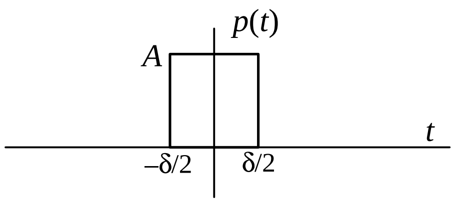
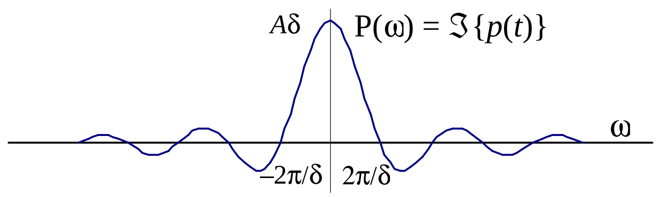
Final Exam

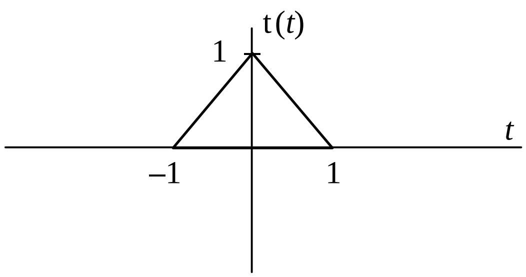
December 13, 2004

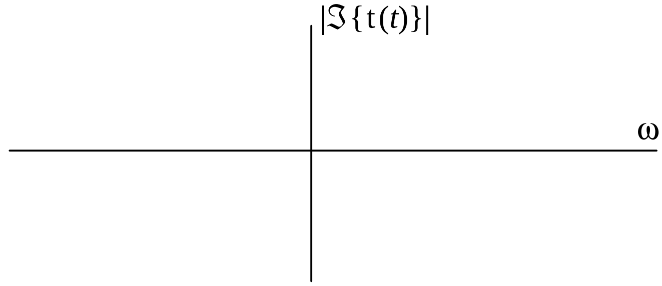
1. (50) We have seen that the Fourier transform of the square pulse $p(t)$ is $\dfrac{A\delta \sin(\omega\delta/2)}{\omega\delta/2}$:



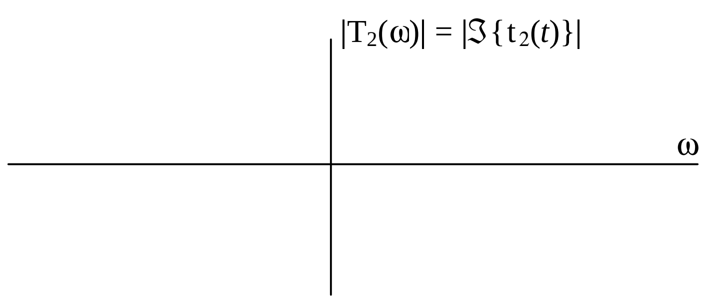


a) We can think of a triangle function t(t), shown below, as the convolution of two square pulses with width 1 and height 1. Using the convolution property, find the Fourier transform of t(t), T(ω) = ℑ{t(t)}. Draw an approximate plot of the magnitude of T(ω).



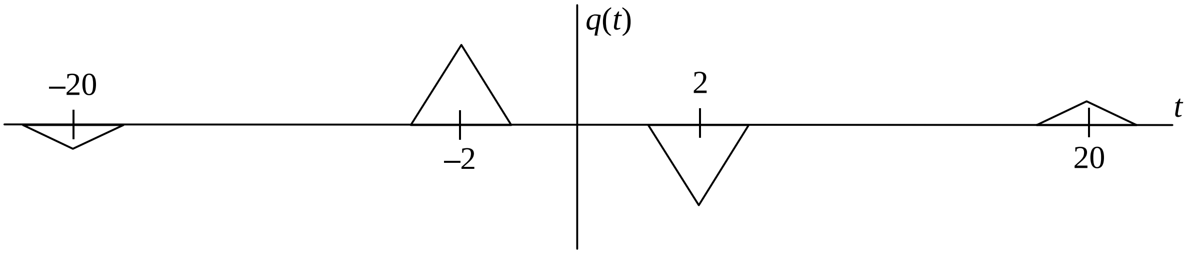


b) Reason, using Fourier transform properties, what the Fourier transform $T_2(\omega)$ would be if the width of t(t) were doubled. Provide a formula and an approximate plot of the magnitude of $T_2(\omega)$.

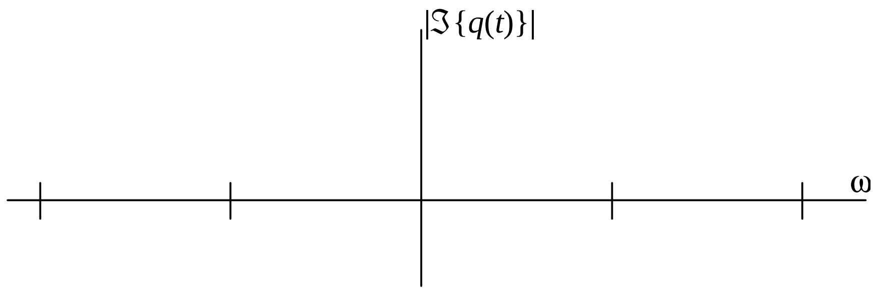


1. (continued)

c) Let $q(t)$ be a function consisting of four triangular pulses of width 2 (the same width as in part a). The pulses centered at ±2 are height 1 and the pulses at ±20 are height 1/4.



Draw the magnitude of the Fourier transform of the function $q(t)$, $|Q(\omega)| = |\Im\{q(t)\}|$.
Remember to spread out your drawing to give space for the features within it.
[If you did not solve (a), you can express $Q(\omega)$ as a function of $T(\omega)$.]



2. (50) In this problem you are asked to explain how darkfield microscopy works.

a) Draw and label an optical system with the elements listed (alphabetically) below.

b) Add and label the most important light path(s) through the system.

c) Explain the function of each element.

- annular aperture

- condenser

- image plane

- objective lens

- source

- specimen plane

2. (continued)

d) Why is this technique called "darkfield"?

e) A darkfield microscope effectively acts as an optical filter that attenuates certain spatial frequencies more than others.

1) State what type of filter it is (low-pass, high-pass, or band-pass).

2) Explain why [you may refer to your answers above, if appropriate].