announcements

Monday, February 28, 2022 3:08 PM

PS 4 due on Monday 3/7.
- be sure to complete #1 - 3 FIRST
  - If you have extra time, you can attempt #4.

Midterm exam 1 on Wed. 3/9

Format for problem sets:
- Please create one document that has the problem number and includes any MATLAB code you wrote for the problem, MATLAB output, and any additional text / narrative explanations.
- For figures, please label each axis with an informative short description and include units, if applicable. Also include a caption explaining what you are showing in the figure, or you can include this text in the main body of the text
- Please print your figure to a file and then embed / insert that image file into your document. You can print your figure to a file using the GUI (click on File then Save) or use the print command in MATLAB (print -dpng FILENAME.png)
- For output in the command window, you can just copy from the command window and paste into your document
- If you want to include your .m files in the submission on Canvas, please upload them as separate files, rather than creating a .zip file. This allows me to annotate directly on your documents, so you can see my feedback.

Spectral analysis

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Breaking up signal into its frequency components.

Fourier Transform

$$x(t) \longrightarrow \boxed{\mathcal{F}\{\cdot\}} \longrightarrow X(f),$$

probes $x(t)$ w/ basis function: $e^{j\omega t}$

CTFT vs DTFT

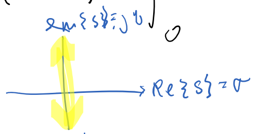
Wednesday, February 10, 2021 3:26 PM

CT

$\mathcal{L}\{x(t)\}$ = Laplace Transform

$$X(s) = \mathcal{L}\{x(t)\} = \int_0^\infty x(t)\cdot e^{-st}\,dt$$

$s = \sigma + j\omega$



$X(s)\big|_{s=j\omega}$

CTFT

$$X(j\omega) = \int_0^\infty x(t)\cdot e^{-j\omega t}\,dt.$$

$\omega = 2\pi f$.

$$X(f) = \int_0^\infty x(t)\cdot e^{-j2\pi f t}\,dt.$$

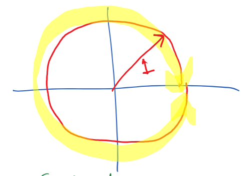
DT

$$X(z) = Z\{x[n]\}. = Z\{x[n]\} = \sum_{n=0}^{\infty} x[n]\cdot z^{-n}$$

$z = e^{\sigma + j\Omega}$

$= e^{\sigma}\cdot e^{j\Omega}$

$= Re^{j\Omega}$



$X(z)\big|_{z=e^{j\Omega}}$

DTFT

$$X(e^{j\Omega}) = \sum_{n=0}^{\infty} x[n]e^{-j\Omega n}$$

$\Omega = 2\pi f$

$$\tilde{X}(f) = \sum_{n=0}^{\infty} x[n]e^{-j2\pi f n}.$$

FFT

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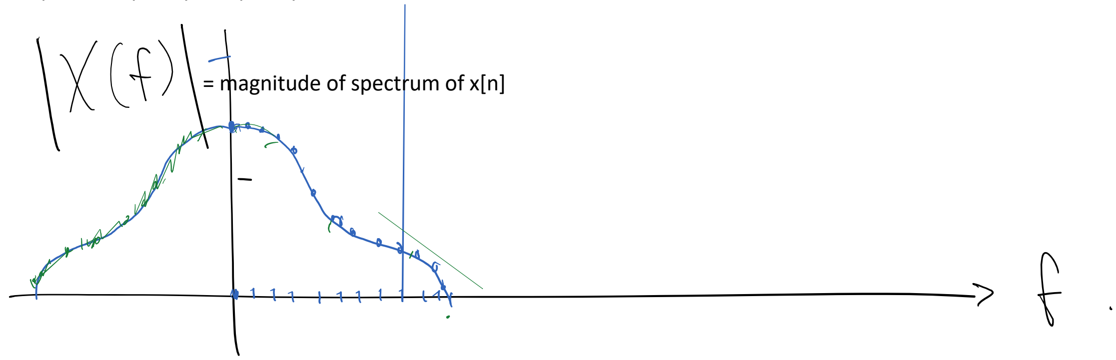
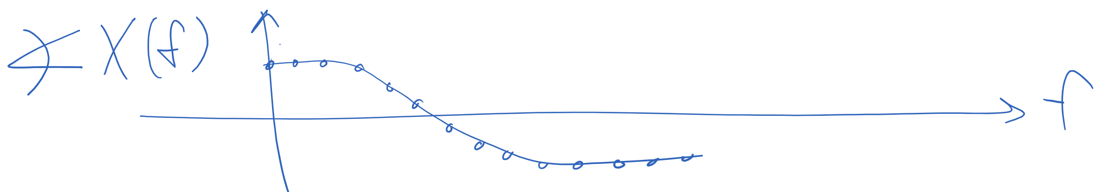
FFT = fast Fourier transform

Computationally efficient way to compute the DTFT

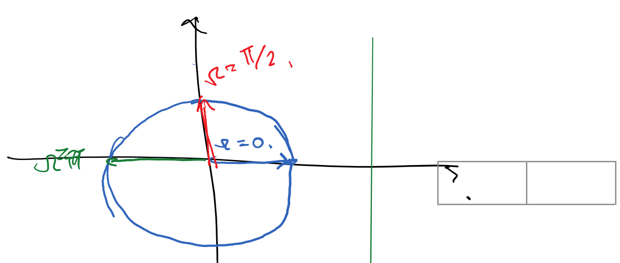
FFT is actually the Discrete Fourier Transform DFT which is an approximation of the DTFT

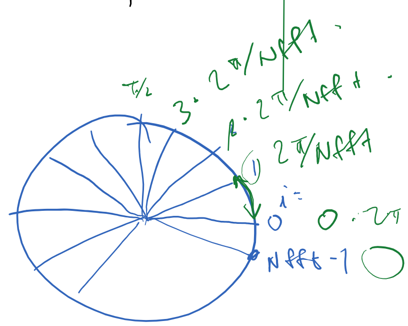
- We don't have an infinite number of points for x (or could not calculate the summation to n = infinity)
- Need to sample in frequency (frequency is not continuous in the DFT)





specify N_{fft} = total # of frequencies @ which to sample spectrum.





$[0 : N_{fft}-1] .* 2\pi/N_{fft}$

DTFT is both periodic and symmetric

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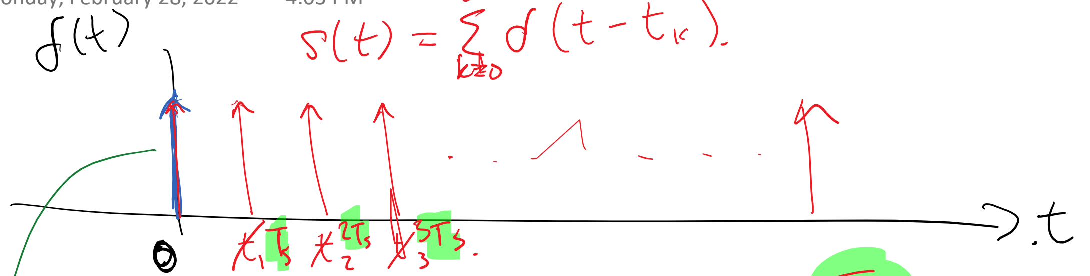
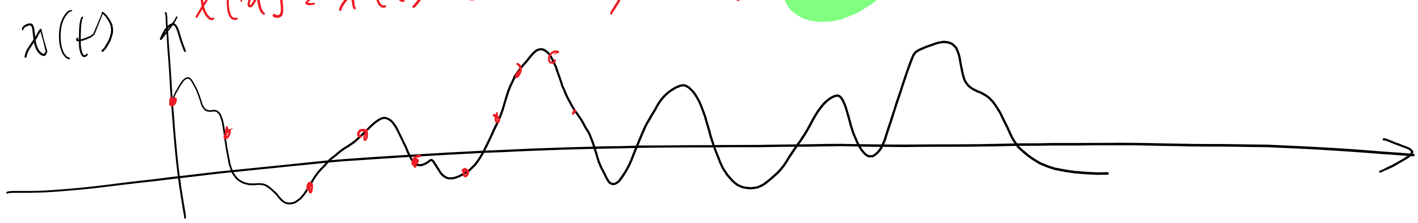
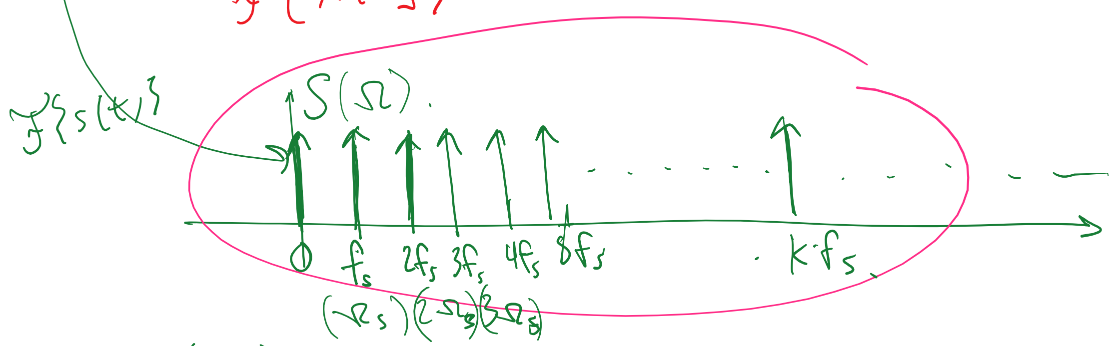
$$s(t) = \sum_{k=0}^{\infty} \delta(t - t_k)$$

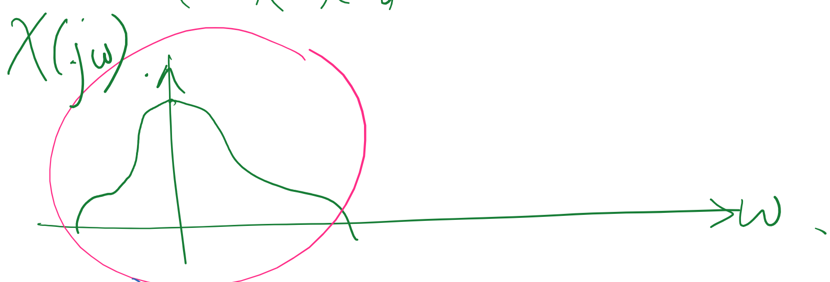


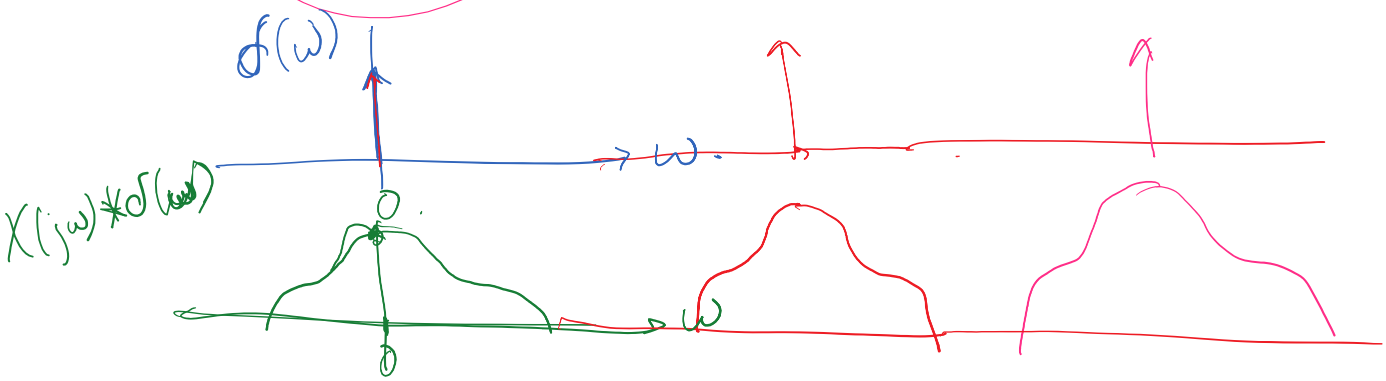
$$x[n] = x(t)\cdot s(t), \quad t_k = T_s$$

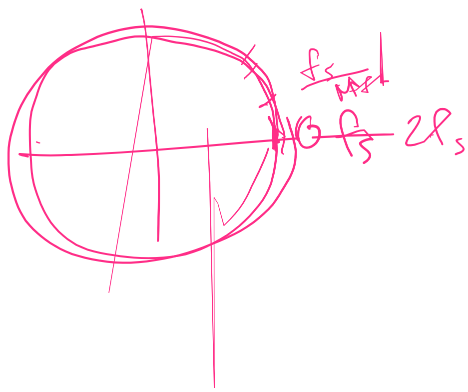


$$\mathcal{F}\{x[n]\} = \mathcal{F}\{x(t)\} * \mathcal{F}\{s(t)\}$$





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