EE 341 - Homework 9

Due October 28, 2005

For problems which require MATLAB, please include a MATLAB m-file which shows how you made your plots.

1. Compute the DTFT of the following signals:
   (a) $x[n] = \{1, 2, 2, 1\}$
   (b) $x[n] = (0.5)^{n+2}u[n]$
   (c) $x[n] = n(0.5)^{2n}u[n]$
   (d) $x[n] = (n+1)(0.5)^n u[n]$

2. The DTFT of $x[n]$ is

$$X(\Omega) = \frac{4}{2 - e^{j\Omega}}$$

   Find the DTFT of the following signals without first finding $x[n]$.
   (a) $x[n-2]$
   (b) $x[n] - x[n-1]$
   (c) $x[n]e^{j\pi n}$
   (d) $nx[n]$

3. Problem 7.6 (c). (You can do this easily from the table of DTFT's. You do not need to do an integral.)

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1(a) $x(n) = \{1,2,2,1\} = \delta(n) + 2\delta(n-1) + 2\delta(n-2) + \delta(n-3)$

$$X(\Omega) = 1 + 2e^{-j\Omega} + 2e^{-j2\Omega} + e^{-j3\Omega}$$

(b) $x(n) = (0.5)^{n+1} u(n) = 0.5(0.5)^n u(n)$

$$X(\Omega) = 0.5 \frac{1}{1-0.5e^{-j\Omega}}$$

(c) $x(n) = n(0.5)^{2n} u(n) = n((0.5)^2)^n u(n) = n(0.25)^n u(n)$

$$(0.25)^n u(n) \leftrightarrow \frac{1}{1-0.25e^{-j\Omega}}$$

$$n(0.25)^n u(n) \leftrightarrow j \frac{d}{d\Omega} \frac{1}{1-0.25e^{-j\Omega}}$$

$$= j \frac{-1}{(1-0.25e^{-j\Omega})^2} \frac{d}{d\Omega}(1-0.25e^{-j\Omega})$$

$$= j \frac{-1}{(1-0.25e^{-j\Omega})} (j0.25e^{-j\Omega})$$

$$= \frac{0.25e^{-j\Omega}}{(1-0.25e^{-j\Omega})^2}$$

(d) $(n+1)(0.5)^n u(n) = n(0.5)^n u(n) + (0.5)^n u(n)$

$$\leftrightarrow \frac{0.5e^{-j\Omega}}{(1-0.5e^{-j\Omega})^2} + \frac{1}{1-0.5e^{-j\Omega}}$$

$$= \frac{1}{(1-0.5e^{-j\Omega})^2}$$

2. $X(\Omega) = \dfrac{4}{2 - e^{j\Omega}}$

(a) $x(n-2) \leftrightarrow X(\Omega)\, e^{-j2\Omega} = \dfrac{4e^{-j2\Omega}}{2 - e^{j\Omega}}$

(b) $x(n) - x(n-1) \leftrightarrow X(\Omega) - X(\Omega)e^{-j\Omega}$

$$= \frac{1 - e^{-j\Omega}}{2 - e^{j\Omega}}$$

(c) $x(n)e^{j\pi n} \leftrightarrow X(\Omega - \pi) = \dfrac{4}{2 - e^{j(\Omega - \pi)}}$

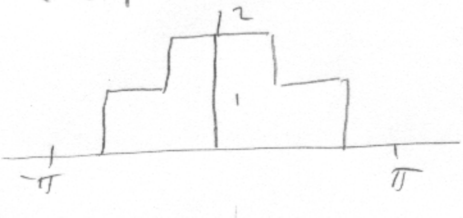
$$= \frac{4}{2 - e^{j\Omega}e^{-j\pi}} = \frac{4}{2 + e^{j\Omega}}$$

(d) $n\, x(n) \leftrightarrow j \dfrac{d}{d\Omega} X(\Omega)$

$$= j \frac{d}{d\Omega}\left(\frac{4}{2 - e^{j\Omega}}\right) = j \frac{-4}{(2 - e^{j\Omega})} \frac{d}{d\Omega}(2 - e^{j\Omega})$$

$$= \frac{-4e^{j\Omega}}{2 - e^{j\Omega}}$$

3. Problem 7.6 (c)



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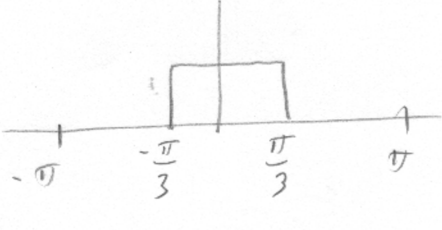

$$x(n) = \frac{\frac{2\pi}{3}}{\pi} \operatorname{sinc}\left(\frac{2\pi/3}{\pi} n\right) + \frac{\pi/3}{\pi} \operatorname{sinc}\left(\frac{\pi/3}{\pi} n\right)$$

$$= \frac{2}{3} \operatorname{sinc}\left(\frac{2}{3} n\right) + \frac{1}{3} \operatorname{sinc}\left(\frac{1}{3} n\right)$$