

Homework Set #7

1. Haykin's problems 4.9 and 4.11.
2. The output of the receive filter in a PCM system is given by

$$y(t) = \sum_{k=-\infty}^{\infty} a_k p(t - kT_b),$$

where the $\{a_k\}$ are iid random variables that take on the values $a_k = 1$ and $a_k = -1$ with equal probability. Suppose that the receiver is not quite synchronized with the transmitter, so that $y(t)$ is sampled at time instants $t_i = iT_b + \delta t$, rather than at $t_i = iT_b$.

- (a) Show that the resulting mean-square-error at the sampled output is

$$E(y(iT_b + \delta) - a_i)^2 = (1 - p(\delta t))^2 + \sum_{k \neq 0} p^2(\delta t + kT_b).$$

- (b) Define the "time-normalized" pulse function $q(t) = p(tT_b)$, and hence show that, if $\delta t/T_b$ is small, then to first order

$$E(y(iT_b + \delta) - a_i)^2 \approx \left(\frac{\delta t}{T_b}\right)^2 \sum_{k=-\infty}^{\infty} (q'(k))^2.$$

- (c) Compute and plot the factor $\sum_{k=-\infty}^{\infty} (q'(k))^2$ as a function of α for the raised cosine signal. (Eq. 4.62 in Haykin.) How many db's of improvement do we get for $\alpha = 1$, compared to $\alpha = 0$ (which is the standard sinc pulse)?
- (d) Compute the factor $\sum_{k=-\infty}^{\infty} (q'(k))^2$ for the correlative level pulse (of Haykin's Eq. (4.70)). How does it compare to the sinc pulse?
3. Haykin's problem 4.32.