



**Datta Meghe College of Engineering, Airoli, Navi Mumbai**

# Pulse Shaping for Optimum Transmission

Digital Communication

Module 3

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# Content

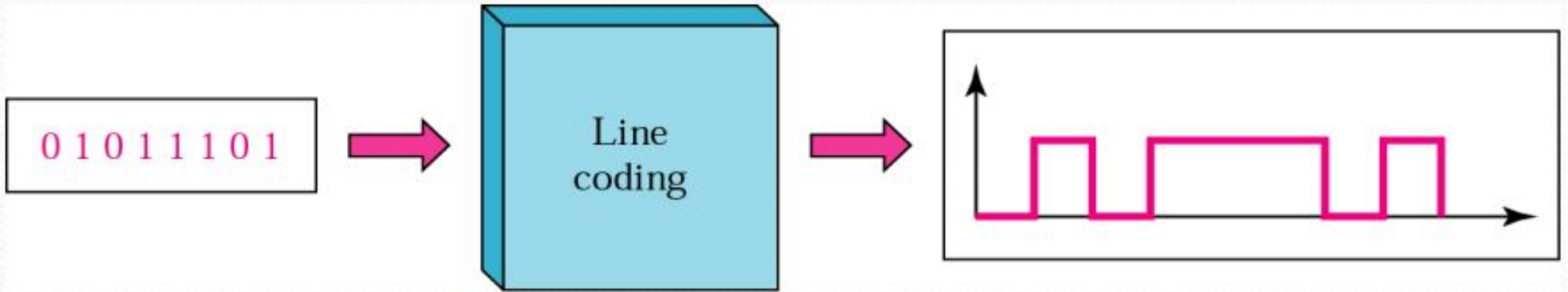
- Line codes and their desirable properties
- PSD of digital data
- Baseband PAM transmission: Concept of Inter symbol interference (ISI)
- Raised Cosine filter
- Nyquist Bandwidth
- Concept of equalizer to overcome ISI



# Line Codes

- Analog waveform are transformed into binary digits via the use of PCM
- Digits are just abstractions- a way to describe the message information.
- Thus we need something physical that will represent or carry the digits
- We will represent the binary digits with electrical pulses in order to transmit them through a baseband channel
- When pulse modulation is applied to a binary symbol the resulting binary waveform is called PCM waveform

Line Coding: A pair of pulses to represent symbols 1 and 0





# Non-Return to Zero (NRZ)

- NRZ-L(L for Level)

- 1: represent by one voltage level

- 0: represent by another voltage level

There is change in level whenever the data changes from 1 to 0 or 0 to 1

- NRZ-M(M for Mark)/Differential encoding

- 1(Mark): represent by change in level

- 0(Space): represent by no change in level

- NRZ-S(S for Space)

- 1: represent by no change in level

- 0: represent by change in level

# Return to Zero (RZ)

- Unipolar RZ

- 1: represent by a half bit-wide pulse

- 0: represent by the absence of pulse

- Bipolar RZ

- 1: represent by pulse one half bit-wide pulse

- 0: represent by opposite level pulse one half bit-wide pulse

- RZ-AMI(AMI-Alternate –Mark-Inversion)

- 1: are represented by equal-amplitude alternating pulse

- 0: represent by the absence of pulse

# Bi-Phase

- Bi- $\phi$ -L(Bi-Phase-Level)/ Manchester Coding

1: represent by a half bit wide pulse positioned during the first half of the bit interval

0: represent by a half bit wide pulse positioned during the second half of the bit interval

## Bi- $\phi$ -M(Bi-Phase-Mark)

1: represent by a second transition one-half-bit interval later

0: represent by no second transition

## Bi- $\phi$ -S(Bi-Phase-Space)

1: represent by no second transition

0: represent by a second transition one-half-bit interval later



1 0 1 1 0 0 0 1 1 0 1

NRZ-L



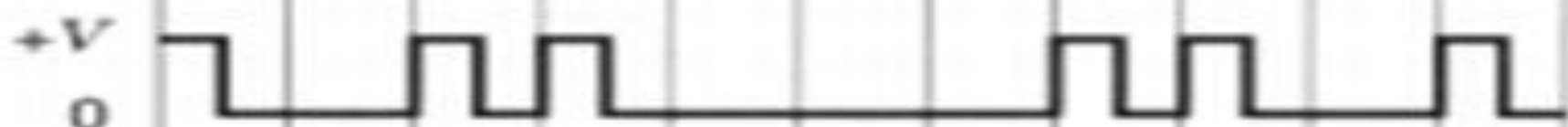
NRZ-M



NRZ-S



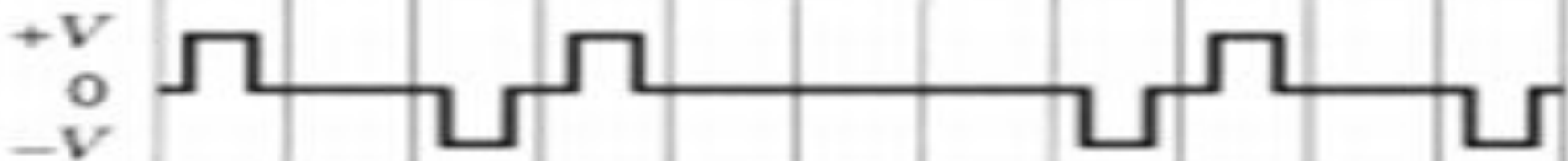
Unipolar RZ



Bipolar RZ



RZ-AMI



1 0 1 1 0 0 0 1 1 0 1

Bi- $\phi$ -L

+V

-V

Bi- $\phi$ -M

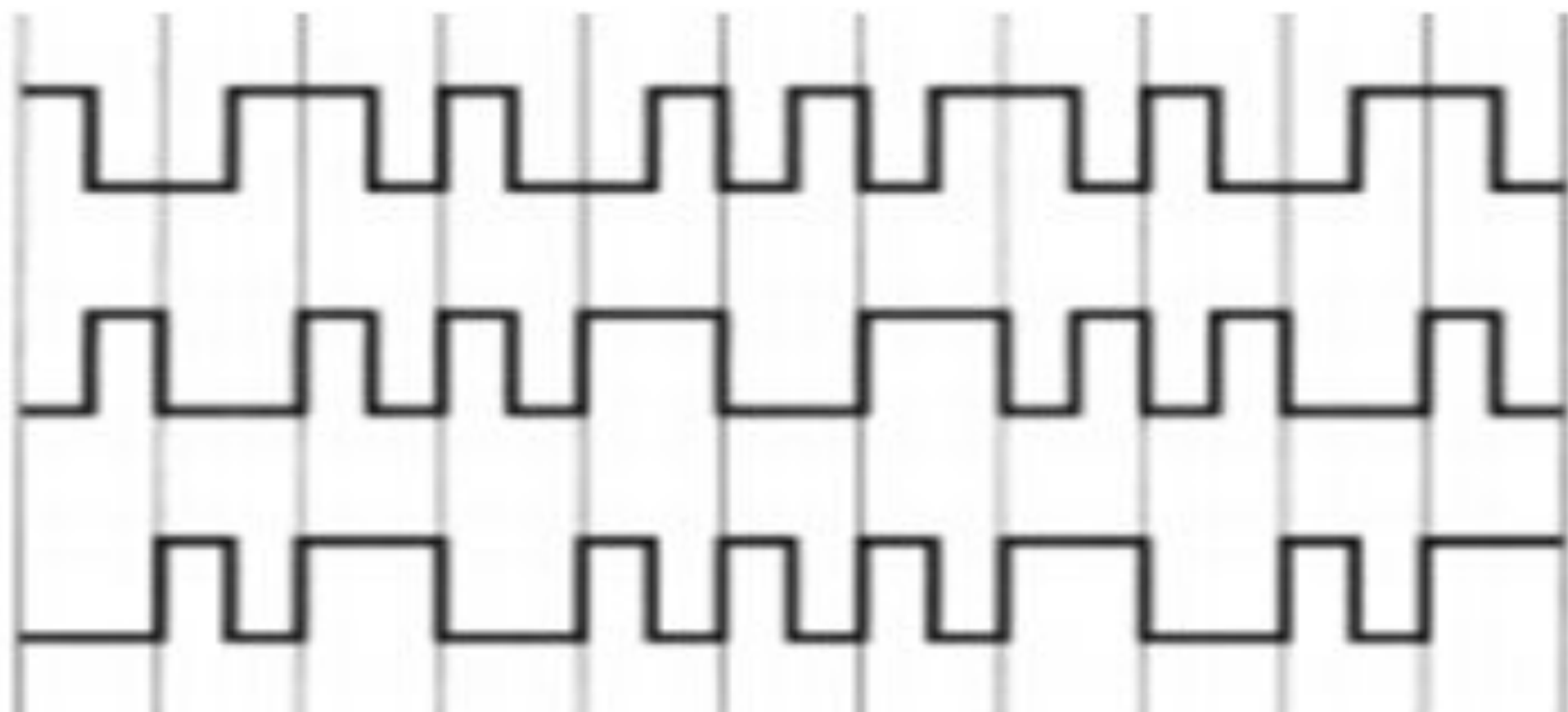
+V

-V

Bi- $\phi$ -S

+V

-V



# Practice Problem

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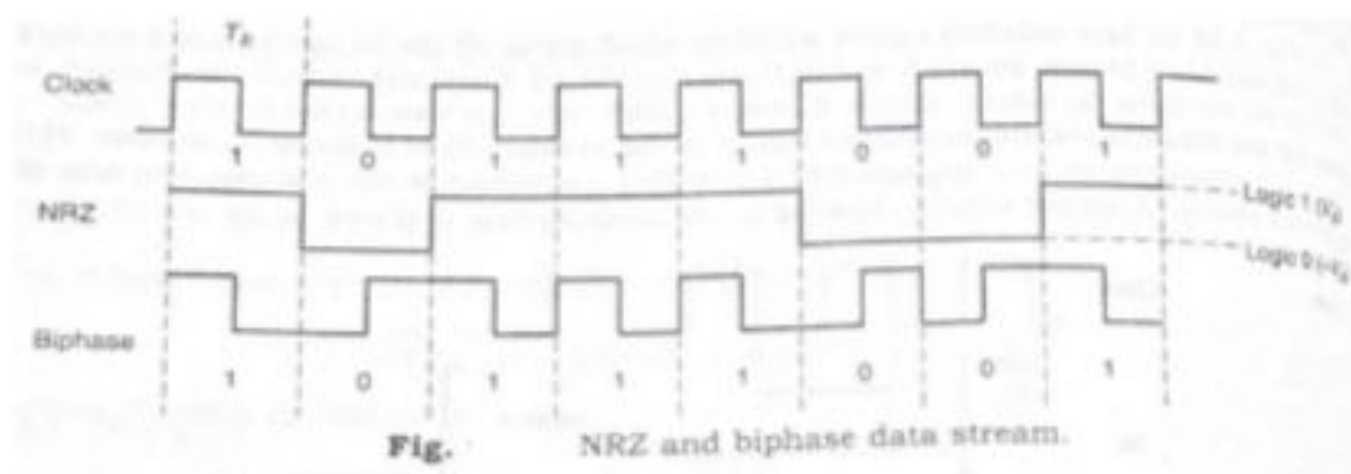


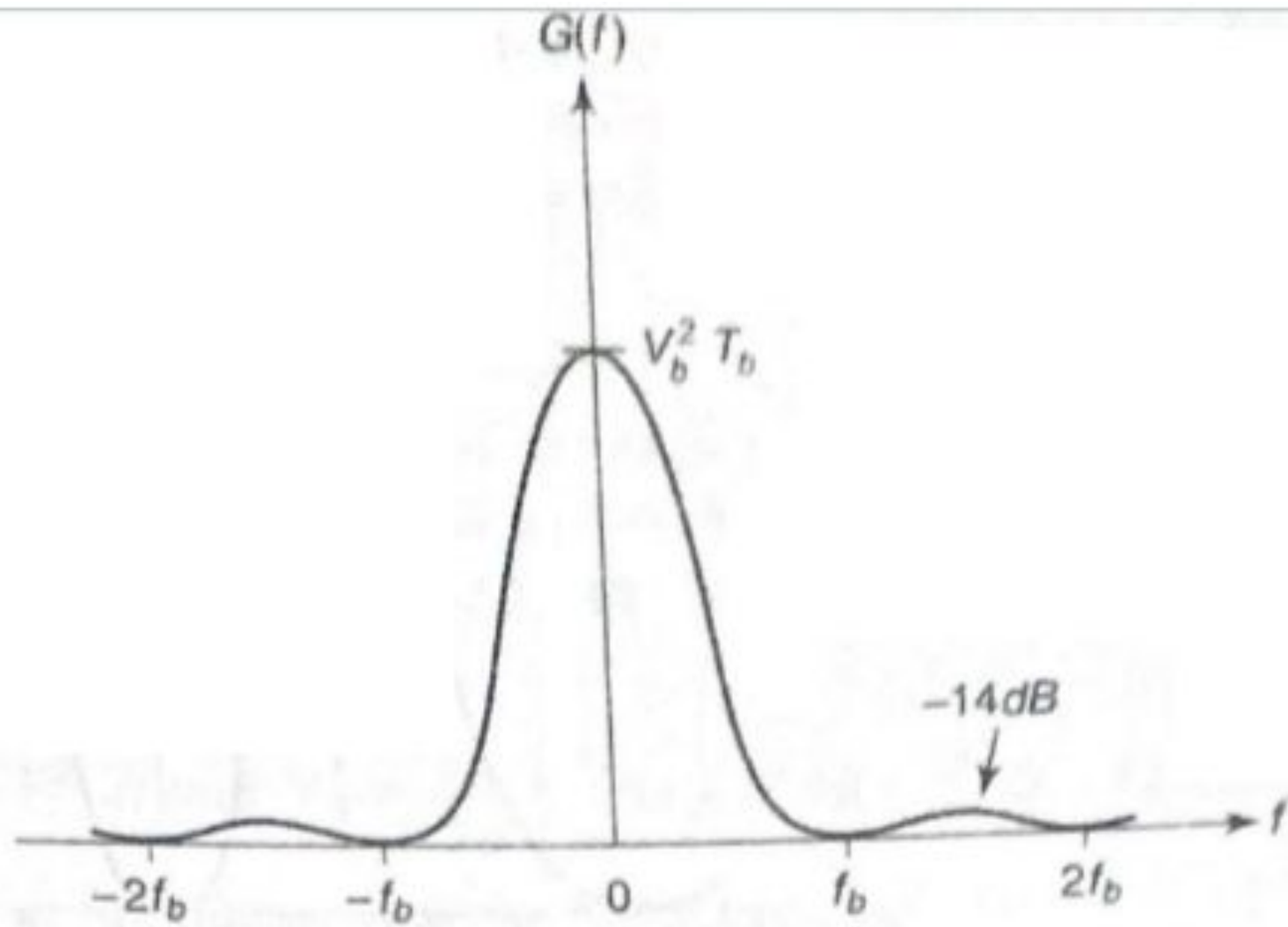
# Choosing PCM for Application

1. DC Component
2. Self- Clocking
3. Error Detection
4. Bandwidth Compression
5. Differential Encoding
6. Noise Immunity

# Power Spectral Density (PSD) of digital data

- Consider digital data
  - Simplest case, bit logic level 1 is represented by  $V_b$   
bit logic level 0 is represented by  $-V_b$
- Clock waveform





**Fig.** Power spectral density of NRZ data.