Example 8-17: Computing CTFT by DFT.

Purpose:

Use the DFT to compute the Fourier transform of the continuous-time signals
(a) $x_1(t) = e^{-|t|}$ (b) $x_2(t) = \frac{1}{\sqrt{2\pi}}e^{-t^2/2}$.

For (a), we have $F[e^{-|t|}]=\frac{2}{\omega^2+1}=\frac{2}{4\pi^2 f^2+1}$
$e^{-6} = 0.0025$, so $e^{-|t|} \approx 0$ for $|t| > 6$.
$\frac{2}{4\pi^2 8^2+1} = 0.0008$, so $\frac{2}{4\pi^2 f^2+1} \approx 0$ for $|f| > 8$.

For (b), we have $F[\frac{e^{-t^2/2}}{\sqrt{2\pi}}]=e^{-\omega^2/2}=e^{-2\pi^2 f^2}$
$\frac{e^{-4^2/2}}{\sqrt{2\pi}}$=0.00013, so $\frac{e^{-t^2/2}}{\sqrt{2\pi}} \approx 0$ for $|t| > 4$.
$e^{-2\pi^2 .6^2}$=.00082, so $e^{-2\pi^2 f^2} \approx 0$ for $|f| > .6$.

Inputs:

X=row vector of samples of $x(t)$.
tmax=maximum time of $x(t)$ in s.
fmax=maximum freq. of $\mathbf{X}(j2\pi f)$ in Hz.

Outputs:

Actual 'o' and computed '+' spectra.

Comments:

- This uses the smallest possible DFT to compute CTFT samples accurately.
- The coarse discretizations of $\frac{1}{16}$ s and $\frac{1}{12}$ Hz work well for (a)!
- The *very* coarse discretizations of 0.8 s and 0.125 Hz work well for (b)!

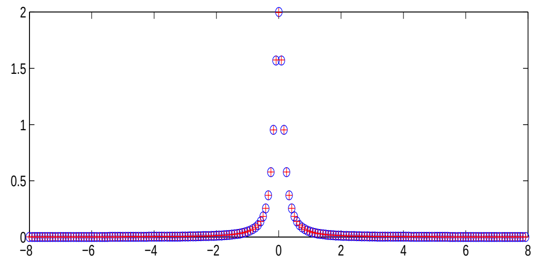

Figure 1: Example 8-17a: Actual 'o' and computed '+' spectrum values.

Program for (a):

```
clear;tmax=6;fmax=8;
T=2*tmax;B=2*fmax;
t=[-tmax:1/B:tmax-1/B];
f=[-fmax:1/T:fmax-1/T];
X=exp(-abs(t));
fX=2./(4*pi*pi*f.*f+1);
FX=fftshift(abs(fft(X)))/B;
subplot(211),
plot(f,fX,'o',f,FX,'+r')
```

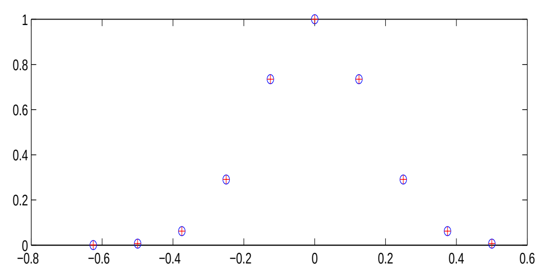

Figure 2: Example 8-17b: Actual 'o' and computed '+' spectrum values.

Program for (b):

```
clear;tmax=4;fmax=0.625;
T=2*tmax;B=2*fmax;
t=[-tmax:1/B:tmax-1/B];
f=[-fmax:1/T:fmax-1/T];
X=exp(-t.*t/2)/sqrt(2*pi);
fX=exp(-2*pi*pi*f.*f);
FX=fftshift(abs(fft(X)))/B;
subplot(211),
plot(f,fX,'o',f,FX,'+r')
```