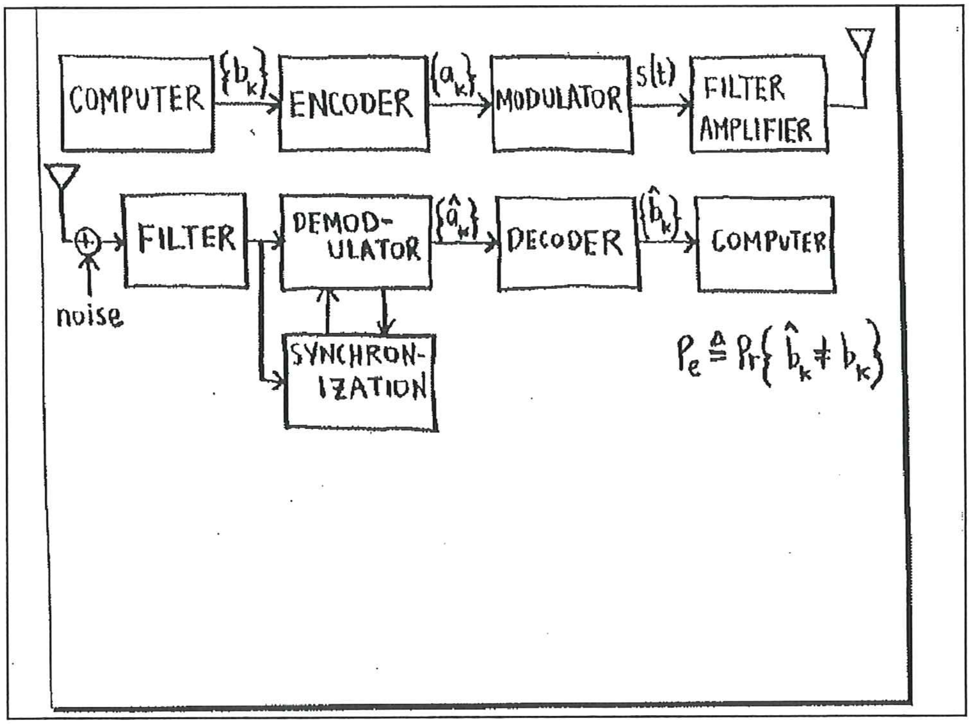
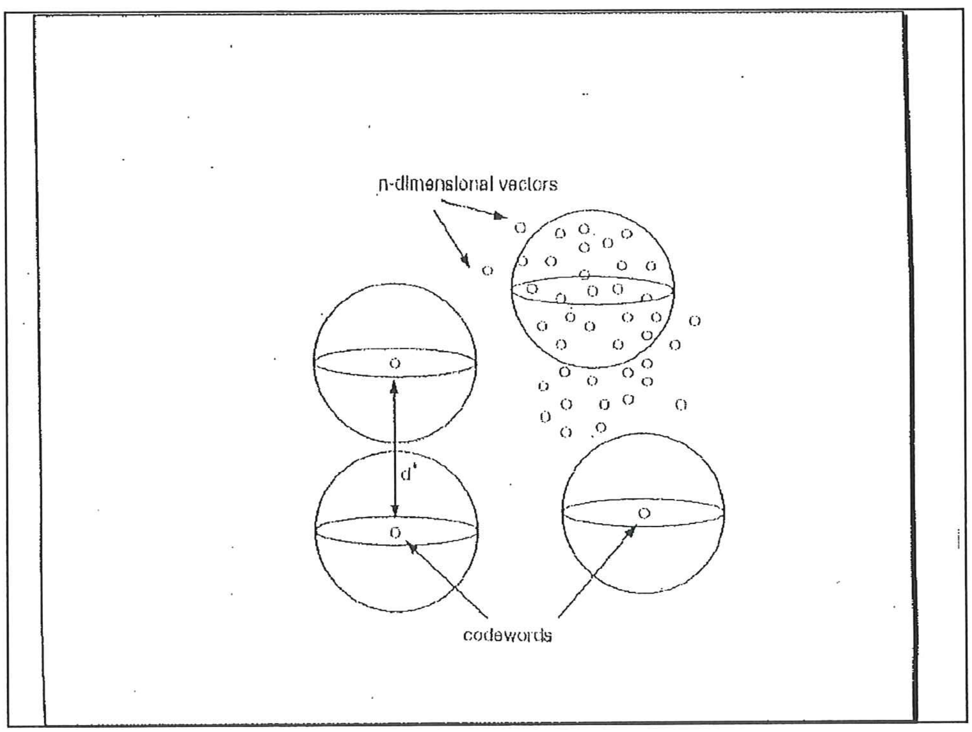
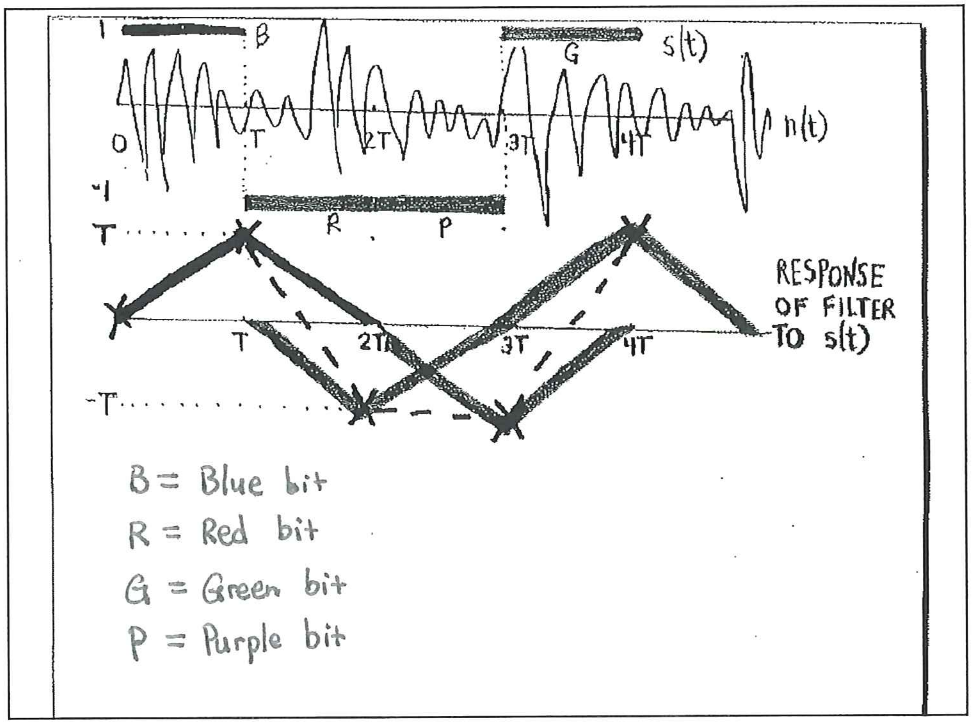
Session 1



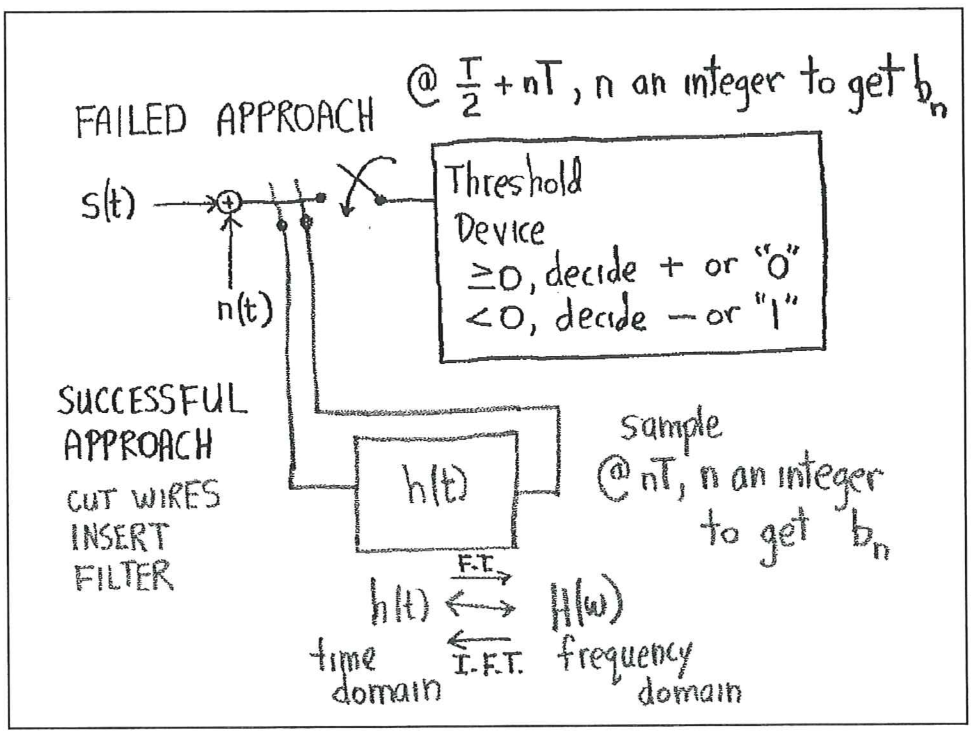
COMPUTER
$\{b_k\}$
ENCODER
$\{a_k\}$
MODULATOR
s(t)
FILTER AMPLIFIER
FILTER
noise
DEMOD-ULATOR
$\{\hat{a}_k\}$
DECODER
$\{\hat{b}_k\}$
COMPUTER
SYNCHRON-IZATION
$P_e \triangleq P_r\{\hat{b}_k \neq b_k\}$



n-dimensional vectors
d'
codewords



1
B
G
s(t)
0
T
2T
3T
4T
n(t)
-1
R
P
T
RESPONSE OF FILTER TO s(t)
-T
B = Blue bit
R = Red bit
G = Green bit
P = Purple bit



FAILED APPROACH
@ $\frac{T}{2}$ + nT , n an integer to get b_n
s(t)
n(t)
Threshold
Device
≥0, decide + or "0"
<0, decide − or "1"
SUCCESSFUL
APPROACH
CUT WIRES
INSERT
FILTER
h(t)
Sample
@ nT, n an integer
to get b_n
F.T.
h(t)
H(ω)
I.F.T.
time
domain
frequency
domain

$$s(t) \longrightarrow \boxed{h(t)} \longrightarrow \text{RESPONSE to } s(t)$$

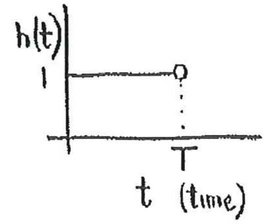
IMPULSE RESPONSE

$$h(t) = P_T(t) = \begin{cases} 1, & 0 \le t \boxed{<} T \\ 0, & \text{elsewhere} \end{cases}$$

$$\text{RESPONSE} = \int_{-\infty}^{\infty} s(\alpha) h(t-\alpha)\, d\alpha$$

$$= \int_{-\infty}^{\infty} s(\alpha) \underbrace{P_T(t-\alpha)}_{=1 \text{ for}}\, d\alpha$$

$$0 \le t-\alpha < T$$
$$-t \le -\alpha < T-t$$
$$t \ge \alpha > t-T$$
$$t-T < \alpha \le t$$



$$= \int_{t-T}^{t} s(\alpha)\, d\alpha \quad @t=T \quad @t=2T$$

$$\tilde{h}(t) = h(-t)$$

$$\underset{(WSS)}{X(t)} \longrightarrow \boxed{h(t)} \longrightarrow \underset{(WSS)}{Y(t)}$$

$$\boxed{\begin{aligned} \mu_Y &= \mu_X * h \\ R_Y(\tau) &= R_X(\tau) * h * \tilde{h} \end{aligned}}$$

$$R_Y(\tau) = E\{Y(t)Y(t+\tau)\}$$

$$= E\left\{\int_{-\infty}^{\infty} X(t-\alpha)h(\alpha)\,d\alpha \int_{-\infty}^{\infty} X(t+\tau-\beta)h(\beta)\,d\beta\right\}$$

$$= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \underbrace{E\{X(t-\alpha)X(t+\tau-\beta)\}}_{R_X(\tau+\alpha-\beta)} h(\alpha)h(\beta)\,d\alpha\, d\beta$$

$$\boxed{\begin{array}{l}\text{Let} \\ \gamma = -\alpha\end{array}} = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} R_X(\tau-\gamma-\beta)\,\tilde{h}(\gamma)\,h(\beta)\,d\gamma\, d\beta$$