Problem 8.17

The following table shows the precoded sequence, the transmitted amplitude levels, the received signal levels and the decoded sequence, when the data sequence 10010110010 modulates a duobinary transmitting filter.

Data seq. d_n:		1	0	0	1	0	1	1	0	0	1	0
Precoded seq. p_n:	0	1	1	1	0	0	1	0	0	0	1	1
Transmitted seq. a_n:	-1	1	1	1	-1	-1	1	-1	-1	-1	1	1
Received seq. b_n:		0	2	2	0	-2	0	0	-2	-2	0	2
Decoded seq. d_n:		1	0	0	1	0	1	1	0	0	1	0

Problem 8.22

1) The output of the matched filter demodulator is

$$\begin{aligned} y(t) &= \sum_{k=-\infty}^{\infty} a_k \int_{-\infty}^{\infty} g_T(\tau - kT_b) g_R(t-\tau) d\tau + \nu(t) \\ &= \sum_{k=-\infty}^{\infty} a_k x(t - kT_b) + \nu(t) \end{aligned}$$

where,

$$x(t) = g_T(t) \star g_R(t) = \frac{\sin \frac{\pi t}{T}}{\frac{\pi t}{T}} \frac{\cos \frac{\pi t}{T}}{1 - 4\frac{t^2}{T^2}}$$

Hence,

$$\begin{aligned} y(mT_b) &= \sum_{k=-\infty}^{\infty} a_k x(mT_b - kT_b) + v(mT_b) \\ &= a_m + \frac{1}{\pi} a_{m-1} + \frac{1}{\pi} a_{m+1} + \nu(mT_b) \end{aligned}$$

The term $\frac{1}{\pi} a_{m-1} + \frac{1}{\pi} a_{m+1}$ represents the ISI introduced by doubling the symbol rate of transmission.

Problem 8.27

Let $G_T(f)$ and $G_R(f)$ be the frequency response of the transmitting and receiving filter. Then, the condition for zero ISI implies

$$G_T(f) C(f) G_R(f) = X_{rc}(f) = \begin{cases} T & 0 \le |f| \le \frac{1}{4T} \\ \frac{T}{2}[1 + \cos(2\pi T(|f| - \frac{1}{T})] & \frac{1}{4T} \le |f| \le \frac{3}{4T} \\ 0 & |f| > \frac{3}{4T} \end{cases}$$

Since the additive noise is white, the optimum tansmitting and receiving filter characteristics are given by (see (8.4.19))

$$|G_T(f)| = \frac{|X_{rc}(f)|^{\frac{1}{2}}}{|C(f)|^{\frac{1}{2}}}, \qquad |G_R(f)| = \frac{|X_{rc}(f)|^{\frac{1}{2}}}{|C(f)|^{\frac{1}{2}}}$$

Thus,

$$|G_T(f)| = |G_R(f)| = \begin{cases} \left[\frac{T}{1+0.3\cos 2\pi fT}\right]^{\frac{1}{2}} & 0 \le |f| \le \frac{1}{4T} \\ \left[\frac{T(1+\cos(2\pi T(|f| - \frac{1}{T})}{2(1+0.3\cos 2\pi fT)}\right]^{\frac{1}{2}} & \frac{1}{4T} \le |f| \le \frac{3}{4T} \\ 0 & \text{otherwise} \end{cases}$$