

Harmonic Frequency Response Applet

As usual, start the applet and play with it a little bit.

In this applet the input has a fixed angular frequency of 1 and the ω_n slider adjusts the resonant frequency of the system.

Choose $f(t)$ to be the sine wave. Look at what happens as you change ω_n . Why does the amplitude of the response go to infinity when $\omega_n = 1$.

Now choose $f(t)$ to be the square wave. Notice that the amplitude of the response becomes infinite at $\omega_n = 1, 3$ or 5 .

Question: As ω_n gets close to 1, 3 or 5 what is the dominant frequency in the output?

Answer: You should have seen that with ω_n near 1 the output resembles a frequency 1 sine wave. For ω_n near 3 the dominant frequency in the output is 3, i.e. there are three peaks in the oscillation over one cycle of the square wave. Likewise for ω_n near 5 the dominant frequency is 5.

We can explain this using Fourier series. The square wave has Fourier series

$$f(t) = \frac{4}{\pi} \sum_{n \text{ odd}} \frac{\sin nt}{n}.$$

Each term in the series affects the system. If the system has natural frequency 3 then the $\sin 3t$ term causes it to resonate with a large amplitude at that frequency. Thus, the response to that term is far larger than the response to any other term.

We will explore this further later in this session.

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