3.23(a)(b) Determine the inverse DTFT of each of the following DTFTs:

a) $H_1(e^{j\omega}) = 1 + 2\cos\omega + 3\cos 2\omega$

$$= 1 + \cancel{2}\left(\frac{e^{j\omega}+e^{-j\omega}}{\cancel{2}}\right) + 3\left(\frac{e^{j2\omega}+e^{-j2\omega}}{2}\right)$$

$$= 1 + e^{j\omega} + e^{-j\omega} + 3/2\, e^{j2\omega} + 3/2\, e^{-j2\omega}$$

$$\{h_1(n)\} = \{3/2,\ 1,\ \underset{\uparrow}{1},\ 1,\ 3/2\}$$

b) $H_2(e^{j\omega}) = (3 + 2\cos\omega + 4\cos 2\omega)\cos(\omega/2)e^{-j\omega/2}$

$$= \left[3 + \cancel{2}\left(\frac{e^{j\omega}+e^{-j\omega}}{\cancel{2}}\right) + \cancel{4}\left(\frac{e^{j2\omega}+e^{-j2\omega}}{\cancel{2}}\right)\right]\left(\frac{e^{j\omega/2}+e^{-j\omega/2}}{2}\right)e^{-j\omega/2}$$

$$= 1/2\left[1 + e^{-j\omega}\right]\left(3 + e^{j\omega} + e^{-j\omega} + 2e^{j2\omega} + 2e^{-j2\omega}\right)$$

$$3e^{-j\omega} + 1 + e^{-j2\omega} + 2e^{j\omega} + 2e^{-j3\omega}$$

$$= 1/2\left[4 + 3e^{j\omega} + 4e^{-j\omega} + 3e^{-j2\omega} + 2e^{j2\omega} + 2e^{-j3\omega}\right]$$

$$= 2 + 3/2\, e^{j\omega} + 2e^{-j\omega} + 3/2\, e^{-j2\omega} + e^{j2\omega} + e^{-j3\omega}$$

$$\{h_2[n]\} = \{1,\ 3/2,\ \underset{\uparrow}{2},\ 2,\ 3/2,\ 1\}$$

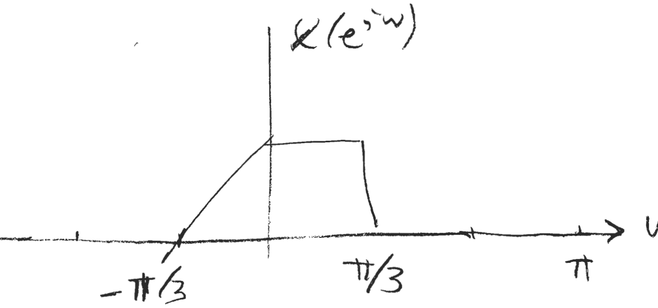
3.31(a),(b) Without computing the DTFT, determine which of the following sequences have real-valued DTFT and which imaginary valued DTFTs:

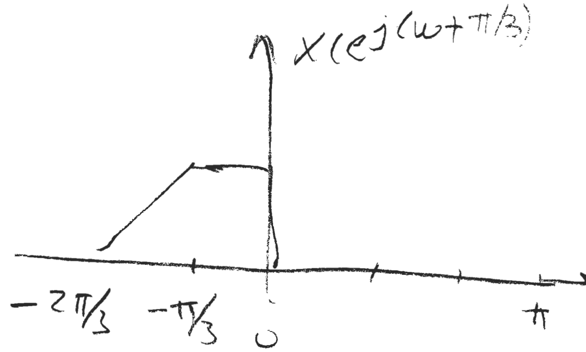
(a) $x_1[n] = \begin{cases} n, & -N \le n \le N \\ 0, & \text{o.w} \end{cases}$

Since $x_1[n]$ is real and odd then the DTFT ...

Since $x_2[n]$ is real and even, then the DTFT is real-valued

3.35 A sequence $x[n]$ has a zero-phase DTFT $X(e^{j\omega})$ as sketched. Sketch the DTFT of the sequence $e^{-j\pi n/3}x[n]$.





3.54 A causal LTI FIR system is characterized by an impulse response $h[n] = a_1\delta[n] + a_2\delta[n-1] + a_3\delta[n-2] + a_4\delta[n-3] + a_5\delta[n-4]$. For what values of the impulse response samples will its frequency response $H(e^{j\omega})$ have a linear phase?

$$H(e^{j\omega}) = a_1 + a_2e^{-j\omega} + a_3e^{-j2\omega} + a_4e^{-j3\omega} + a_5e^{-j4\omega}$$

$$= \left(a_1e^{j2\omega} + a_5e^{-j2\omega}\right)e^{-j2\omega} + \left(a_2e^{j\omega} + a_4e^{-j\omega}\right)e^{-j2\omega} + a_3e^{-j2\omega}$$

IF $a_1 = a_5$ & $a_2 = a_4$ then

$$H(e^{j\omega}) = \left(2a_1\cos(2\omega) + 2a_2\cos(\omega) + a_3\right)e^{-j2\omega}$$

↑ linear phase

3.55 An FIR LTI is described by

$$y[n] = a_1 x[n+k] + a_2 x[n+k-1] + a_2 x[n+k-2] + a_1 x[n+k-3]$$

$$H(e^{jw}) = a_1 e^{jkw} + a_2 e^{j(k-1)w} + a_2 e^{j(k-2)w} + a_1 e^{j(k-3)w}$$

Determine the frequency for its freq response $H(e^{jw})$. For what values of k will the system have a freq. response that is a real $f(w)$

$$= e^{jkw}\left(a_1 + a_2 e^{-jw} + a_2 e^{-j2w} + a_1 e^{-j3w}\right)$$

$$= e^{j(k-3/2)w}\left[a_1 e^{j3/2w} + a_1 e^{-j3/2w} + a_2 e^{j1/2w} + a_2 e^{-j1/2w}\right]$$

$$= e^{j(k-3/2)w}\left[2a_1 \cos(3/2w) + 2a_2 \cos(1/2w)\right]$$

$H(e^{jw})$ will be real if $k = 3/2$