Use the definitions \( \text{sinc}(x) = \frac{\sin(\pi x)}{\pi x} \), \( p_T(t) = \begin{cases} 1, & |t| \leq T \\ 0, & |t| > T \end{cases} \), and the Fourier transform pairs
\( p_T(t) \xrightarrow{F} 2T \text{sinc} \left( \frac{\omega T}{\pi} \right) \) and \( \frac{B}{\pi} \text{sinc} \left( \frac{\omega B}{\pi} \right) \xrightarrow{F} P_B(\omega) \), and other transform pairs, as needed, in all of the problems below.

1. Use the Fourier transform properties, including the scaling, differentiation, and integration properties, as needed, to find the Fourier transform of the following.
   a. \( x(t) = \frac{d}{dt} \text{sinc}(at), a > 0 \).
   b. \( x(t) = \frac{12}{9+t^2} \).
   c. \( x(t) = \frac{12t}{9+t^2} \).
   d. \( x(t) = 20e^{-5|t|} \sin(2 \pi 800t) \).
   e. \( x(t) = 20(t-2)e^{-5|t-2|} \).

2. Text, Problem 5.19.

3. The analog signal \( x_a(t) = \sin(16\pi t) \) is sampled at rate \( F_s = \frac{1}{T} \) samples/sec to form the sampled data signal \( x_a(nT) \). The analog signal \( y_a(t) \) is generated as
\[
y_a(t) = \sum_{n=-\infty}^{\infty} x_a(nT)h(t-nT)
\]
a. If \( \frac{1}{T} = 20 \) samples/sec, and \( h(t) = \text{sinc}(\frac{t}{T}) \), find \( y_a(t) \).
   b. If \( \frac{1}{T} = 10 \) samples/sec, and \( h(t) = \text{sinc}(\frac{t}{T}) \), find \( y_a(t) \).
   c. Using \( \frac{1}{T} = 20 \) and only the samples for \( n = 0, 1, ..., 5 \), sketch the waveform \( y_a(t) \) for \( h(t) = [u(t) - u(t-T)] \). (This is the “sample-and-hold” reconstruction.) For this set of sample times, the sampled signal values are
   \( x(n) = (0, 0.5878, -0.9511, 0.9511, -0.5878, 0, ...) \) for \( n = 0, 1, ..., 5, ... \)
   d. Repeat c) for the linear interpolation pulse,
\[
h(t) = \begin{cases} 1 + \frac{t}{T}, & -T \leq t < 0 \\ 1 - \frac{t}{T}, & 0 \leq t \leq T \\ 0, & \text{otherwise} \end{cases}
\]
   Compare the results in c) and d) to the analog signal, \( x_a(t) = \sin(16\pi t) \).

4. Text, Problem 5.28. (Note: Read text, pages 253-261, and especially Example 5.25 first.)

5. Text, Problem 5.23.

6. Use the sample and reconstruction block diagram below to answer the following.

Find \( y(t) \) if \( x(t) = 10 \sin(14\pi t) - 25 \sin(19\pi t) + 18 \cos(38\pi t) \) and the sampling rate is
a. \( \frac{1}{T} = 30 \) samples/sec.
b. \( \frac{1}{T} = 50 \) samples/sec.
c. \( \frac{1}{T} = 18 \) samples/sec.