Problem 6.6

Assume the following perfect conditions:

- The residual distortion in the data transmission system is zero.
- The pulse shaping is partitioned equally between the transmitter-channel combination and the receiver.
- The transversal equalizer is infinitely long.

(a) Find the corresponding value of the equalizer's transfer function in terms of infinite the overall pulse spectrum $P(f)$.

(b) For the roll-off factor $\alpha = 1$, demonstrate that a transversal equalizer of length 6 would essentially satisfy the perfect condition found in part (a) of the problem.

Solution

(a) With the pulse-shaping shared equally between the transmit filter-channel combination and receive filter, we may use an equalizer of transfer function $P^{1/2}(f)$ to realize the receive filter, where $P(f)$ is the raised cosine-pulse spectrum.

(b) For a roll-off factor $\alpha = 0$, $P(f)$ reduces to the idealized brick-wall function

$$P(f) = \begin{cases} \dfrac{\sqrt{E}}{2B_0}, & \text{for } B_0 < f < B_0 \\ 0, & \text{otherwise} \end{cases}$$

which defines the Nyquist channel. In light of the transfer function of the equalizer (used to realize the receive filter) is defined by

$$P(f) = \begin{cases} \dfrac{E^{1/4}}{(2B_0)^{1/2}}, & \text{for } B_0 < f < B_0 \\ 0, & \text{otherwise} \end{cases}$$

Correspondingly, the impulse response of the equalizer is required to pass through an infinite number of time instants at $t = \pm 1/(2B_0)$, $\pm 1/B_0$, $\pm 3/(2B_0)$,.... We may satisfy this idealized requirement by using an equalizer of infinite length. Such an equalizer would have an infinite number of adjustable parameters $\ldots W_N, \ldots, W_{-1}, W_0, W_1, \ldots, W_N$ that can be used to satisfy the zero-forcing basis of Eq. (6.43) of the text. In practice, however, the idealized impulse response of the channel reduces effectively to zero at some large enough time t, which, in turn, means that an equalizer of large enough length can be used to satisfy the idealized Nyquist channel.

Note: In the first printing of the book, the following correction in the first line of part (b) of Problem 6.6 should be made: - Roll-off factor $\alpha = 0$.