

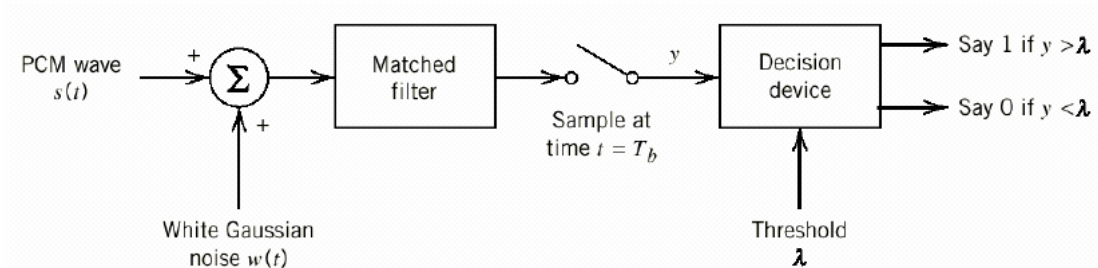
1.

(a) Describe what is matched filter

(b) Prove that matched filter maximizes the output signal to noise ratio under AWGN
(Hint : slide 4-4~4-9)

2.

For polar non-return-to-zero system with optimal matched filter receiver over AWGN channel. The pulse shaping function $g(t)$ is real. (Hint : slide 4-13~4-19)



(a)

Derive $y(t)$ where

$$h(\tau) = g^*(T - \tau), t = T, I \in \{+1, -1\}, E_g = \int_{-\infty}^{\infty} |g(\tau)|^2 d\tau, n = \int_{-\infty}^{\infty} g^*(\tau) w(\tau) d\tau$$

(b)

Derive $E[n^2]$

(c)

Suppose transmit in equal probability, determine the threshold λ that achieves optimal decision. (Do Not write down the threshold λ only.)

(d)

Prove that $BER_{opt} = \frac{1}{2} \text{erfc}\left(\sqrt{\frac{E_g}{N_0}}\right)$

3.

Let $X(t) = \sum_{-\infty}^{\infty} a_k \delta(t - kT_b)$, $X(t)$ is not WSS, please find the *Time Average*

Autocorrelation Function $\overline{R_X(\tau)}$. (Note: $\{a_k\}$ is i.i.d.) (Hint: slide 4-58)