NANYANG TECHNOLOGICAL UNIVERSITY
School of Electrical & Electronic Engineering

EE/IM4152 Digital Communications

Tutorial No. 4 (Sem 1, AY2016-2017)

1. Figure 1 shows the spectrum $P(f)$ of a basic pulse $p(t)$, where $f_x = R_b/6$.
   (a) Explain if $P(f)$ satisfies the Nyquist criterion for zero ISI in the frequency domain.
   (b) If the pulse does satisfy the Nyquist criterion, what is the roll-off factor?

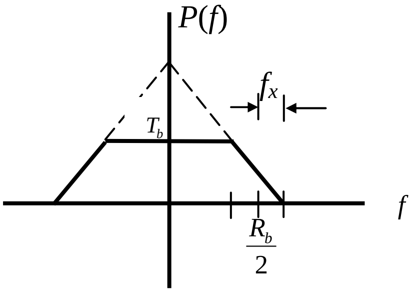

Figure 1

2. The family of pulses satisfying the Nyquist first criterion has been given in the lecture notes (see Slide 102). When the excess bandwidth $f_x = R_b/2$, show that

$$P(f) = \frac{1}{2}\left(1 + \cos\frac{\pi f}{R_b}\right)\text{rect}\left(\frac{f}{2R_b}\right)$$

where rect(·) is the rectangular waveform and R_b denotes the bit rate.

3. A half-width rectangular pulse

$$g(t) = \text{rect}\left(\frac{t}{T_b/2}\right)$$

is transmitted over a band-limited channel, where T_b is the bit duration. The channel is modelled as a low-pass filter with transfer function

$$H(f) = \text{rect}\left(\frac{f}{4R_b}\right), \qquad R_b = \frac{1}{T_b}.$$

The channel output $y(t)$ can be computed numerically. Plot $y(t)$ versus t and discuss the pulse spreading effect.

4. To achieve zero intersymbol interference (ISI), the desired pulse $p(t)$ needs to satisfy

$$p(nT_b) = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$$

where n is an integer and T_b denotes the bit duration of the pulse. In the frequency domain, the corresponding requirement becomes

$$\sum_{n=-\infty}^{\infty} P(f - nR_b) = T_b$$

where $R_b = 1/T_b$ is the pulse rate. Now suppose the channel has a bandwidth of B Hz. For the following three cases:

(i) $R_b > 2B$

(ii) $R_b = 2B$

(iii) $R_b < 2B$

discuss the possibilities of finding $P(f)$ that achieves zero ISI.