VSB modulation

- In Exam 2, Fall 2007, we showed that if

$$h_{VSB}[n] = \begin{cases} 0, & -\pi < \omega < -\Delta \\ H_{VSB}(\omega), & -\Delta < \omega < \Delta \\ 2, & \Delta < \omega < \omega_{max} \end{cases} \qquad (\omega_{max} < \pi)$$

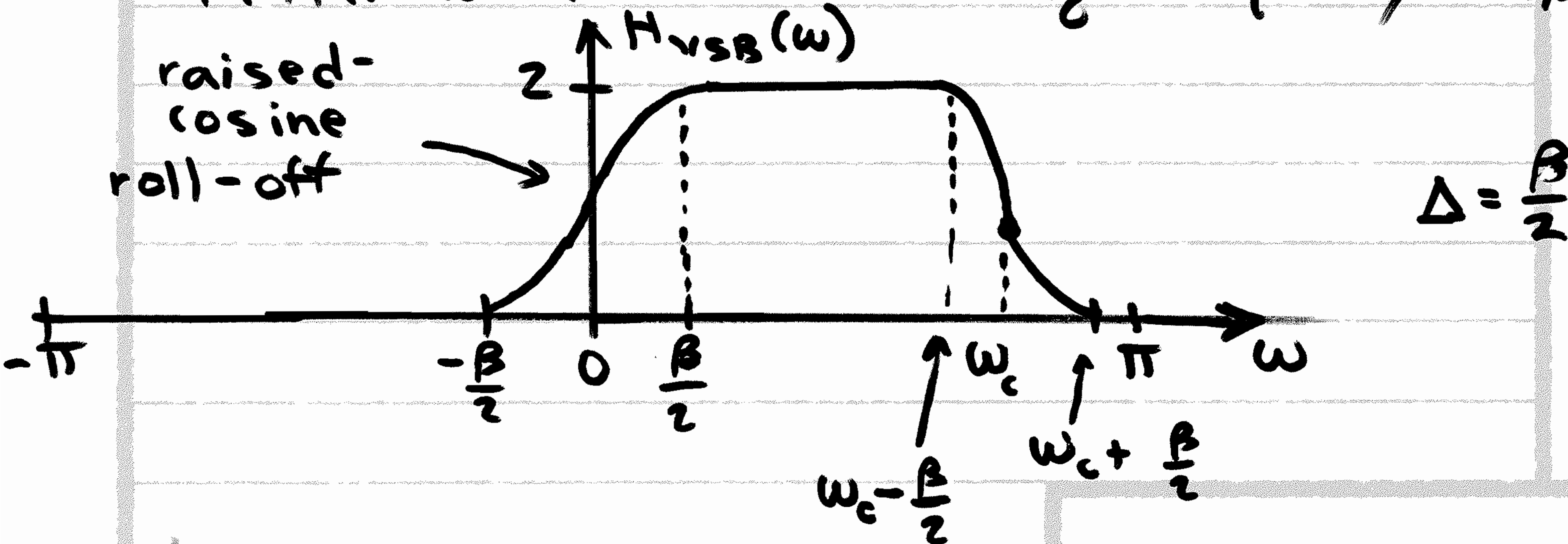
and $\quad H_{VSB}(-\omega) + H_{VSB}(\omega) = 2 \quad$ for $|\omega| < \Delta$

then for $\quad y[n] = x[n] * h_{VSB}[n]$

$$y_R[n] = \mathrm{Re}\{y[n]\} = \frac{1}{2}\{y[n] + y^*[n]\}$$

$$= x[n]$$

• For the 8 VSB Digital TV Standard (US) ("coming on-line" in 2009), they use a filter with the following frequency response



$$H_{VSB}(\omega) = 1 + \cos\left(\frac{\pi}{\beta}\left(\omega - \frac{\beta}{2}\right)\right), \quad -\frac{\beta}{2} < \omega < \frac{\beta}{2}$$

Check if condition is satisfied

3

$$H_{VSB}(-\omega) = 1 + \cos\left(\frac{\pi}{\beta}\left[(-\omega) - \frac{\beta}{2}\right]\right)$$

$$= 1 + \cos\left(\frac{\pi}{\beta}\left(\omega + \frac{\beta}{2}\right)\right)$$

$$= 1 + \cos\left(\frac{\pi}{\beta}\omega + \frac{\pi}{2}\right)$$

$$= 1 - \sin\left(\frac{\pi}{\beta}\omega\right)$$

whereas:

$$H_{VSB}(\omega) = 1 + \cos\left(\frac{\pi}{\beta}\left(\omega - \frac{\beta}{2}\right)\right)$$

$$= 1 + \cos\left(\frac{\pi}{\beta}\omega - \frac{\pi}{2}\right)$$

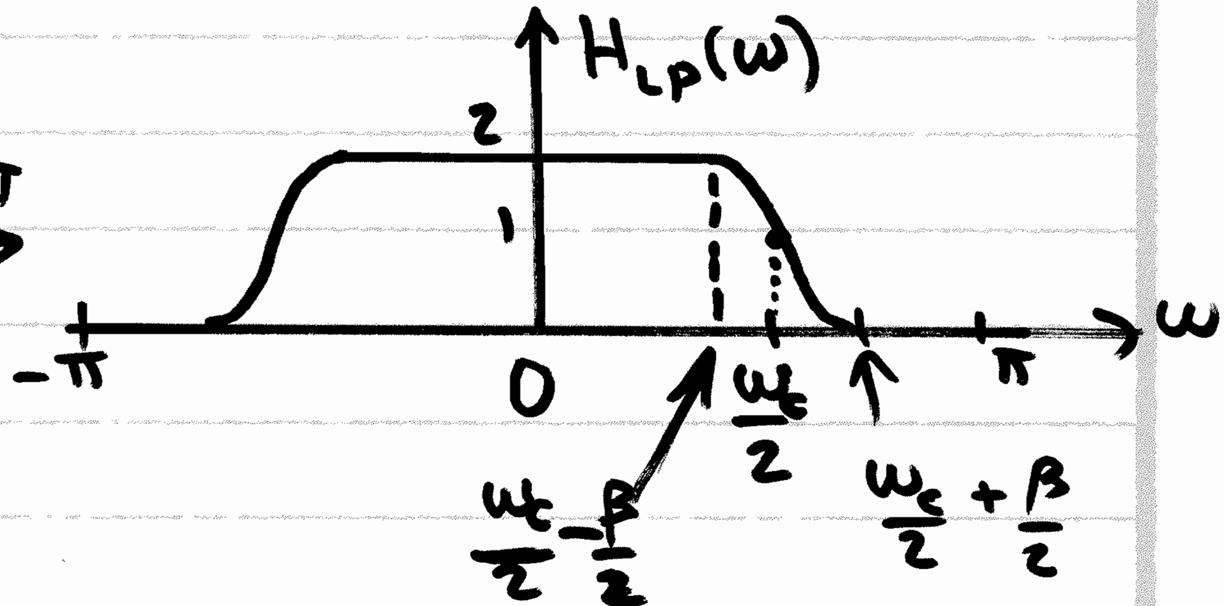
$$= 1 + \sin\left(\frac{\pi}{\beta}\omega\right)$$

Hence: $H_{VSB}(\omega) + H_{VSB}(-\omega) = 2$ ✓

• Note: $h_{VSB}[n] = e^{j\frac{\omega_c}{2}n}\, h_{LP}[n]$

where:

$$\underbrace{h_{LP}[n]}_{\text{real-valued and even-symmetric}} \overset{DTFT}{\longleftrightarrow}$$



$$H_{LP}(\omega) = \begin{cases} 2, & 0 < |\omega| < \frac{\omega_c}{2} - \frac{\beta}{2} \\ 1 + \cos\left(\frac{\pi}{\beta}\left(|\omega| - \left[\frac{\omega_c}{2} - \frac{\beta}{2}\right]\right)\right), & \frac{\omega_c}{2} - \frac{\beta}{2} < |\omega| < \frac{\omega_c}{2} + \frac{\beta}{2} \\ 0, & \frac{\omega_c}{2} + \frac{\beta}{2} < |\omega| < \pi \end{cases}$$