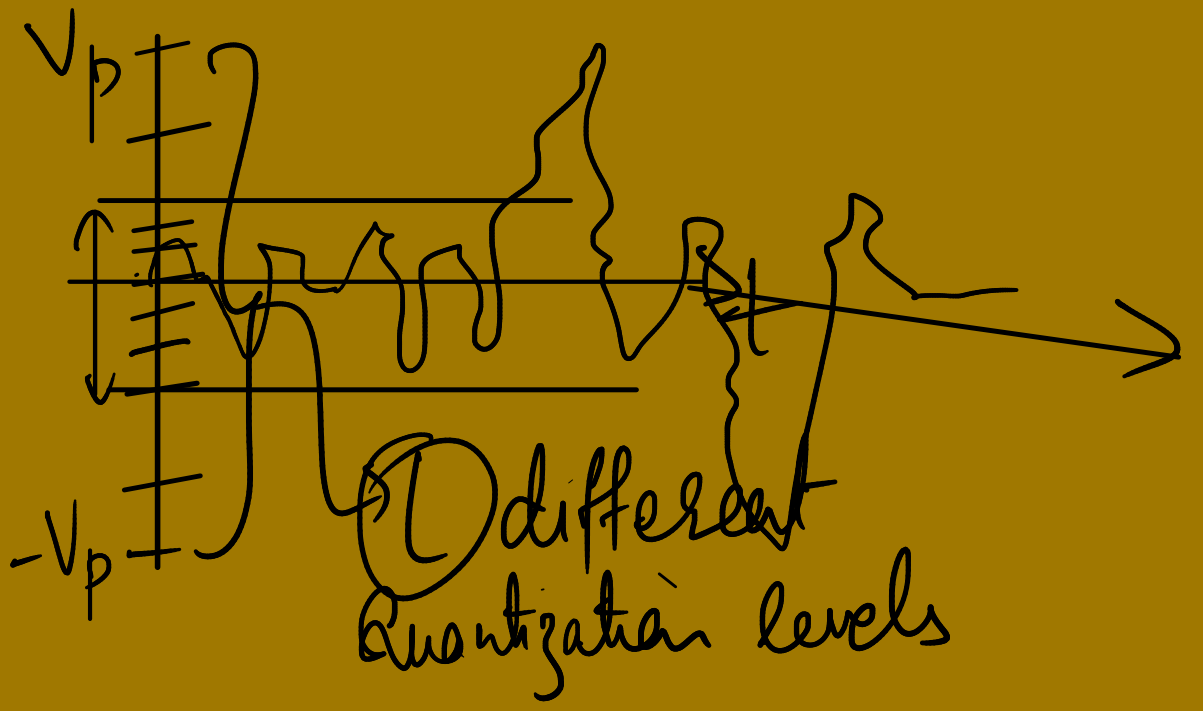
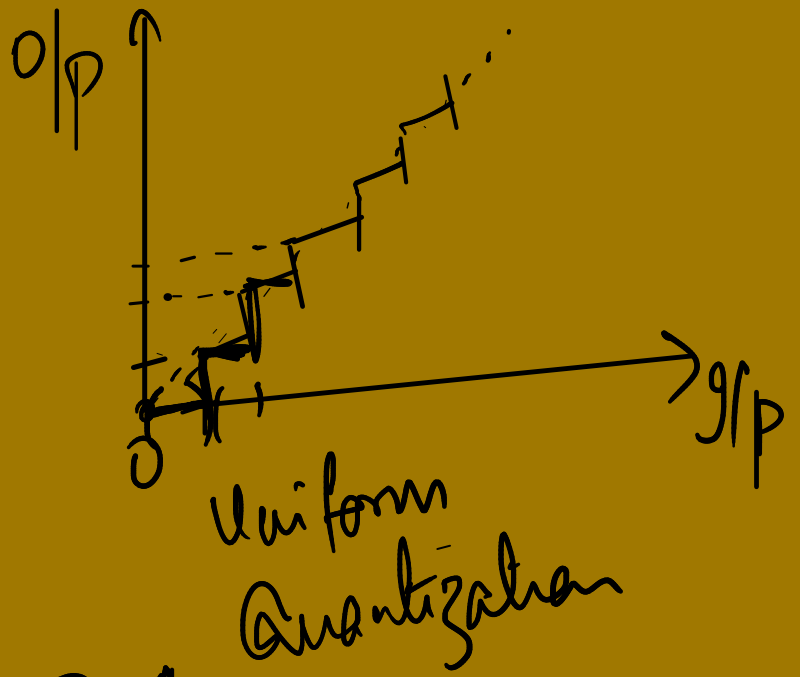
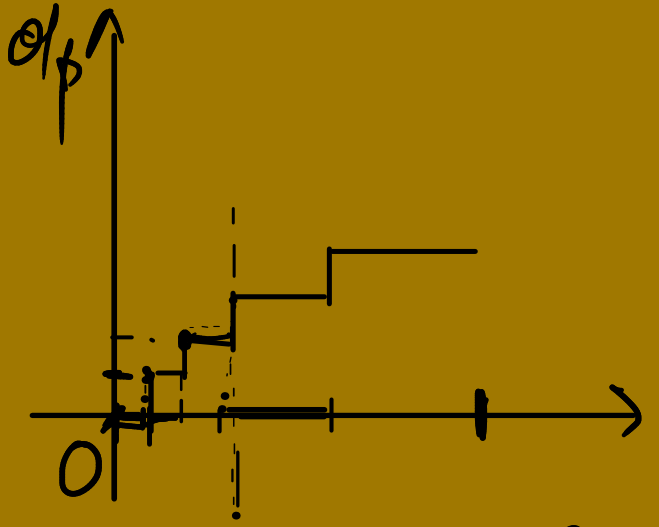
CT303 - Lecture 12: 30 September.

- PCM: Quantized samples $\{-V_p + \frac{q}{2}, -V_p + \frac{3q}{2}, \ldots, 0, \ldots, V_p - \frac{q}{2}\} \rightarrow \{0, 1, \ldots, L-1\} \rightarrow \{(0)_2, (1)_2, \ldots, (L-1)_2\}$, each of length $log_2(L)$ bits.
- Non-uniform Quantization.

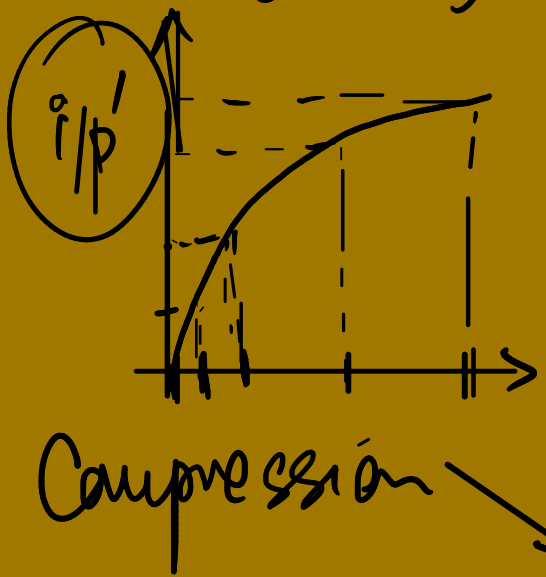




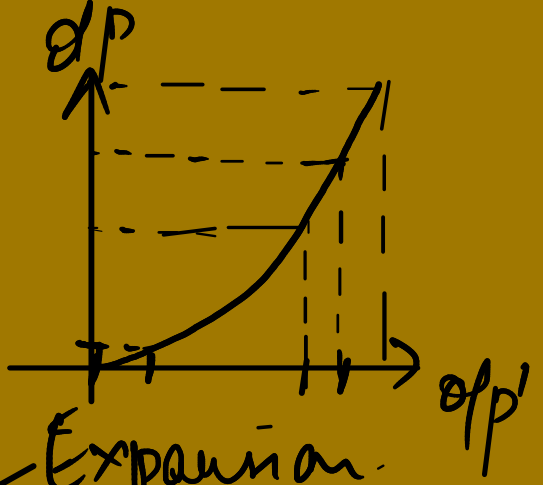
Uniform Quantization



Non-Uniform Quantization



Compression



Expansion

[Companding]

Baseband Modulation

- Formatting - *Analog source to bit stream:* Sample and Quantize (L levels). Each sample encoded with $log_2(L)$ bits, called *digital (code)word*.
- Formatting - *Digital source to bit steam:* Assign $log_2(L)$ bits to each character of the message.
- Binary and M-ary PCM waveforms.

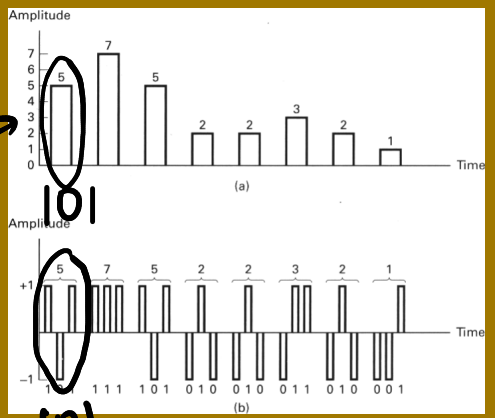


Figure: (Top) 8-level PAM, (Bottom) Binary PCM

- M-ary PCM waveforms: Assign one waveform or *symbol* for each group of $log_2(M)$ bits.

Binary PCM

- 1 bit / waveform

+5 V pulse → +1

-5V pulse → 0

-5 +5

0 1

M-ary PCM

→ More bits per waveform (Symbol).

→ [-5, 5] into 7/8 parts.

-5, -3.5

000 001

(0) (1)

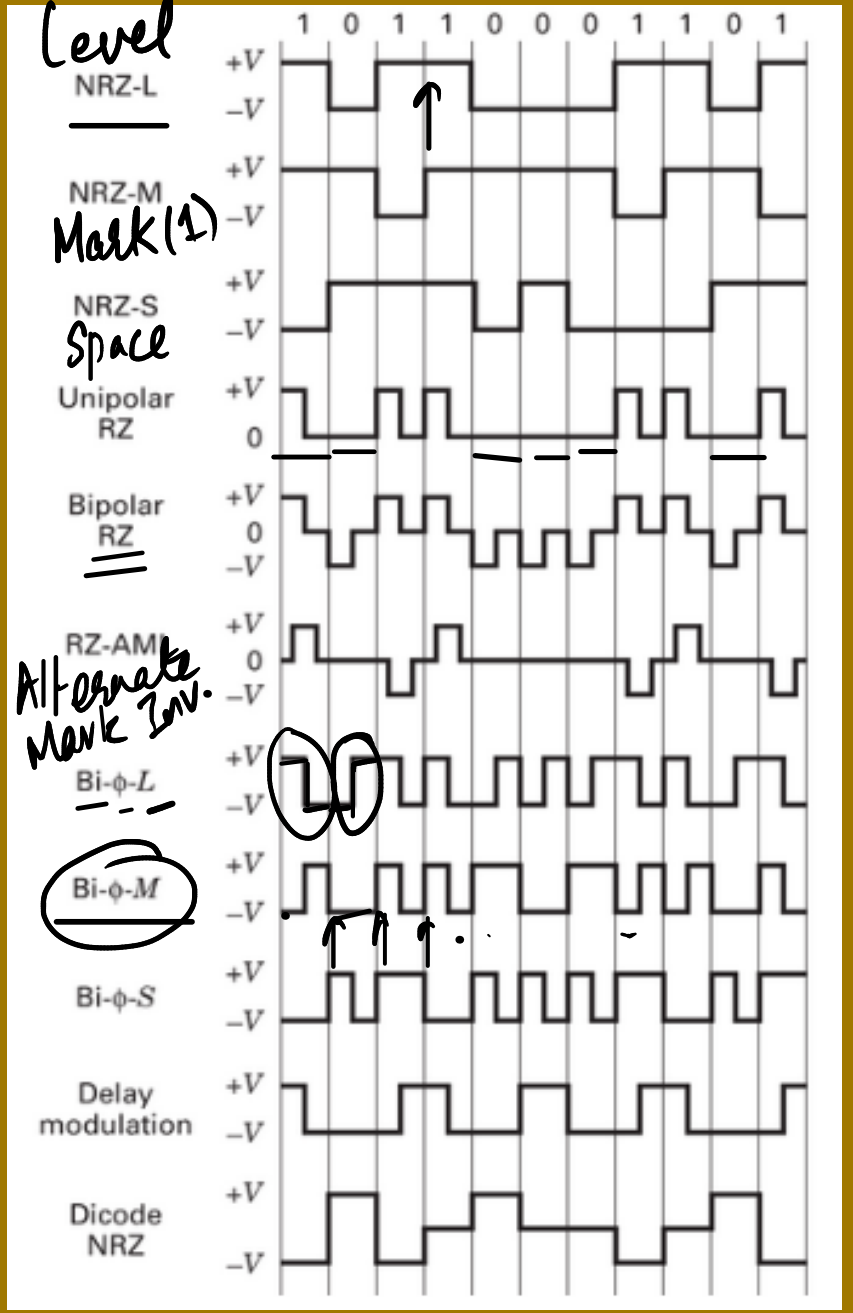
→ Detection is more challenging

[-100, 100] → Better detection requires higher power!

Binary PCM

1 of / bit

- NRZ (Non-return to zero)
- RZ (Return-to-zero)
- Phase (delay)



Duration of each pulse is T sec.

Source: Sklar

Figure: Binary PCM

Lab 4: ① Generate Arbitrary bit sequence

② Encode the bit sequence using NRZ-L scheme. (Sampled)

$x(nT_b) = x(t)$

Sampled NRZ-L PCM signal.

③ Check if $\{X_n\} = \{x(nT_b)\}$ is WSS or not?

④ $\{Y_n\}$ variation of X_n.

Check if $\{Y_n\}$ is WSS

For any WSS SP (out of X_n, Y_n) compute the PSD.

Comparison parameters

- DC Component → Does the PCM scheme have a DC component? (PSD)
- Synchronization →
- Error detection
- Bandwidth efficiency : How much BW is reqd for a particular data rate (symbol rate) $R_s = 1/T$.
- Cost of implementation.

Binary PCM
Datarate (Bitrate) = Symbol rate.

Spectral Characteristics

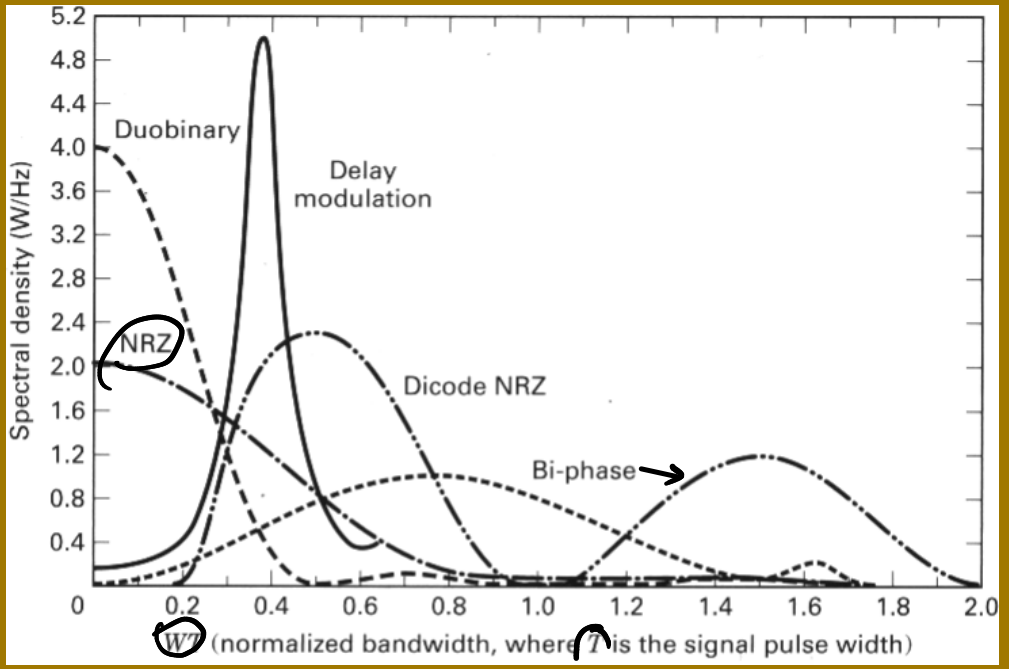


Figure: PSD vs Normalized frequency (Hertz-bit width).

Sources of Corruption

- Sampling and Quantization
  1. Quantization error. $\simeq$ SQNR $\simeq 3L^2$
  2. Jitter in sampling — T sec. $T \pm \Delta t$ sec.
- Channel
  1. Noise (Electronics, Interference) — AWGN
  2. Channel distortion due to a BL channel. Inter-Symbol Interference (ISI)