

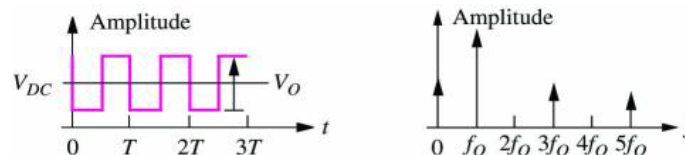
Frequency Spectrum of Electronic Signals

- Nonrepetitive signals have continuous spectra often occupying a broad range of frequencies
- Fourier theory tells us that repetitive signals are composed of a set of sinusoidal signals with distinct amplitude, frequency, and phase.
- The set of sinusoidal signals is known as a **Fourier series**.
- The frequency spectrum of a signal is the amplitude and phase components of the signal versus frequency.

Fourier Series

- Any periodic signal contains spectral components only at discrete frequencies related to the period of the original signal.
- A square wave is represented by the following Fourier series:

$$v(t) = V_{DC} + \frac{2V_O}{\pi} \left(\sin \omega_0 t + \frac{1}{3} \sin 3\omega_0 t + \frac{1}{5} \sin 5\omega_0 t + \dots \right)$$



$\omega_0 = 2\pi/T$ (rad/s) is the fundamental radian frequency and $f_0 = 1/T$ (Hz) is the fundamental frequency of the signal. $2f_0, 3f_0, 4f_0$ and called the second, third, and fourth harmonic frequencies.



Frequencies of Some Common Signals

- | | |
|------------------------------|-----------------|
| • Audible sounds | 20 Hz - 20 KHz |
| • Baseband TV | 0 - 4.5 MHz |
| • FM Radio | 88 - 108 MHz |
| • Television (Channels 2-6) | 54 - 88 MHz |
| • Television (Channels 7-13) | 174 - 216 MHz |
| • Maritime and Govt. Comm. | 216 - 450 MHz |
| • Cell phones | 1710 - 2690 MHz |
| • Satellite TV | 3.7 - 4.2 GHz |