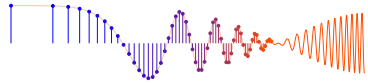


PROBLEM:

An LTI system has impulse response given by

$$h(t) = \frac{10\sin[200\pi(t-0.001)]}{\pi(t-0.001)}.$$

(a) First make a detailed and accurately labeled sketch of $h(t)$. Mark the important amplitudes and time locations of peaks and zero crossings.

(b) Now determine the Fourier transform $H(j\omega)$ of this impulse response; i.e., $H(j\omega)$ is the frequency response of the system. Make detailed plots of $|H(j\omega)|$ and $\angle H(j\omega)$ versus ω. Label your plots carefully.

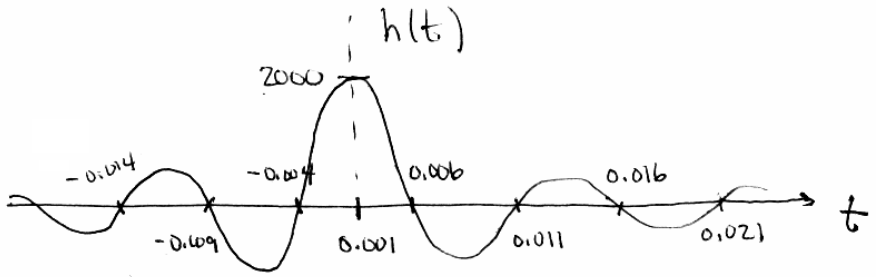
(c) What is the time delay of this system?

McClellan, Schafer and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.
Prentice Hall, Upper Saddle River, NJ 07458.

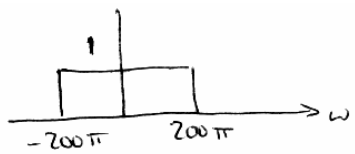
SOLUTION

(a) $h(t) = \dfrac{10\sin[200\pi(t-0.001)]}{\pi(t-0.001)} = 200(10)\,\dfrac{\sin[200\pi(t-0.001)]}{200\pi(t-0.001)}$

$\Rightarrow$ Mainlobe has a peak value of 2000 located at $t = 0.001$. Zero locations determined by $\sin[200\pi(t-0.001)]$ are located at $t = \frac{k}{200} + 0.001$, $k = \pm 1, \pm 2, \cdots$.

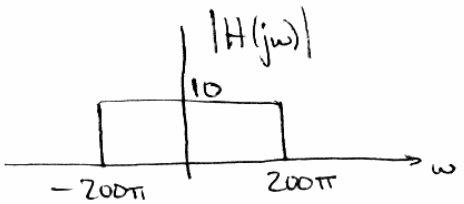


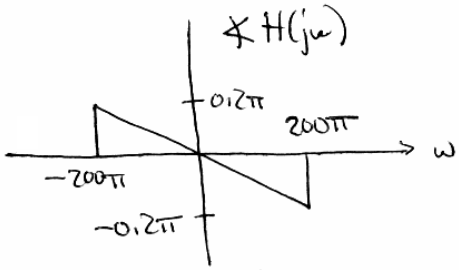
(b) From the table: $\dfrac{\sin(200\pi t)}{\pi t} \longleftrightarrow$



This signal must be time shifted and scaled to get $h(t)$.

$$\Rightarrow H(j\omega) = \begin{cases} 10\,e^{-j(0.001)\omega}, & |\omega| \le 200\pi \\ 0, & |\omega| > 200\pi \end{cases}$$





$$|H(j\omega)| = \begin{cases} 10, & |\omega| \le 200\pi \\ 0, & |\omega| > 200\pi \end{cases} \qquad \angle H(j\omega) = \begin{cases} -(0.001)\omega, & |\omega| \le 200\pi \\ 0, & |\omega| > 200\pi \end{cases}$$

(c) Time delay is the negative derivative of the phase of the frequency response $\Rightarrow$ 0.001 s.