PROBLEM 2.1. A transmitter using zero excess bandwidth is trying to achieve a bit rate of \(100 \text{ Mb/s}\) over a channel with the following frequency response:

![Frequency Response Diagram]

What modulation scheme would you recommend?

PROBLEM 2.2. Suppose the transmitter pulse shape \(g(t)\) is the rectangular pulse as shown in Fig. 2.2 of the book, and suppose the channel impulse response is \(h(t) = \exp(-t)u(t)\), where \(u(t)\) is the unit step function. Suppose the receiver filter has impulse response \(c(t)\) and frequency response \(C(f)\). Find and sketch the frequency response \(C(f)\) of a receiver filter that produces an overall impulse response \(p(t) = g(t) \ast h(t) \ast c(t)\) that satisfies the Nyquist Criterion.

PROBLEM 2.3. Consider the pulse \(p(t)\) with Fourier Transform \(P(f)\) shown below:

![Fourier Transform Diagram]

Is \(p(t)\) a Nyquist pulse when the symbol rate is 1000 baud? Explain your answer.

PROBLEM 2.4. Problem 7.1 from textbook.

PROBLEM 2.5. Repeat Problem 7.1 from textbook, but this time using the signal \(s(t) = e^{-t}u(t)\), where \(u(t)\) is the unit step function.

PROBLEM 2.6. Consider the following binary signal set:

\[s_1(t) = \sin(\pi t), \quad t \in [0,1]\]

\[s_2(t) = 1, \quad t \in [0,1]\]

Specify the decision made by the minimum-distance receiver if it were to observe each of the following waveforms:

(a) \(r(t) = \sin(4\pi t)\).

(b) \(r(t) = \sin(\pi t)\).

(c) \(r(t) = -\cos(\pi t)\).

(d) \(r(t) = \sin(\pi t) + \sqrt{2}\).
**Problem 2.7.** Suppose a binary transmitter emits either $s_1(t)$ or $s_2(t)$, and the receiver observation $r(t)$ is the sum of the transmitted signal plus noise. In class we defined the minimum-distance receiver as that which minimizes $\int_{-\infty}^{\infty} |r(t) - s_k(t)|^2 dt$.

In other words, the minimum-distance receiver decides $s_1(t)$ if $\int_{-\infty}^{\infty} |r(t) - s_1(t)|^2 dt < \int_{-\infty}^{\infty} |r(t) - s_2(t)|^2 dt$, and it decides $s_2(t)$ if $\int_{-\infty}^{\infty} |r(t) - s_2(t)|^2 dt \leq \int_{-\infty}^{\infty} |r(t) - s_1(t)|^2 dt$.

One realization of the minimum-distance receiver is the correlation receiver, which can be implemented using two matched filters, one matched to $s_1(t)$ and the other matched to $s_2(t)$. However, it is possible to get by with only one matched filter. Show that a single filter matched to the difference $s_1(t) - s_2(t)$ is sufficient to implement the minimum-distance receiver.

**Problem 2.8.** Consider the 4-ary signal set and the received signal $r(t)$ shown below:

![Signal Diagram](image)

What decision is made by the minimum-distance receiver? Explain.