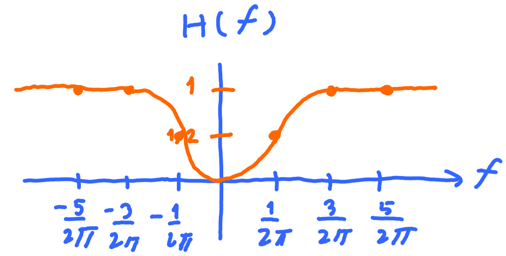
Channels and the Corresponding Transfer Functions

Wednesday, July 18, 2012
8:54 AM

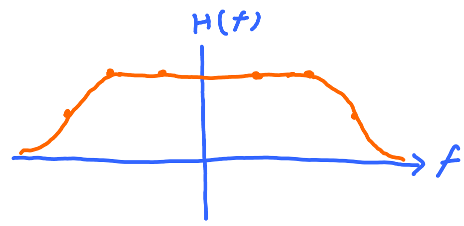
Goal: To be more specific about the channels that we discussed last time (via slides)

We have seen many types of channel.

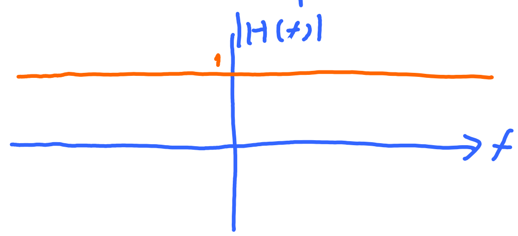
1. Channel with low-freq. attenuation



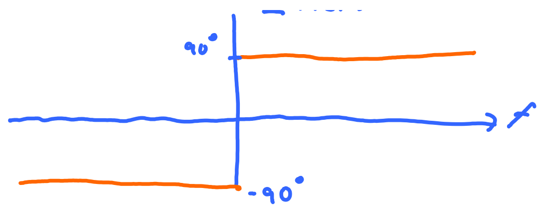
2. Channel with high-freq attenuation



3. Channel with constant phase shift



$\angle H(f)$



How can this be?

Y u no 90° ??

Recall: For our channel under consideration,

$$\cos(2\pi f_0 t) \rightarrow \boxed{H} \rightarrow \cos(2\pi f_0 t + \theta)$$

channel input: $\cos(2\pi f_0 t) = \frac{1}{2} e^{j 2\pi f_0 t} + \frac{1}{2} e^{-j 2\pi f_0 t}$

channel output: $\cos(2\pi f_0 t + \theta) = \frac{1}{2} e^{j(2\pi f_0 t + \theta)} + \frac{1}{2} e^{-j(2\pi f_0 t + \theta)}$

$$= \frac{1}{2} e^{j\theta} e^{j 2\pi f_0 t} + \frac{1}{2} e^{-j\theta} e^{-j 2\pi f_0 t}$$

$$H(f) = \begin{cases} e^{j\theta}, & f > 0 \\ e^{-j\theta}, & f < 0 \end{cases}$$

When we set $\theta = 90°$

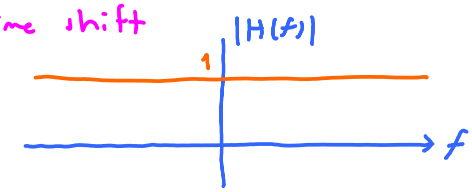
④ Channel with linear phase shift:

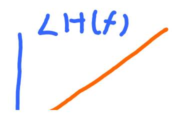
$$\cos(2\pi f_0 t) \rightarrow \boxed{H} \rightarrow \cos(2\pi f_0 t + \alpha f_0)$$

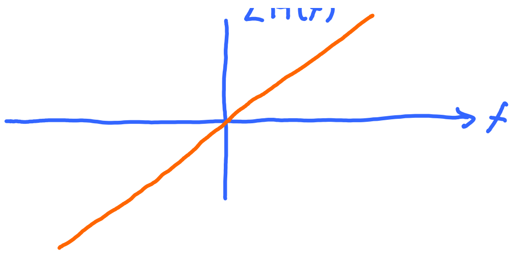
$\cos\left(2\pi f_0 \left(t + \frac{\alpha}{2\pi}\right)\right)$

amount of time shift

the amount of phase shift varies linearly with the freq. f_0.







5 Multipath (fading) channel

$$y(t) = \sum_i \beta_i x(t - \underset{\sim}{\tau_i})$$

time delay ← $\frac{\text{distance}}{c}$

$$h(t) = \sum_i \beta_i \delta(t - \tau_i)$$

$$H(f) = \sum_i \beta_i e^{-j2\pi f \tau_i}$$

only one term/path

6 Really nice channel

$$y(t) = \beta x(t - \tau)$$

$$h(t) = \beta \delta(t - \tau)$$

$$H(f) = \beta e^{-j2\pi f \tau}$$ (again, linear phase shift)

$$|H(f)| = |\beta|$$ ← "flat fading"
(with linear phase shift)