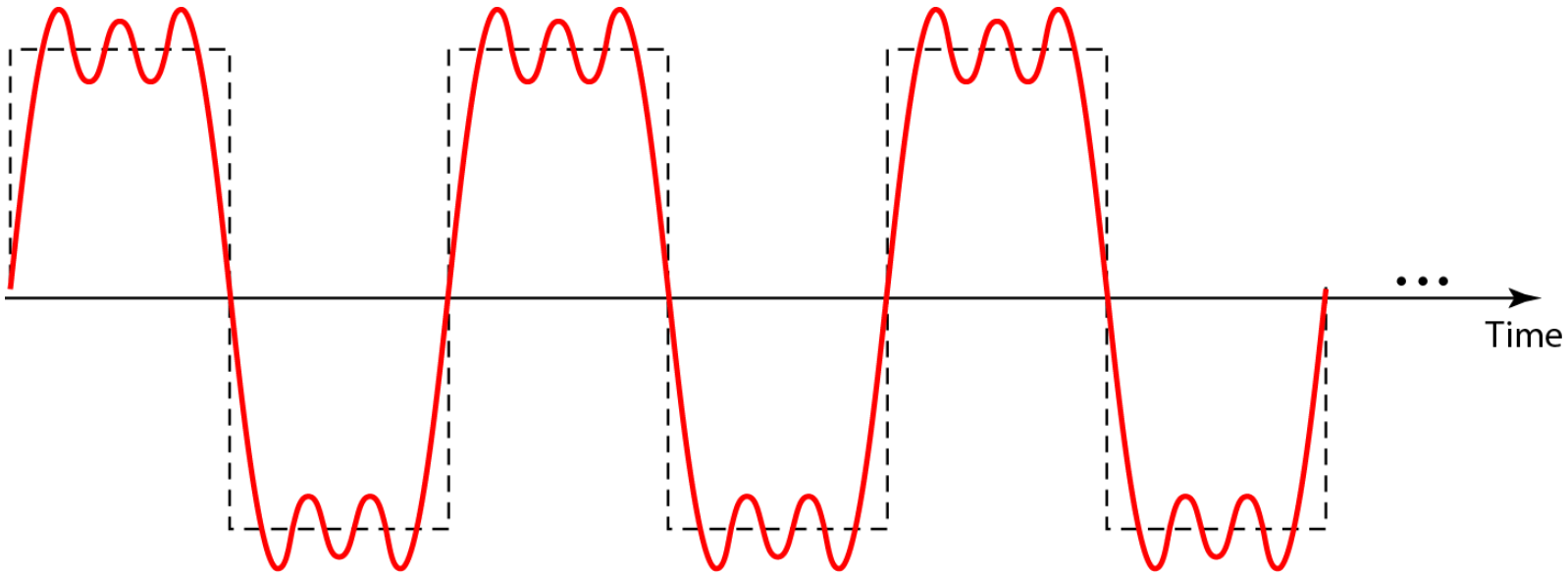
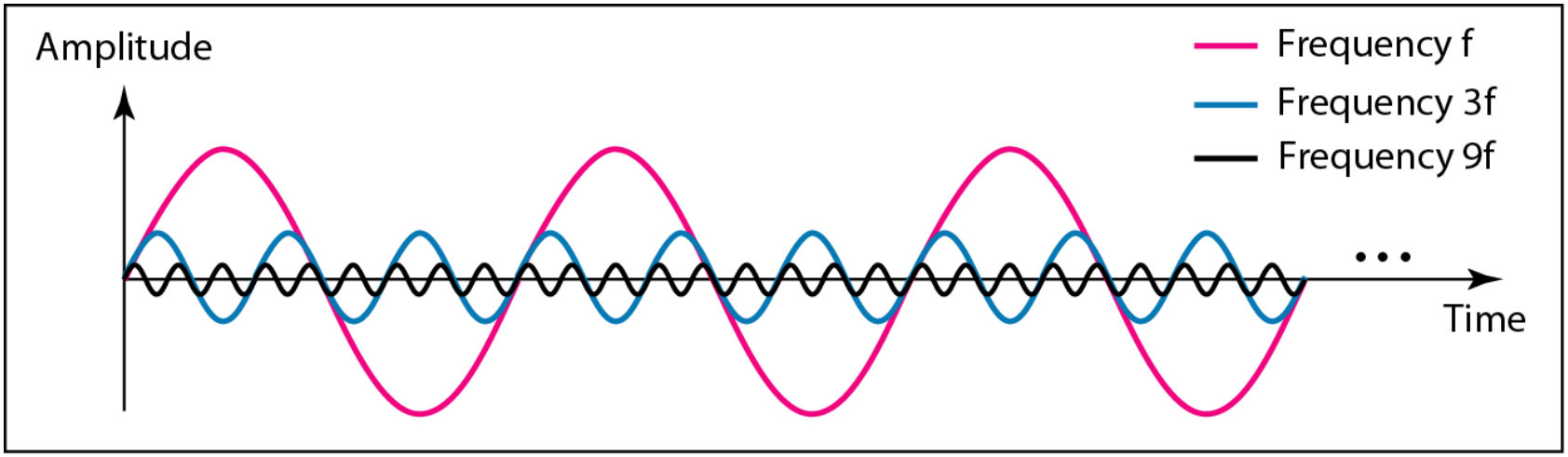
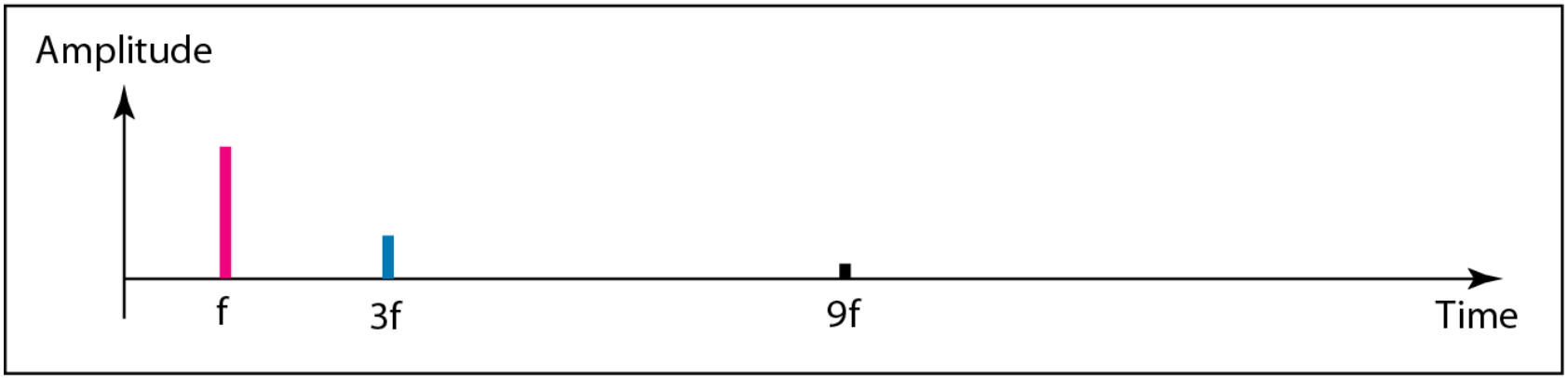


Figure-5: A composite periodic signal



a. Time-domain decomposition of a composite signal

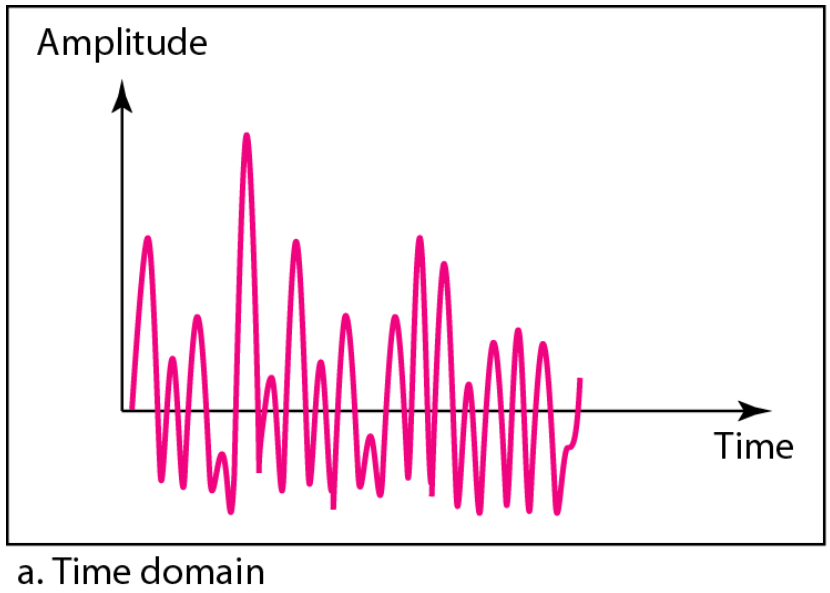


b. Frequency-domain decomposition of the composite signal

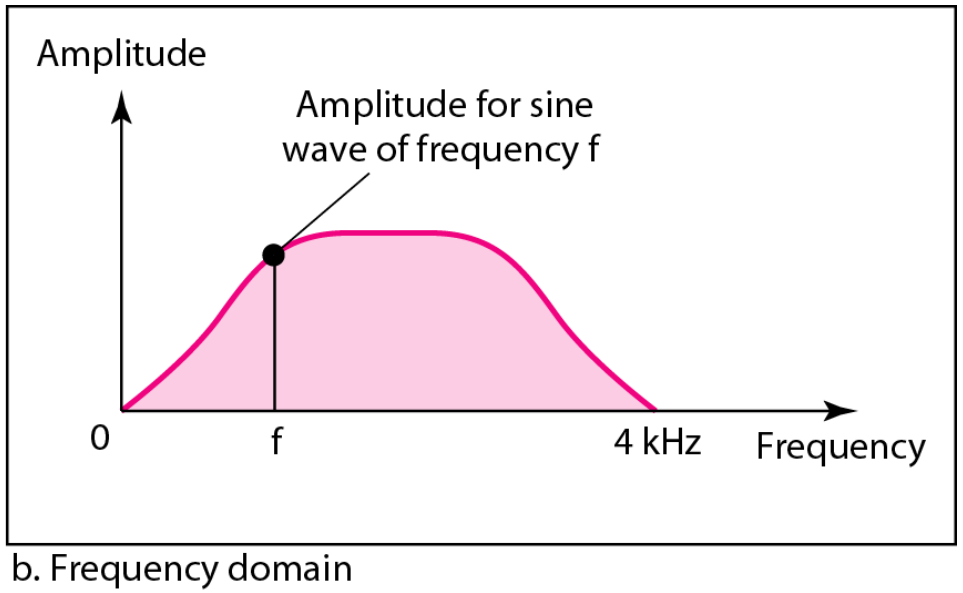
Figure-6: Decomposition of a composite periodic signal in the time and frequency domains

Note

If the composite signal is periodic, the decomposition gives a series of signals with discrete frequencies;
if the composite signal is nonperiodic, the decomposition gives a combination of sine waves with continuous frequencies.



a. Time domain



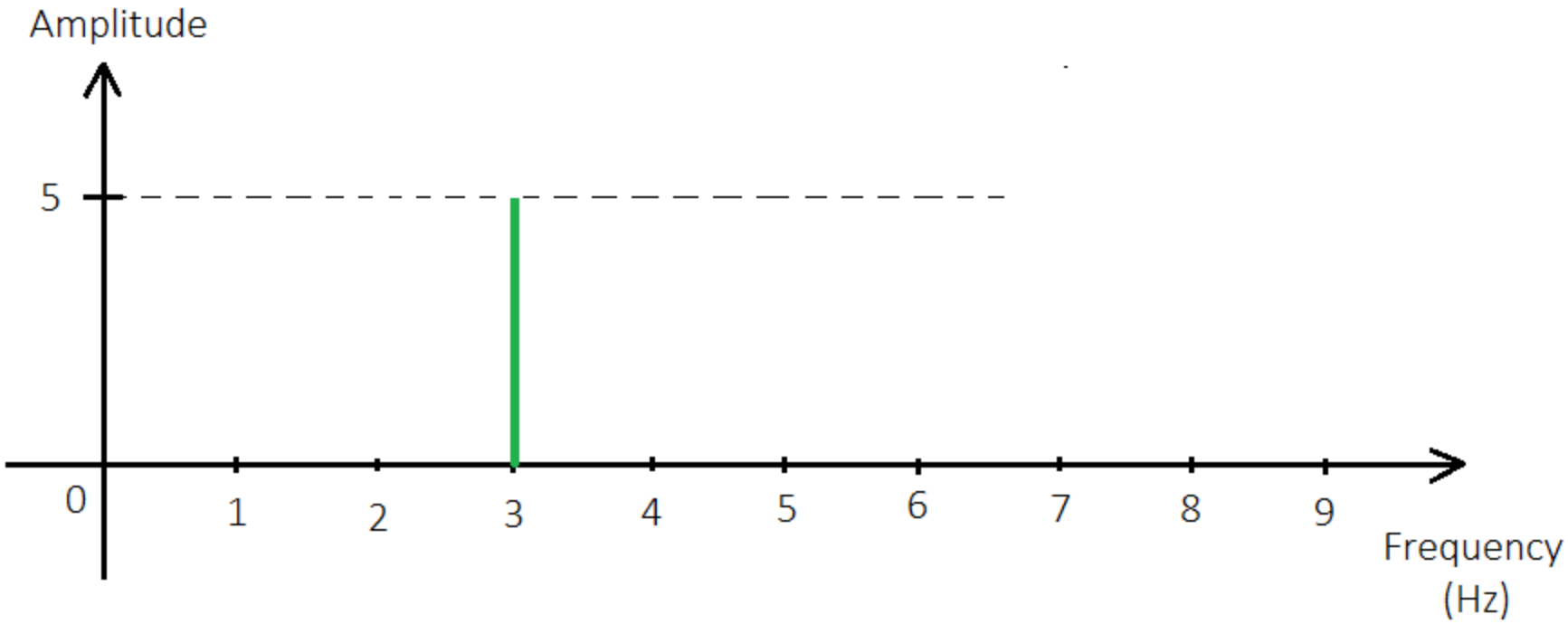
b. Frequency domain

Figure-7: The time and frequency domains of a non-periodic signal

Figure 7 shows a non-periodic composite signal. It can be the signal created by a microphone or a telephone set when a word or two is pronounced. In this case, the composite signal cannot be periodic, because that implies that we are repeating the same word or words with exactly the same tone.

Home Work

Draw the given signal in time domain.



That's all for today

Thank You