

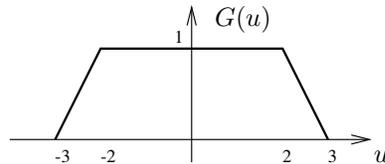
Homework #2, EECS 516, F09. Due **Due Fri. Sep. 25**, by 1:30PM

Sampling

1. [10] What should the sampling intervals be if the signal $f(x, y) = \text{sinc}^4(x) \text{sinc}^5(y)$ is to be sampled without aliasing?

Signal synthesis via FFT

2. [25] Use the `ifft` command in Matlab to synthesize and plot (a sampled version of) the signal $g(x)$ whose Fourier transform $G(u)$ is shown below.



The units of u are to be cycles/mm for this problem.

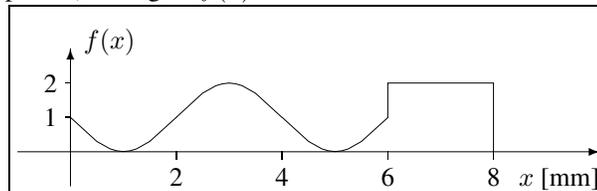
Analytical solutions will not be accepted (although they could be used to check your use of `ifft`).

For full credit, you must clearly label both axes of all of your plots, including units!

- (a) [20] Provide 4 plots (use `subplot(2,2,1)` etc.): 1) $G(u)$, 2) the real part of $g(x)$, 3) the imaginary part of $g(x)$, 4) the real part of $g(x)$ with x axis limited to ± 4 mm (use `axis`).
- (b) [5] Use Fourier transform properties to explain why the synthesized value corresponding to $g(0)$ is correct. (If not then fix it!)
- (c) [0] Use Fourier transform properties to explain why the imaginary part looks the way it does.

Signal filtering via FFT

3. [10] Use Matlab to synthesize (samples of) the signal $f(x)$ shown below.



(The wavy part of the signal is sinusoidal.)

Use `fft`, `*`, and `ifft` in Matlab to determine $g = h * f$ (approximately), where $h(x)$ is a (1st-order) Butterworth filter. The frequency response is:

$$H(u) = \frac{1}{\sqrt{1 + (u/u_c)^2}},$$

where u_c is the cutoff frequency. Use $u_c = 0.4$ cycles/mm for this problem. Choose the sampling parameters appropriately to minimize aliasing artifacts or end effects. Plot the real and imaginary parts of the filtered signal, clearly labeled. Hint: consider how the value of $H(0)$ should affect the scale of the signal.