For DT signals & systems, "low" freqs are around

$\omega = 0, \pm 2\pi, \pm 4\pi, \ldots$ (even multiples of π)

and high freqs are around $\omega = \pm\pi, \pm 3\pi, \ldots$ (odd multiples of π)

... see Fig. 1.27

Ex

$y[n] = x[n] - x[n-1]$ what kind of filter?

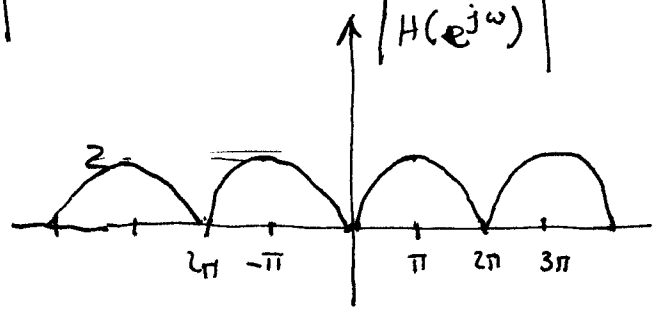
$h[n] = \delta[n] - \delta[n-1]$

$$H(e^{j\omega}) = \sum_{n=-\infty}^{\infty} h[n]\, e^{-j\omega n} = 1 - e^{-j\omega} = e^{\frac{-j\omega}{2}}\left(\frac{e^{\frac{j\omega}{2}} - e^{\frac{-j\omega}{2}}}{2j}\right)2j$$

$$H(e^{j\omega}) = 2j\, e^{\frac{-j\omega}{2}} \sin\frac{\omega}{2}$$

$$|H(e^{j\omega})| = \left|2j\, e^{-j\omega/2} \cdot \sin\frac{\omega}{2}\right| = \left|2\right|\left|j\right|\left|e^{-j\omega/2}\right|\left|\sin\frac{\omega}{2}\right|$$

$$|H(e^{j\omega})| = 2\left|\sin\frac{\omega}{2}\right|$$



Hi-Pass (contains π)

$$\angle H(e^{j\omega}) = \angle\left(2j\, e^{-j\omega/2} \sin\frac{\omega}{2}\right) = \angle 2 + \angle j + \angle e^{-j\omega/2} + \angle \sin\frac{\omega}{2}$$

$$= 0 + \frac{\pi}{2} - \frac{\omega}{2} + \begin{cases} 0 & \text{if } 0 < \frac{\omega}{2} < \pi \\ -\pi & \text{if } \pi < \frac{\omega}{2} < 2\pi \end{cases}$$