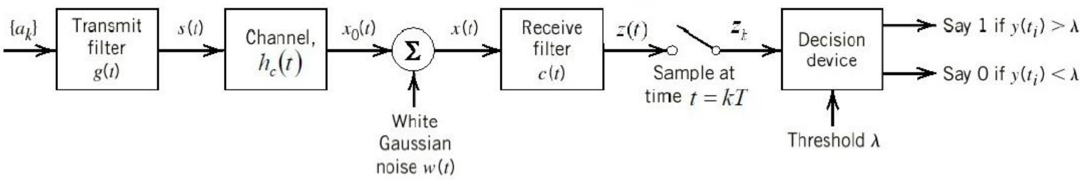
PROBLEMS SET II

PULSE SHAPING

Problem (1-4) (Haykin, 5th edition) 8.13, 8.14, 8.15, 8.16.

Problem (5*) A model of a baseband transmission system is shown below. Symbols a_k = ±1 are sent with time separation *T*. The symbols a_k are statistically independent, and the probabilities for +1 and -1 are equal.



The transmitter filter has transfer function:

$$G(f) = \begin{cases} \sqrt{T}\cos(\pi f T/2) & |f| \le 1/T \\ 0 & \text{elsewhere.} \end{cases}$$

The channel can be considered ideal and the noise is white and Gaussian with zero mean and power spectral density *No*/2.

a) Find the transfer function for the receiver filter, *C*(*f*), that is optimum with respect to signal to noise ratio at the sampling instant.
b) If the resulting impulse response for the part of the system that comes before the sampler is given by:

$$p(t) = \frac{\sin(2\pi t/T)}{(2\pi t/T)\cdot(1-4t^2/T^2)}$$

Is the Nyquist criterion fulfilled for the given system? Justify your answer.
c) Calculate the noise power at the output of the receive filter.
d) Calculate the bit error rate of the system if E_b/N_o = 8 dB.

Problem (6*) Suppose a digital communication system employs Gaussian-shaped pulses of the form $x(\mathrm{t}) = \exp(-\pi a^2 t^2)$. In order to reduce the level of ISI to a relatively small amount, we impose the condition that $x(T) = 0.01$, where *T* is the symbol interval. The BW *W* of the pulse $x(t)$ is defined as that value of *W* for which $\frac{X(W)}{X(0)} = 0.01$, where $X(f)$ is the Fourier transform of $x(t)$. Determine the value of *W* and compare this value to that of raised cosine spectrum with 100 % roll off. (**Hint:** first, try to find $X(f)$. Use the two given conditions to formulate two equations for the two unknowns *W* and *T* in terms of *a*. Then, try to link them together to get the required result.)

REPRESENTATION OF SIGNALS

Problem (1-5) (Haykin, 4th edition) 5.1, 5.2*, 5.3, 5.4, 5.5
Problem (6-7) (Lathi, 3rd edition) 14.1-2, 14.1-4*

- (*) Starred problems are HW problems.