

EE3101 Communication Engineering

Tutorial 5

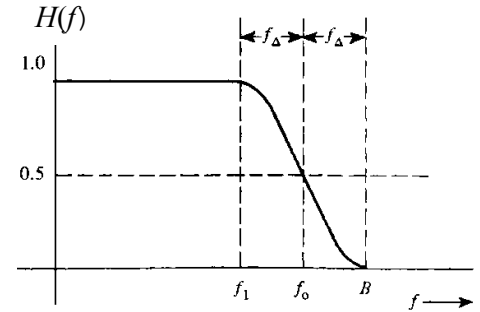
- (1) Determine the minimum baseband without ISI for the following systems:
 - (a) 100Mb/s with 2 levels.
 - (b) 140Mb/s with 16 levels.

- (2) If a proper raised cosine filter with excess bandwidth of 30% (i.e. $\alpha=0.3$) is used for a 45Mb/s system with 2-level discrete impulses, what are
 - (a) the 6dB bandwidth (i.e. the frequency that the output signal amplitude is reduced by half), and
 - (b) the 100% power bandwidth?

- ****(3) A proper raised cosine filter with α is used to reduce the bandwidth of an impulse sequence. The separation of the impulses is T . The transfer function of the raised cosine filter is:

$$\begin{aligned} H(f) &= 1 & \text{for } 0 \leq f \leq f_1 \\ H(f) &= \frac{1}{2} \left\{ 1 + \cos \left[\frac{\pi(f-f_1)}{2f_\Delta} \right] \right\} & \text{for } f_1 \leq f \leq B \\ H(f) &= 0 & \text{for } B \leq f \end{aligned}$$

$$\begin{aligned} f_0 &= \frac{1}{2T} \\ f_\Delta &= B - f_0 = f_0 - f_1 \\ \alpha &= \frac{f_\Delta}{f_0} \end{aligned}$$



- (a) If the filter output signal is sampled at a rate of $1/T$ without any timing offset, show that the equivalent transfer function for the sampled data is:

$$H_{eq}(f) = 1 \quad \text{for } 0 \leq f \leq \frac{1}{T}$$

Note: $H_{eq}(f) = H(f) + H_{imag}(f)$

where $H_{imag}(f)$ is the image of $H(f)$ due to the sampling process.

- (b) The average power of the sampled data is:

$P_{av} = A \int_0^{1/T} |H_{eq}(f)|^2 df$ where A is the power spectrum density of the impulse sequence which is a constant. If there exists a sampling time offset ϵ in the sampling process, show that

$$P_{av}^{0 < \epsilon < T} < P_{av}^{\epsilon=0} \quad \text{for } 0 < \alpha$$

i.e. P_{av} has the maximum sampling power when there is no sampling time offset for $0 < \alpha$. How about the case for $\alpha = 0$?

- (c) Can we draw the same conclusion if the signal is sampled at a rate of $\frac{2}{T}$?

**** Not included in Quiz/Test/Exam**

******(4) Show that the PSD of a random $\pm$ half sine wave, i.e. $\pm\sin(\frac{\pi t}{T})$ with $t = 0$ to T , sequence is:

$$S(\omega) = \frac{4T \cos^2(\pi f T)}{\pi^2 (4f^2 T^2 - 1)^2}$$

**** Not included in Quiz/Test/Exam**

(5) Evaluate the PSD of On-Off Keying, BPSK and QPSK systems.

Background

A bandpass waveform can be represented as:

$$v(t) = \text{Re}\{g(t) \exp(j2\pi f_c t)\}$$

where $g(t)$ is the baseband signal and f_c is the carrier frequency.

The power spectrum density, $P_v(f)$, of the waveform is:

$$P_v(f) = \frac{1}{4} [P_g(f - f_c) + P_g(f + f_c)]$$

where P_g is the power spectrum density of $g(t)$

Evaluate the power spectrum density at the modulator output of the following:

- (a) ***On-Off*** Keying,
- (b) ***BPSK***, and
- (c) ***QPSK***.