EE206 2020 Spring

通信原理
习题课

Digital Assignment 4

SUSTech
Southern University
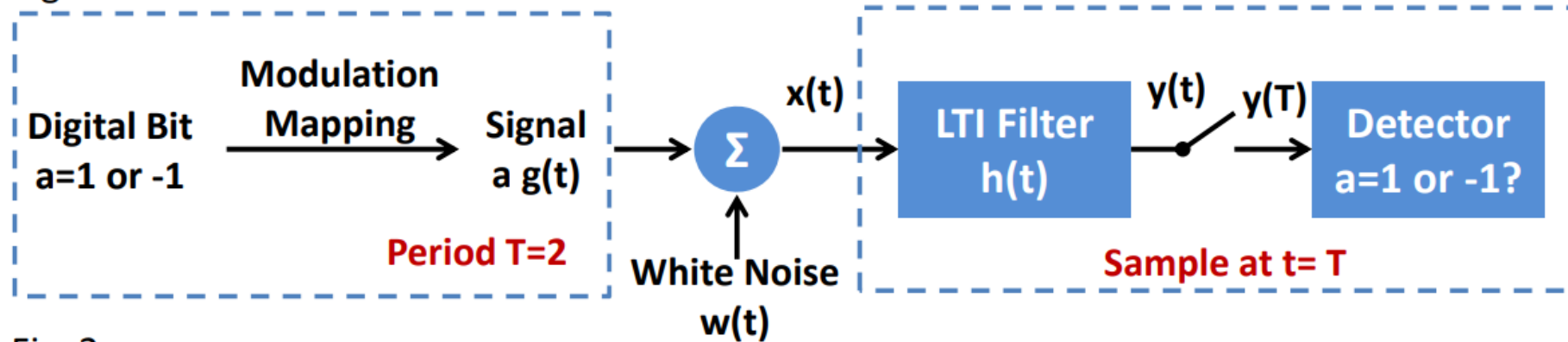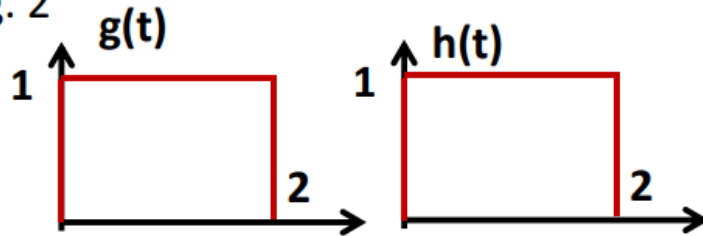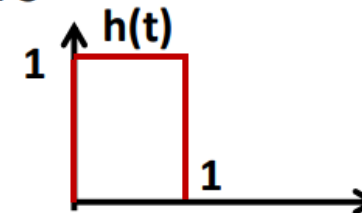of Science and
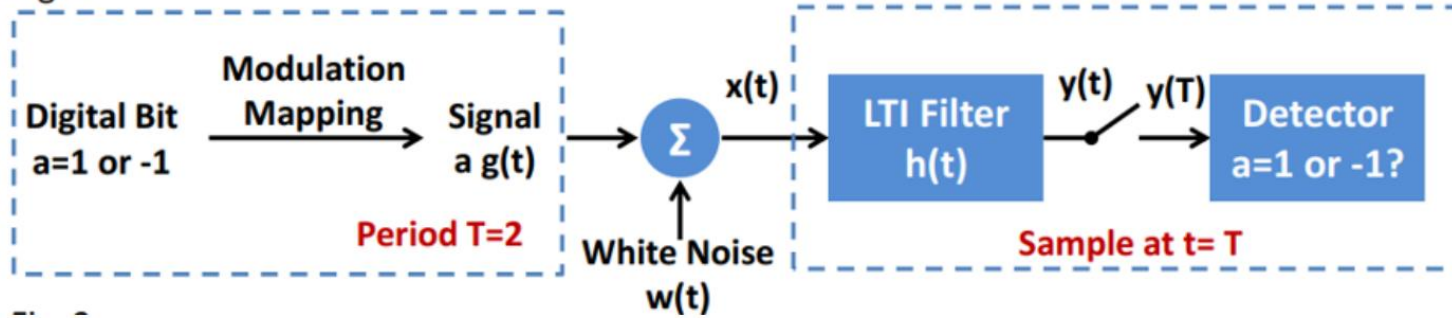Technology

Homework #D4

Fig. 1

Fig. 2

Fig. 3

- D4.1

Consider the baseband transceiver in Fig. 1, where g(t) and h(t) are given by Fig. 2,

(a) Please sketch the PSD of noise in y(t).

(b) What is the signal power in y(T)? What is the noise power in y(T)? What is the SNR of y(T)?

(c) If h(t) is given by Fig. 3, what is your answer of question (b)?

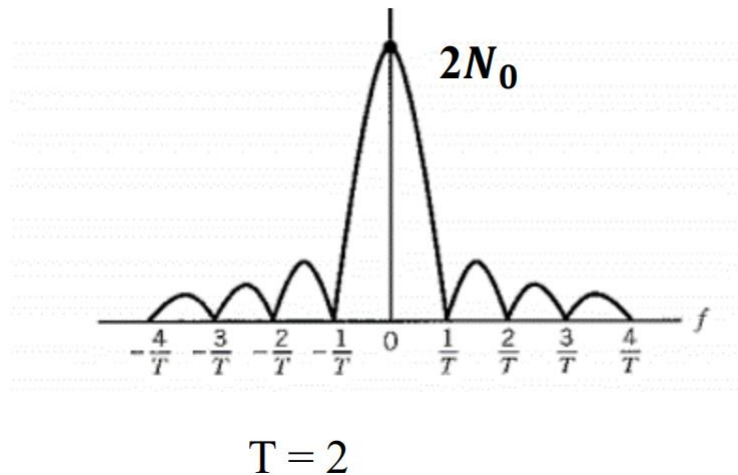(d) Compare the SNR of question (b) and (c), which impulse response h(t) is better for receiver?

Fig. 1

Modulation Mapping

Digital Bit a=1 or -1 → Signal a g(t), Period T=2 → Σ → x(t) → LTI Filter h(t) → y(t) → y(T) → Detector a=1 or -1?

White Noise w(t)

Sample at t= T

Solution:

$$x(t) = ag(t) + w(t)$$

signal   noise

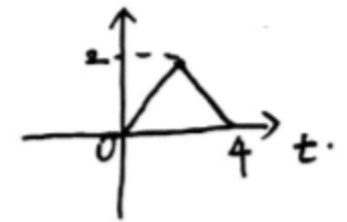$$y(t) = x(t)\otimes h(t) = (ag(t) + w(t))\otimes h(t) = \boxed{ag(t)\otimes h(t)} + \boxed{w(t)\otimes h(t)}$$

a) PSD of noise in y(t) $= \dfrac{N_0|H(f)|^2}{2}$

$2N_0$

$-\frac{4}{T}$ $-\frac{3}{T}$ $-\frac{2}{T}$ $-\frac{1}{T}$ 0 $\frac{1}{T}$ $\frac{2}{T}$ $\frac{3}{T}$ $\frac{4}{T}$ f

$T = 2$

b) $y(T) = ag(t)\otimes h(t)|_{t=T} + w(t)\otimes h(t)|_{t=T} = g_0(T) + n(T)$

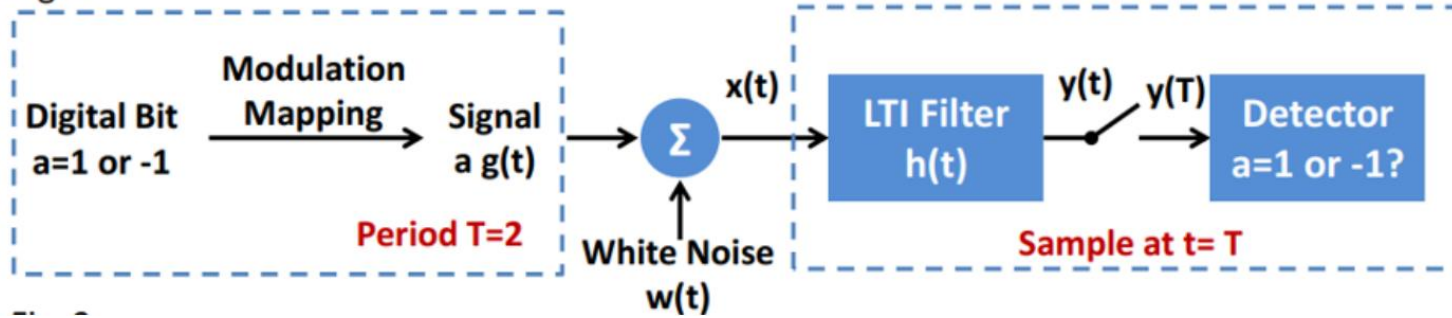Signal power $= |ag(t)\otimes h(t)|_{t=T}|^2 = |g_0(T)|^2$

$g(t)\otimes h(t)$

Signal power $= 2^2 = 4$

Noise power $= E(n^2(T)) = \dfrac{N_0}{2}\int_{-\infty}^{\infty}|H(f)|^2 df = \dfrac{N_0}{2}\int_0^2 |h(t)|^2 dt = N_0$

$SNR = \dfrac{4}{N_0}$

Fig. 1

Modulation

Digital Bit | **Mapping** → | Signal
a=1 or -1 | | a g(t)

Σ

x(t)

LTI Filter h(t)

y(t) | y(T)

Detector a=1 or -1?

Period T=2

White Noise w(t)

Sample at t= T

c) $y(T) = ag(t)\otimes h(t)|_{t=T} + w(t)\otimes h(t)|_{t=T} = g_0(T) + n(T)$ $g(t)\otimes h(t)$

Signal power $= |ag(t)\otimes h(t)|_{t=T}|^2 = |g_0(T)|^2$

Signal power $= 1^2 = 1$

Noise power $= E(n^2(T)) = \frac{N_0}{2}\int_{-\infty}^{\infty}|H(f)|^2 df = \frac{N_0}{2}\int_0^1 |h(t)|^2 dt = \frac{N_0}{2}$

$\text{SNR} = \frac{1}{\frac{N_0}{2}} = \frac{2}{N_0}$

d)

$SNR_b > SNR_c$

The impulse response h(t) in b is better