Problem 6.13

According to Eq. (6.30), the pulse-shaping criterion for zero-intersymbol interference is embodied in the relation

$$\sum_{m=-\infty}^{\infty} P\left(f - \frac{m}{T}\right) = \text{constant} \tag{1}$$

where $P(f)$ is pulse-shaping spectrum and $1/T$ is the signaling rate.

(a) The pulse-shaping spectrum of Fig. 6.13(a) is defined by

$$P(f) = \begin{cases} \sqrt{E}/(2B_0) & \text{for} \quad f = 0 \\ \dfrac{\sqrt{E}}{2B_0}\left(1 - \dfrac{f}{B_0}\right) & \text{for} \quad 0 < f < B_0 \\ 0 & \text{for} \quad f = B_0 \end{cases} \tag{2}$$

Substituting Eq. (2) into (1) leads to the following condition on the signaling rate

$$\frac{1}{T} = \frac{B_0}{2}$$

or, equivalently,

$$B_0 = 2/T \tag{3}$$

(b) The pulse-shaping spectrum of Fig. 6.12(b) is defined by

$$P(f) = \begin{cases} \sqrt{E}/(2B_0) & \text{for } 0 \le |f| < f_1 \\ \dfrac{\sqrt{E}}{2B_0}\left(1 - \dfrac{f - f_1}{B_0 - f_1}\right) & \text{for } f_1 < f < B_0 \\ 0 & \text{for } f > B_0 \end{cases} \tag{4}$$

Substituting Eq. (3) into (1) leads to the following condition on the signaling rate

$$\frac{1}{T} = \frac{1}{2}(f_1 + B_0)$$

Equivalently, for a given f_1, we require that

$$B_0 = \frac{2}{T} - f_1 \tag{5}$$

(c) Among the four pulse-shaping spectra described in Figs. 6.2(a), 6.3(a), 6.12(a) and 6.12(b) the prescriptions defined in Fig. 6.3(a) corresponding to the roll-off factor $\alpha = 1/2$ and $\alpha = 1$ are the preferred choices in practice for the following reasons:

- Mathematical simplicity and therefore relative ease of practical realization.
- Improved signaling rate compared to the prescriptions described in Fig.s 6.12(c) and 6.12(b).