7.7-2 In a PAM scheme with $M = 16$, do the following.

(a) Determine the minimum transmission bandwidth required to transmit data at a rate of 12,000 bit/s with zero ISI.

(b) Determine the transmission bandwidth if Nyquist criterion pulses with a roll-off factor $r = 0.2$ are used to transmit data.

7.7-3 An audio signal of bandwidth 3.2 kHz is sampled at a rate 25% above the Nyquist rate and quantized. The quantization error is not to exceed 0.5% of the signal peak amplitude. The resulting quantized samples are now coded and transmitted by 4-ary pulses.

(a) Determine the minimum number of 4-ary pulses required to encode each sample.

(b) Determine the minimum transmission bandwidth required to transmit this data with zero ISI.

(c) Determine the transmission bandwidth if Nyquist criterion 4-ary pulses with 25% roll-off are used to transmit the data.

7.7-4 Binary data is transmitted over a certain channel at a rate R_b bit/s. To reduce the transmission bandwidth, it is decided to transmit this data using 16-ary PAM signaling.

(a) By what factor is the bandwidth reduced?

(b) By what factor is the transmitted power increased, assuming minimum separation between pulse amplitudes to be the same in both cases?

Hint: Take the pulse amplitudes to be $\pm A/2, \pm 3A/2, \pm 5A/2, \pm 7A/2, \ldots, \pm 15A/2$, so that the minimum separation between various amplitude levels is A (same as that in the binary case pulses $\pm A/2$). Assume all the 16 levels to be equally likely. Recall also that multiplying a pulse by a constant k increases its energy k^2-fold.

7.7-5 Consider a case of binary transmission using polar signaling that uses half-width rectangular pulses of amplitudes $A/2$ and $-A/2$. The data rate is R_b bit/s.

(a) What is the minimum transmission bandwidth and the transmitted power?

(b) This data is to be transmitted by M-ary rectangular half-width pulses of amplitudes

$$\pm\frac{A}{2}, \pm\frac{3A}{2}, \pm\frac{5A}{2}, \ldots, \pm\left(\frac{M-1}{2}\right)A$$

Note that to maintain about the same noise immunity, the minimum pulse amplitude separation is A. If each of the M-ary pulses is equally likely to occur, show that the transmitted power is

$$P = \frac{(M^2 - 1)A^2}{24 \log_2 M}$$

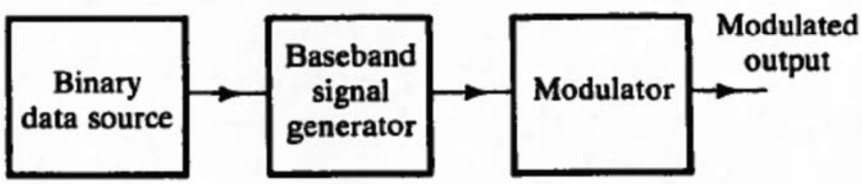
Also determine the transmission bandwidth.

7.7-6 An audio signal of bandwidth 15 kHz is sampled at a rate of 44.1 kHz, quantized into 256 levels, and coded by means of M-ary PAM pulses satisfying Nyquist's criterion with a roll-off factor $r = 0.25$. A 30 kHz bandwidth is available to transmit the data. Determine the best value of M.

7.8-1 Figure P7.8-1 shows a binary data transmission scheme. The baseband signal generator uses full-width pulses and polar signaling. The data rate is 1 Mbit/s.

(a) If the modulator generates a PSK signal, what is the bandwidth of the modulated output?

(b) If the modulator generates FSK with the difference $f_{c1} - f_{c0} = 100$ kHz (Fig. 7.32c), determine the modulated signal bandwidth.



7.8-2 Repeat Prob. 7.8-1(a) if instead of full-width pulses, Nyquist criterion pulses with $r = 0.2$ are used.

Problem 8: (not from text book)

Polar pulses are used to transmit data at the rate of 100 kbps. The detection error probability is required to be less than 10^{-7}. The rms. value of the channel noise at the receiver input is 1 mV. The signal attenuation over the channel is 40 dB.

a) Determine the minimum required pulse amplitude and power at the receiver input
b) Determine the minimum signal power that must be transmitted.
c) Determine the average number of errors in one hour