Computer Networks

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The Computer Network

- Network Architecture - Interfaces and services
- Protocol and Standards
- ISO-OSI Reference Model
- TCP/IP Protocol suite
- Comparison of OSI and TCP/IP

Separate file uploaded for this topic also

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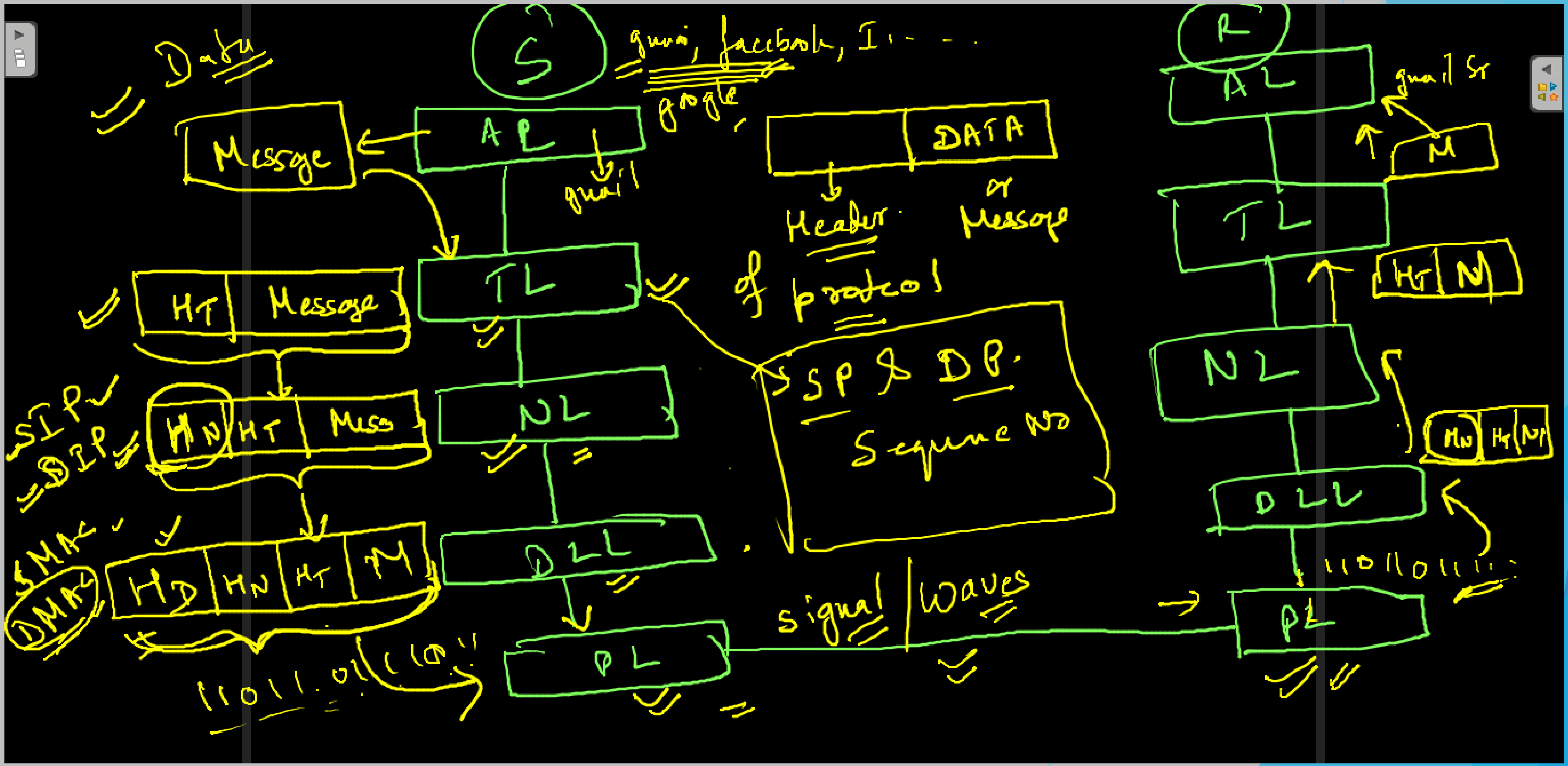
Class Content



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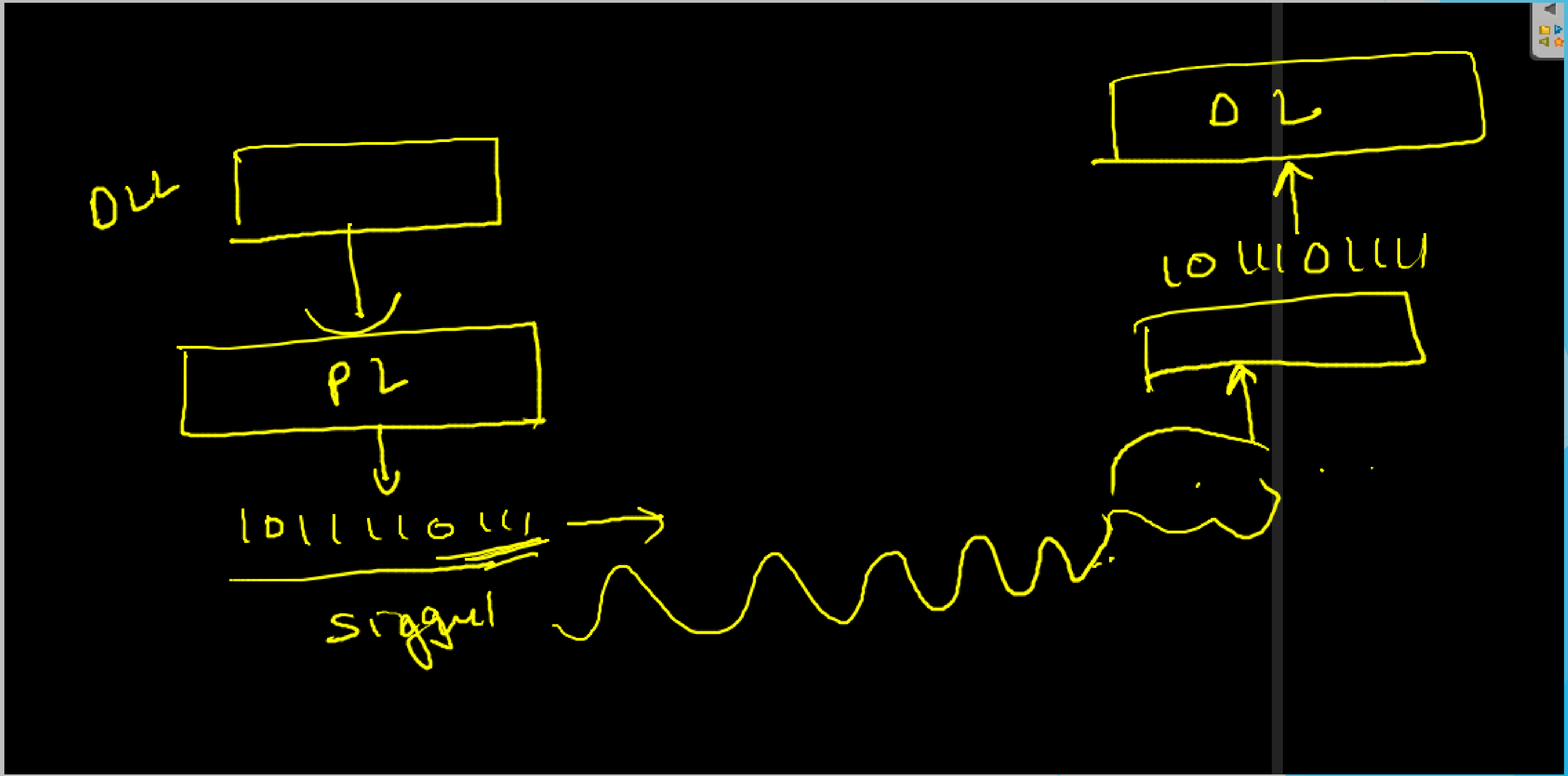

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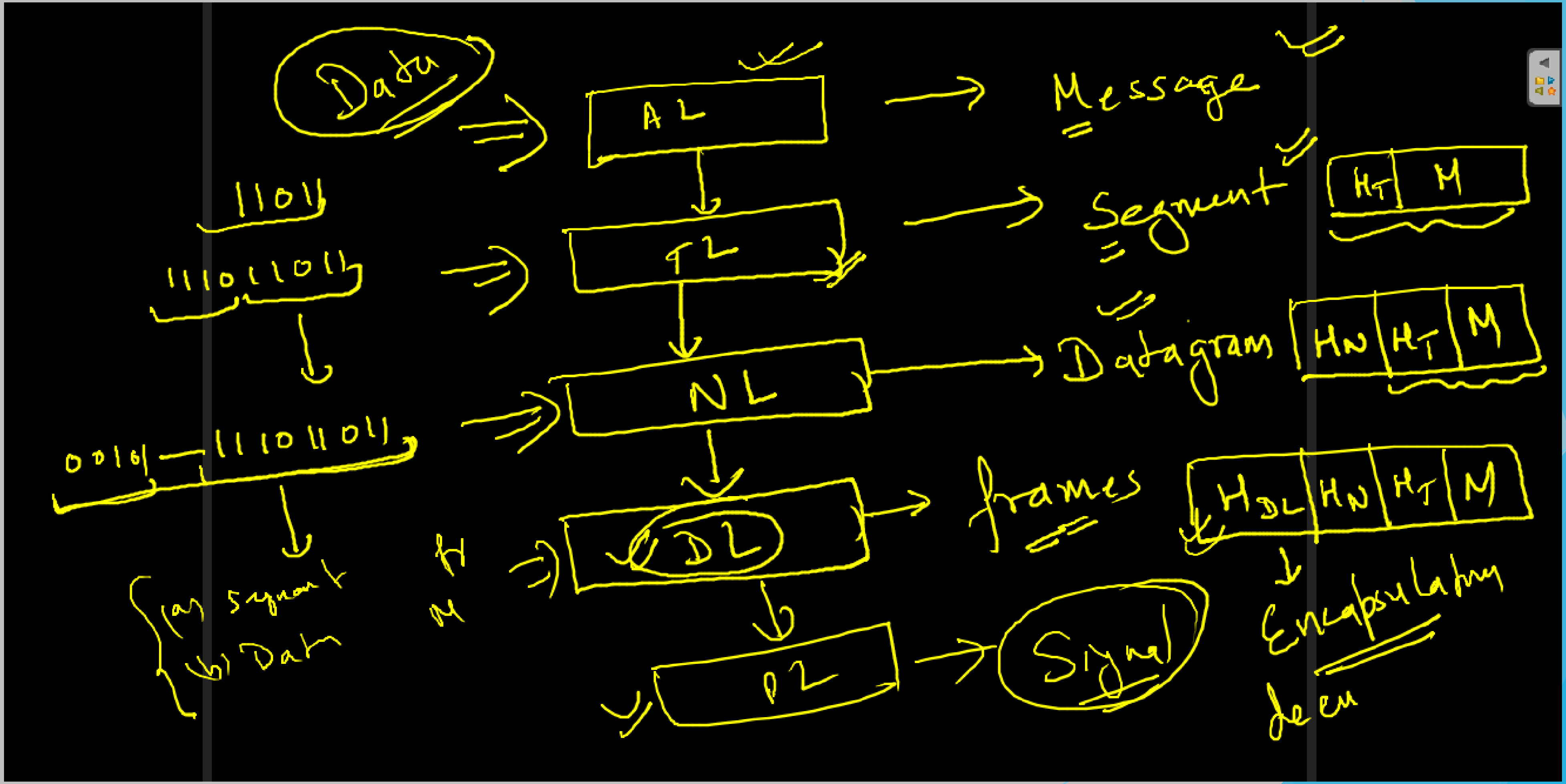

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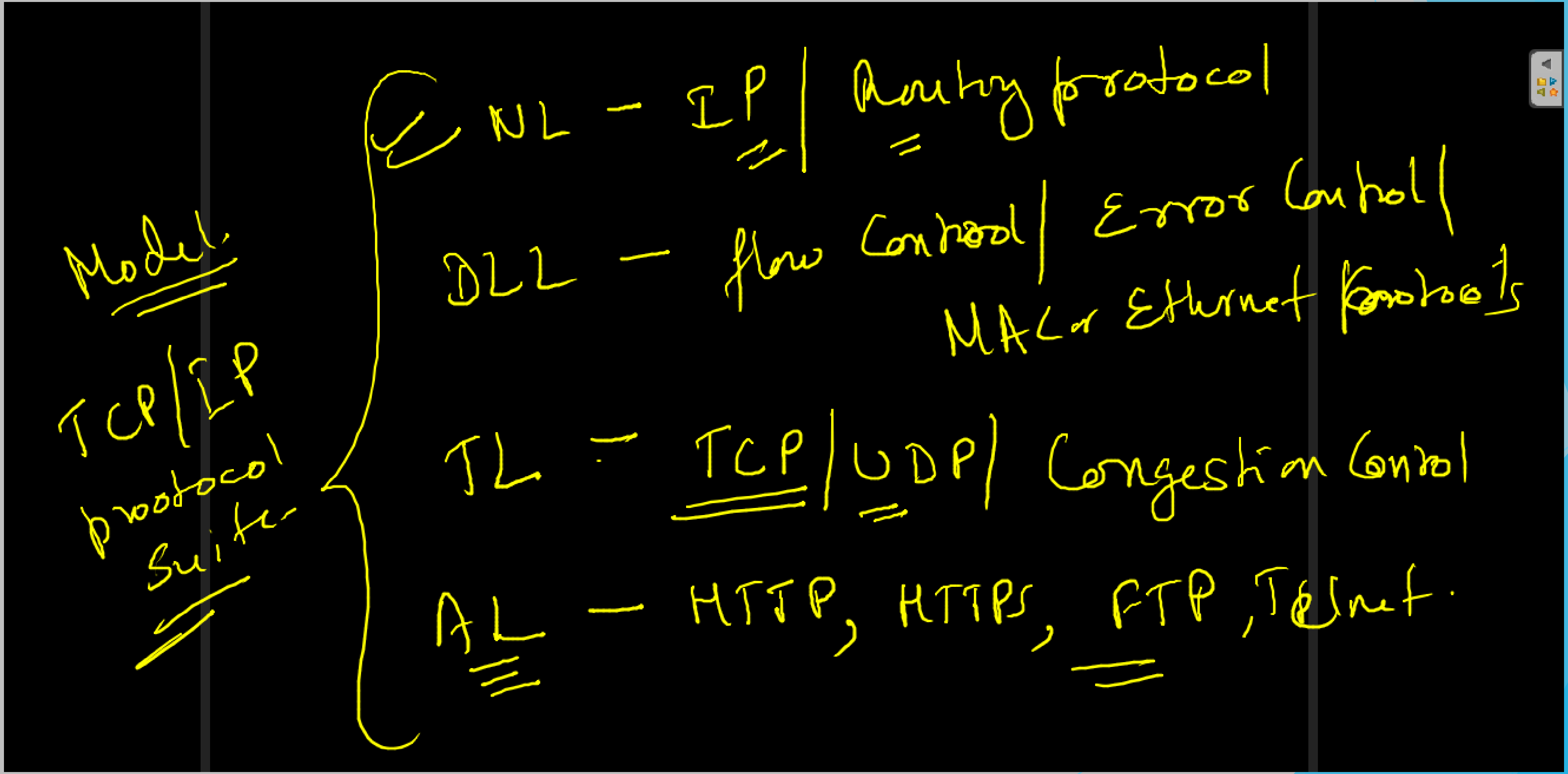

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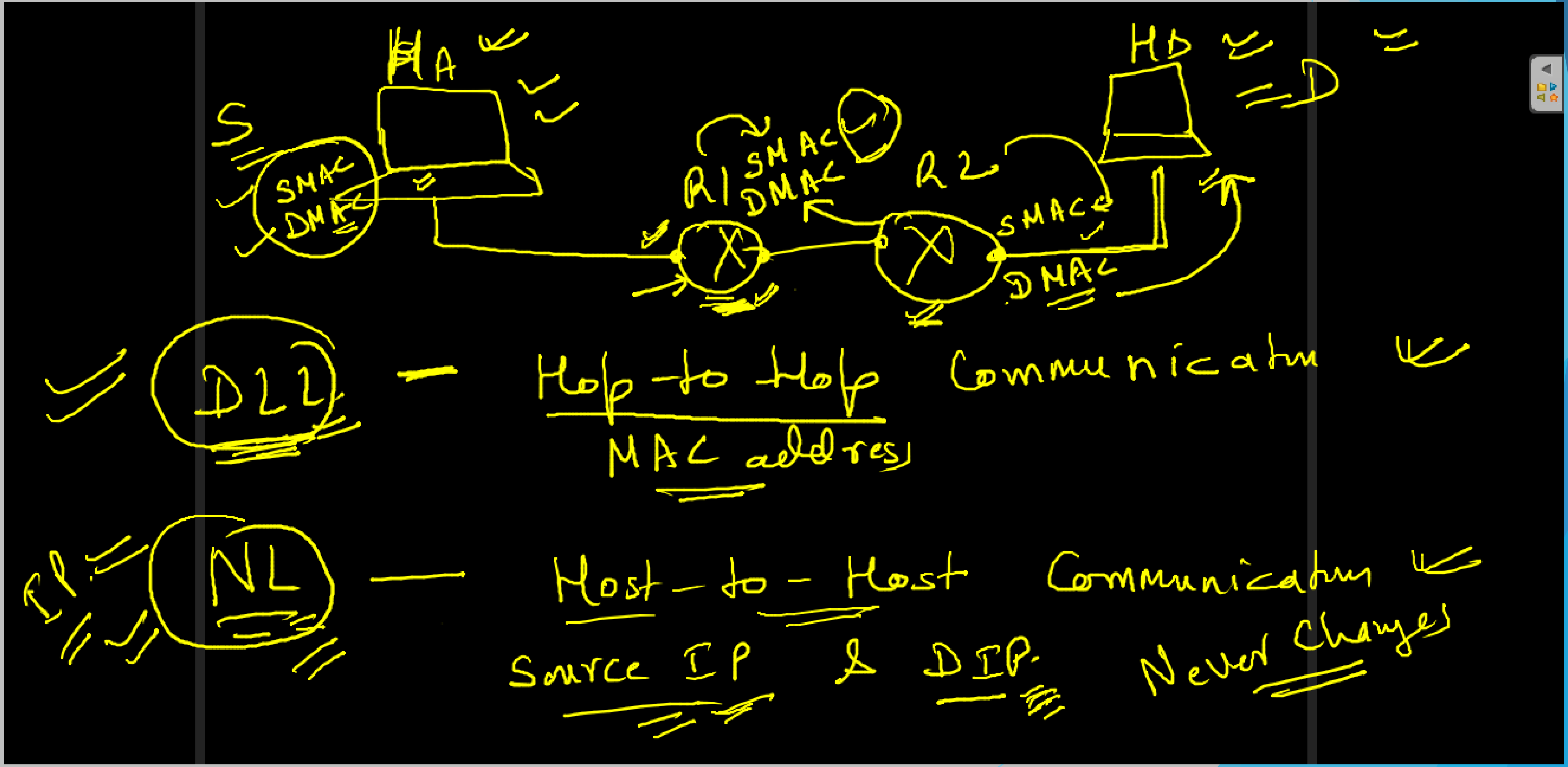

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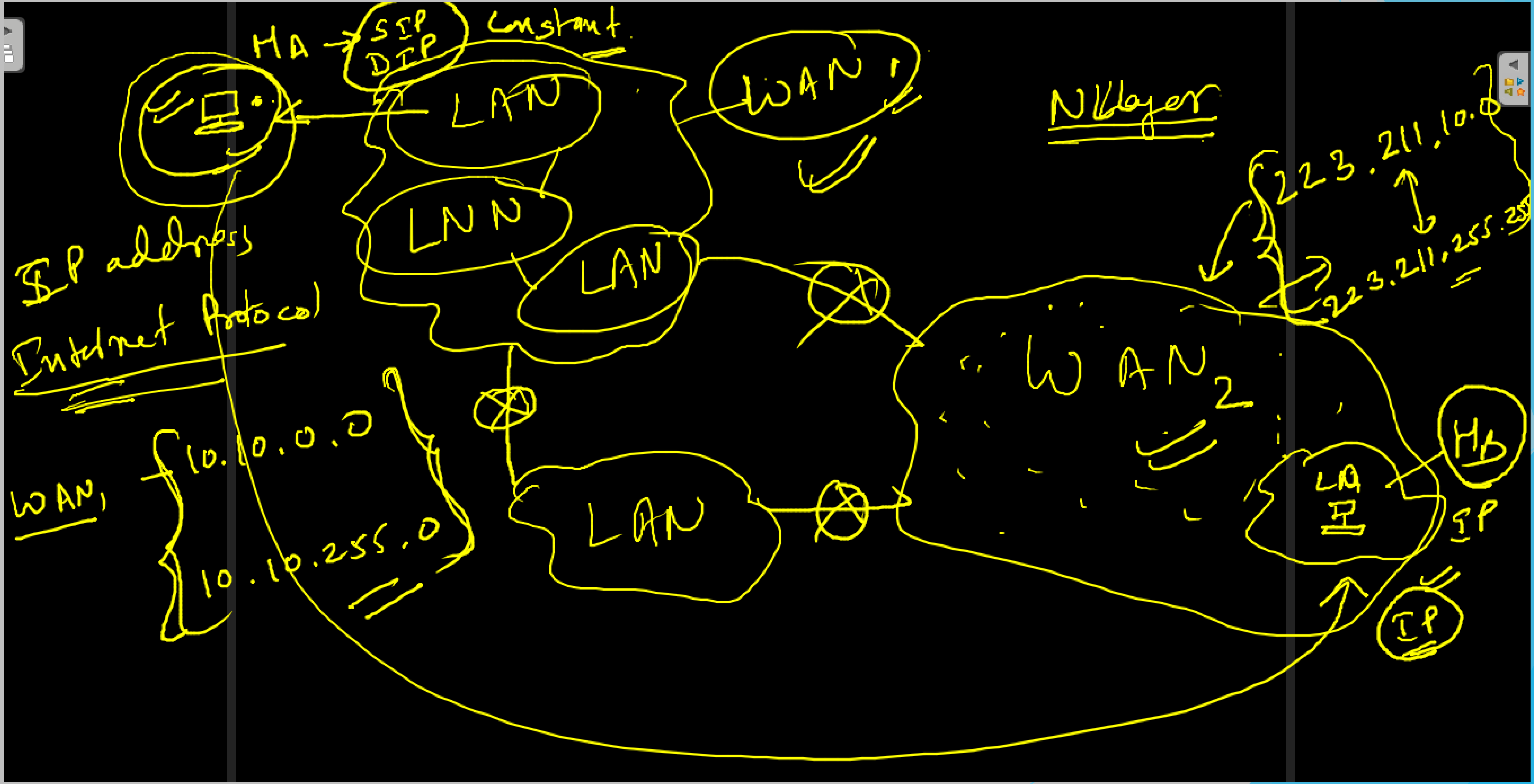

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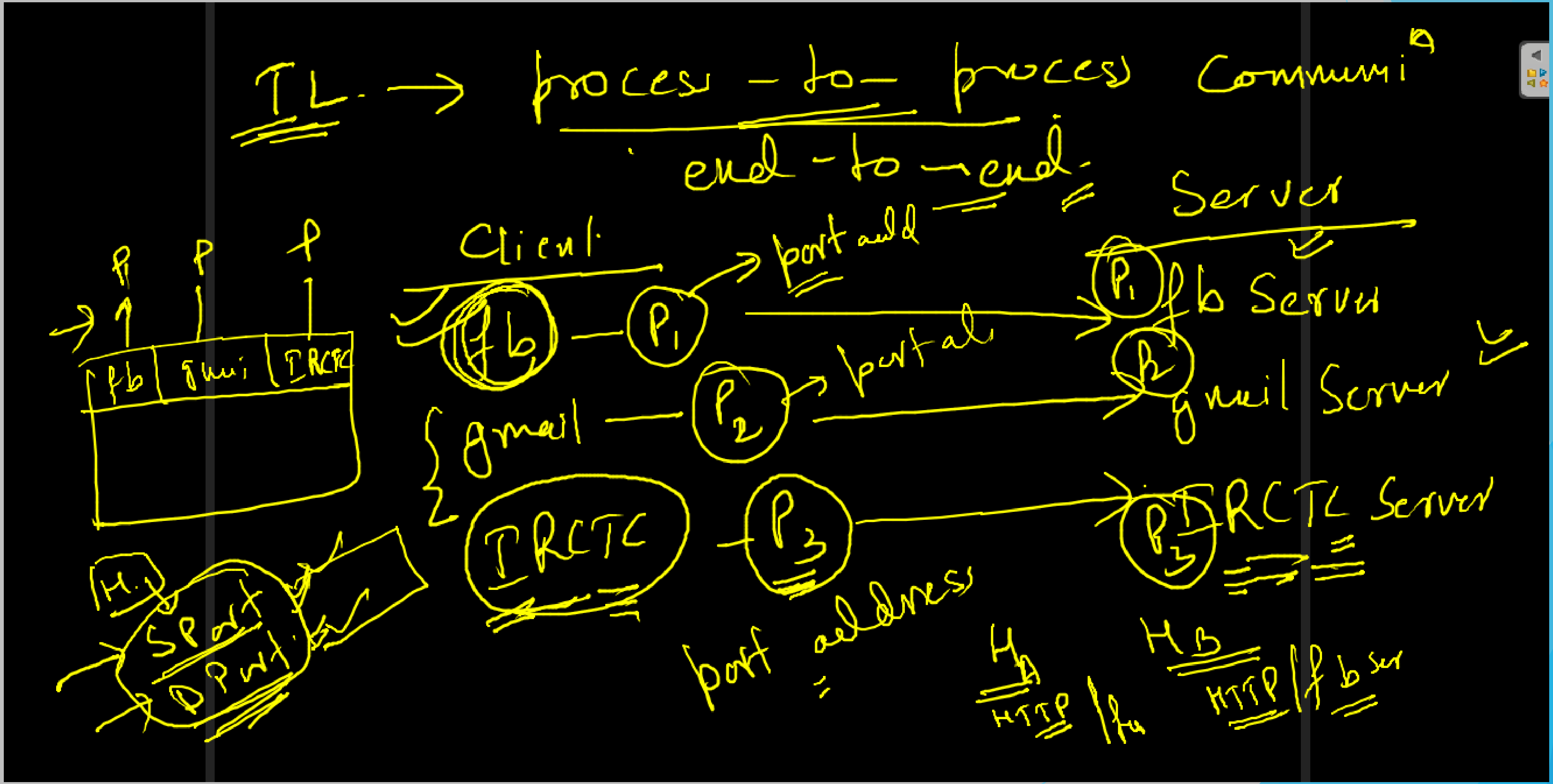

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Addressing format:

.com → india
.in
.edu
gmail.com

DLL — MAC addr/Physical : 48 bits

NL — IP-address : 32-bits

TL — Port-address : 16-bits

Users ← AL — Names are assigned.

gmail, fb

0111

server

DNS → Domain name system

server

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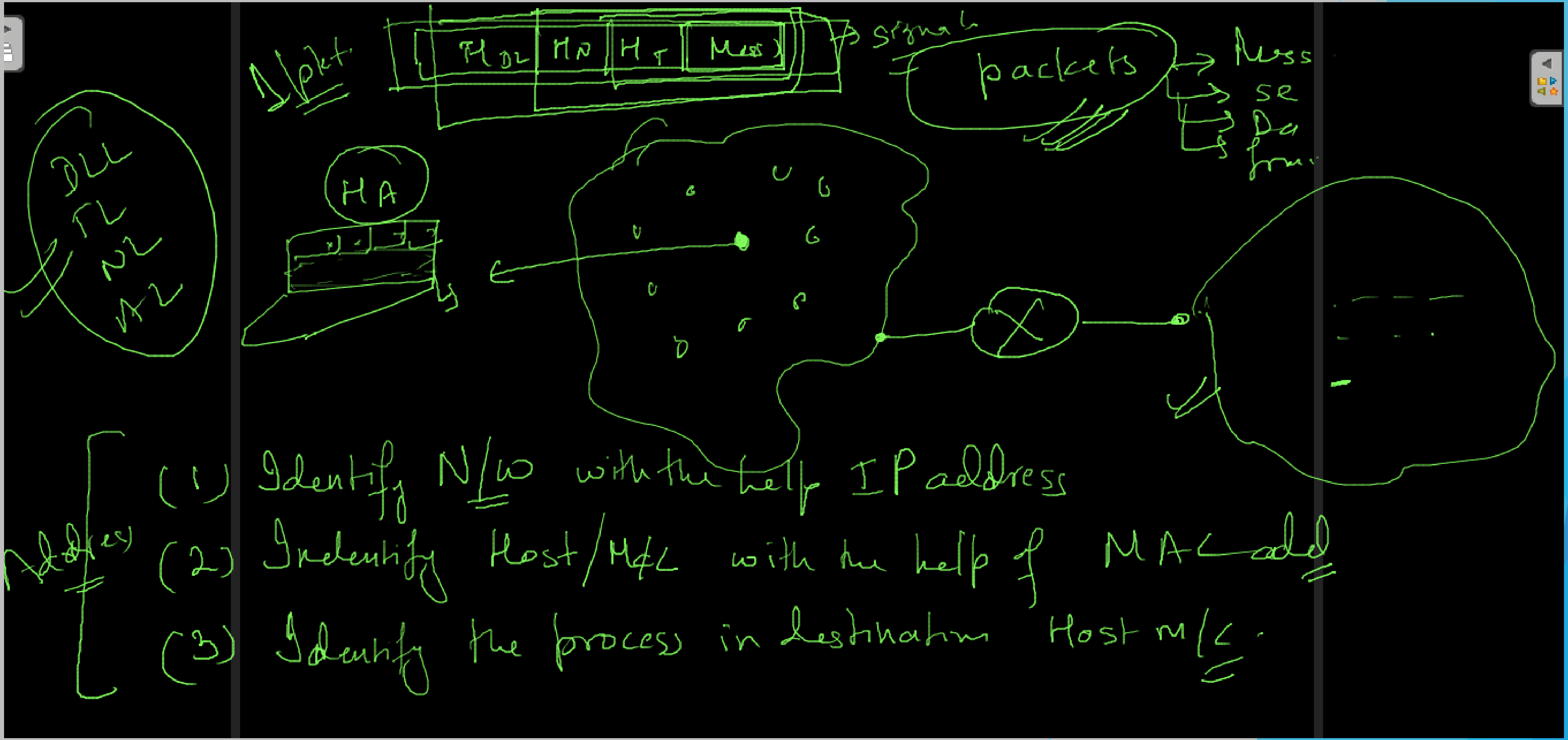

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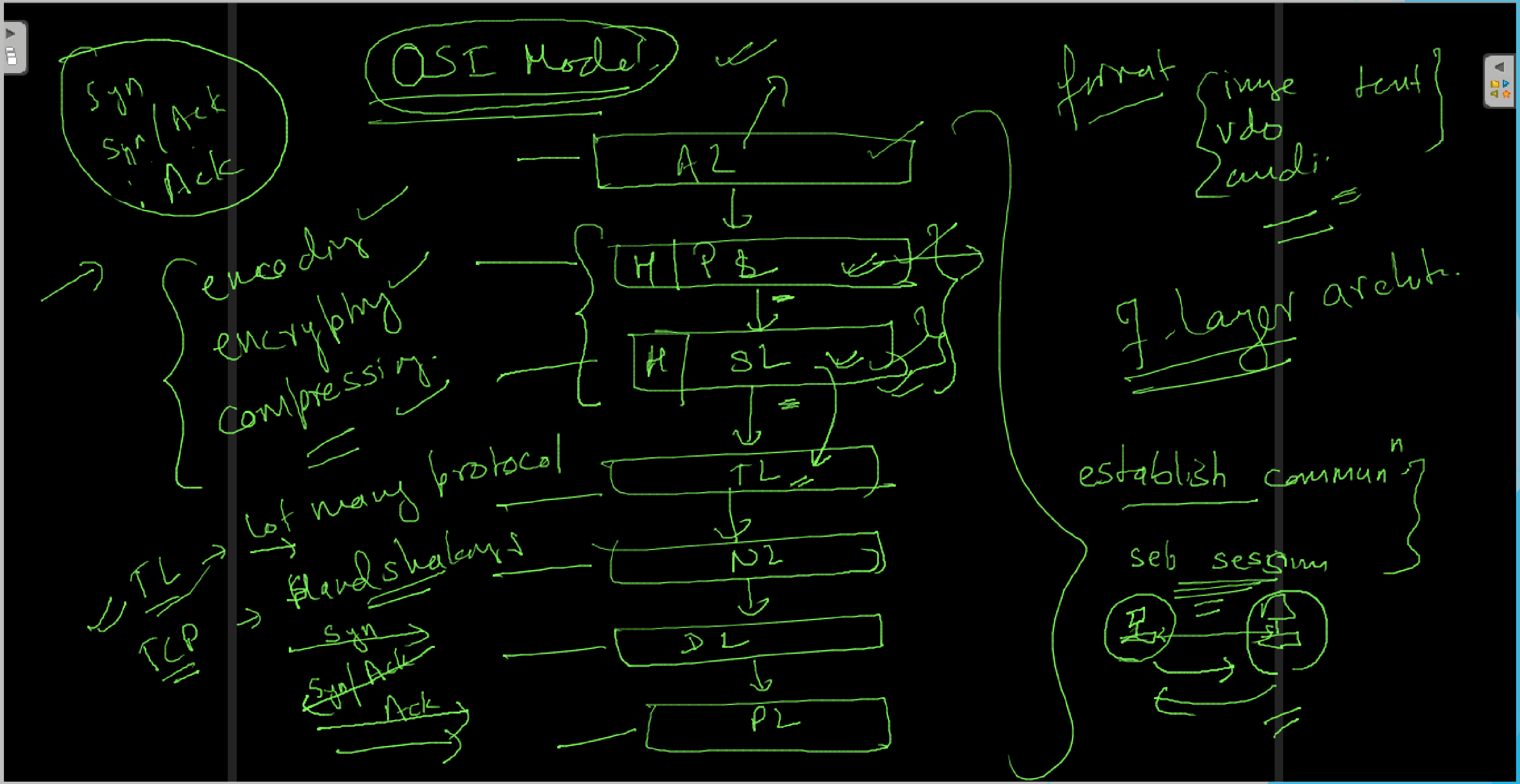

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y OSI not a success?

(1) TCP/IP → was developed before OSI model. ①

Some of the protocols were not
(2) properly or fully defined in OSI model

(3) TCP/IP protocol. (lot of protocol in TL & Appl.)

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Data and Signals:

Data:

- To be transmitted, data must be transformed to electromagnetic signals
- Data can be analog or digital. Analog data are continuous and take continuous values. Digital data have discrete states and take discrete values.

- Analogy: Real number vs. Integer number
- Analog data example: voice

  temperature captured by analog sensor

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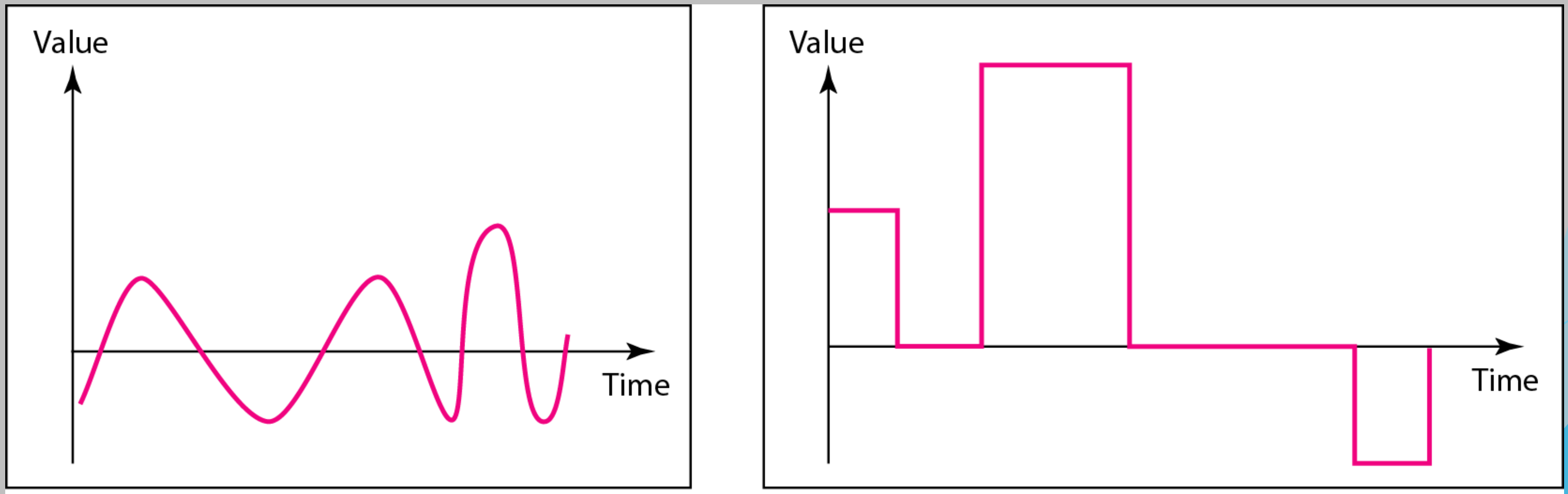
Data and Signals:

Signals:

Signals can be analog or digital. Analog signals can have an infinite number of values in a range; digital signals can have only a limited number of values.



a. Analog signal   b. Digital signal

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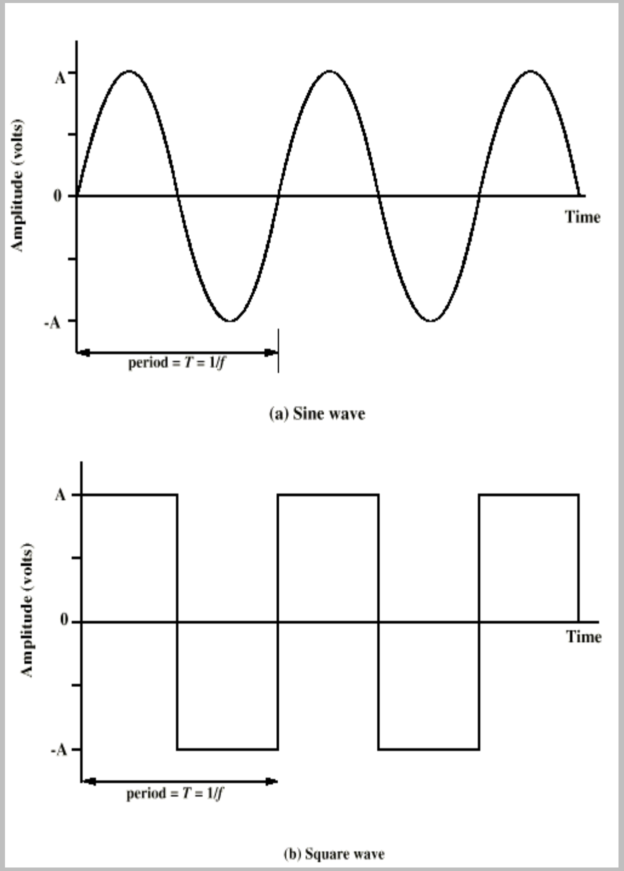
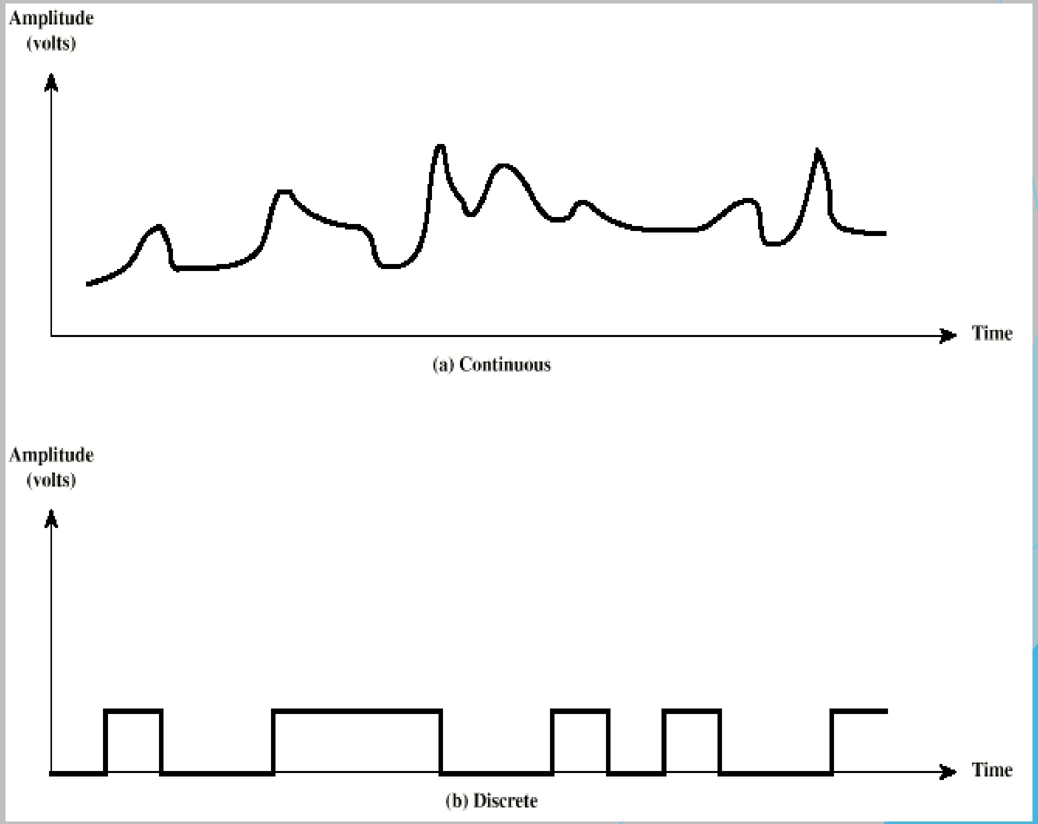
Data and Signals: ***Periodic analog signal is used as data carrier (such as AM/FM radio)***

In data communications, we commonly use periodic analog signals and non-periodic digital signals.

Periodic signal





Non- Periodic signal

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Analog Signal and Digital Signal:

Analog Signal

- Continuous
- Infinite range of values
- More exact values, but more difficult to work with

Digital Signal

- Discrete
- Finite range of values
- Not as exact as analog, but easier to work with

Example:

A digital thermostat in a room displays a temperature of 72°. An analog thermometer measures the room temperature at 72.482°. The analog value is continuous and more accurate, but the digital value is more than adequate for the application and significantly easier to process electronically.

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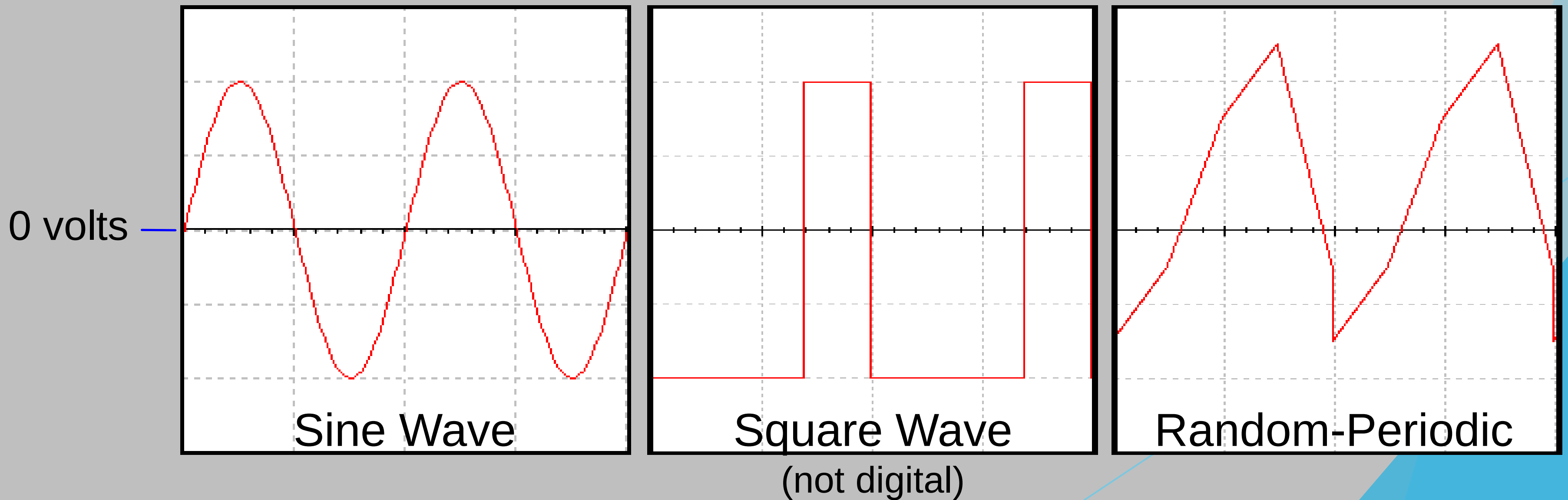
Characteristics of Analog Signal:

- An analog signal can be any time-varying signal.
- Minimum and maximum values can be either positive or negative.
- They can be periodic (repeating) or non-periodic.
- Sine waves and square waves are two common analog signals.
- Note that this square wave is not a digital signal because its minimum value is negative.



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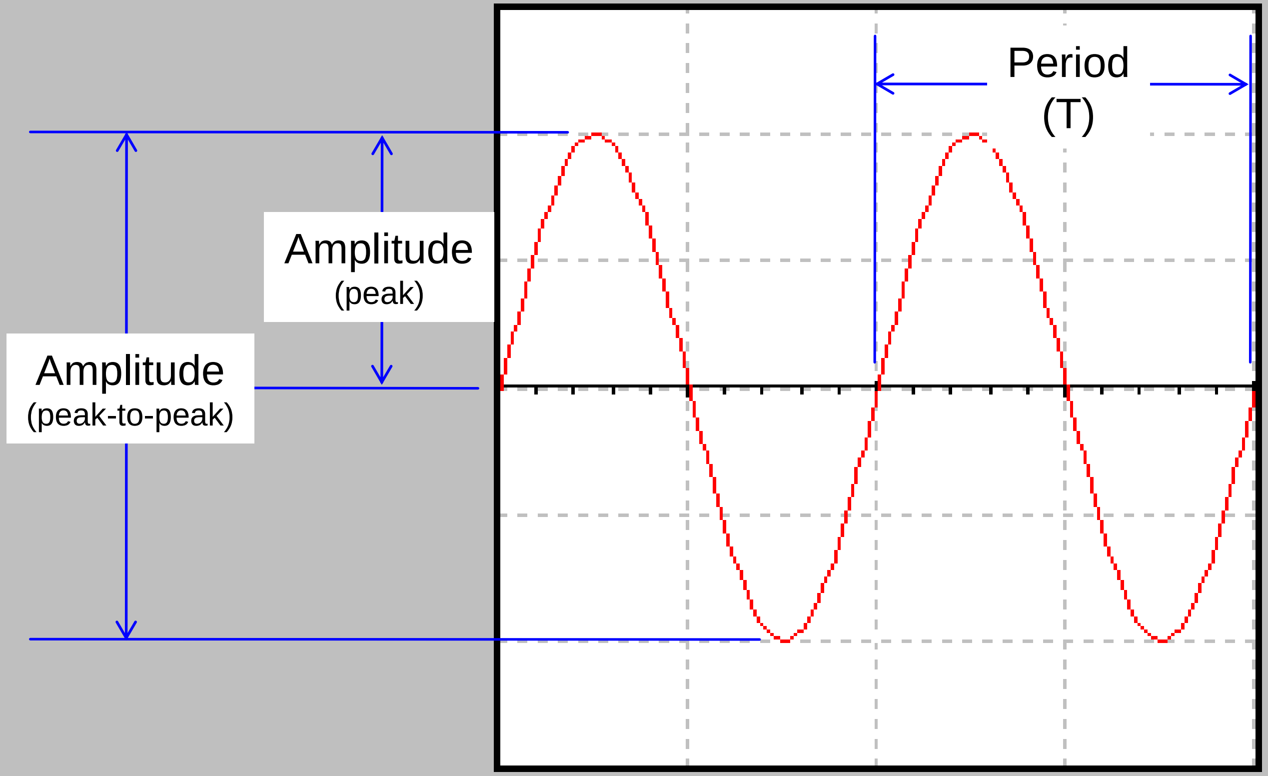
Parts of an Analog Signal:



Frequency:

$$F = \frac{1}{T}\text{Hz}$$

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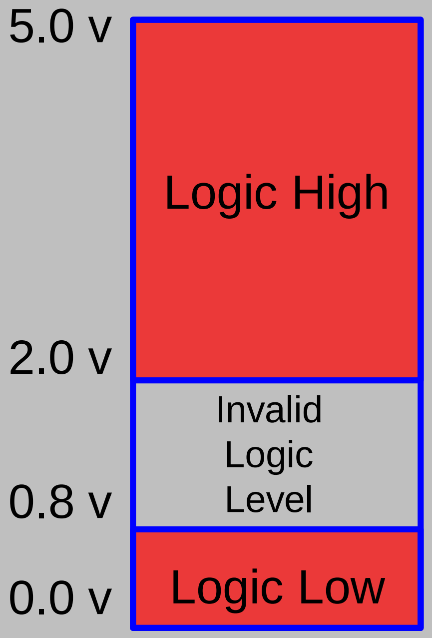
Logic Levels:

Before examining digital signals, we must define logic levels. A logic level is a voltage level that represents a defined digital state.

Logic HIGH: The higher of two voltages, typically 5 volts

Logic LOW: The lower of two voltages, typically 0 volts



Logic Level	Voltage	True/False	On/Off	0/1
HIGH	5 volts	True	On	1
LOW	0 volts	False	Off	0

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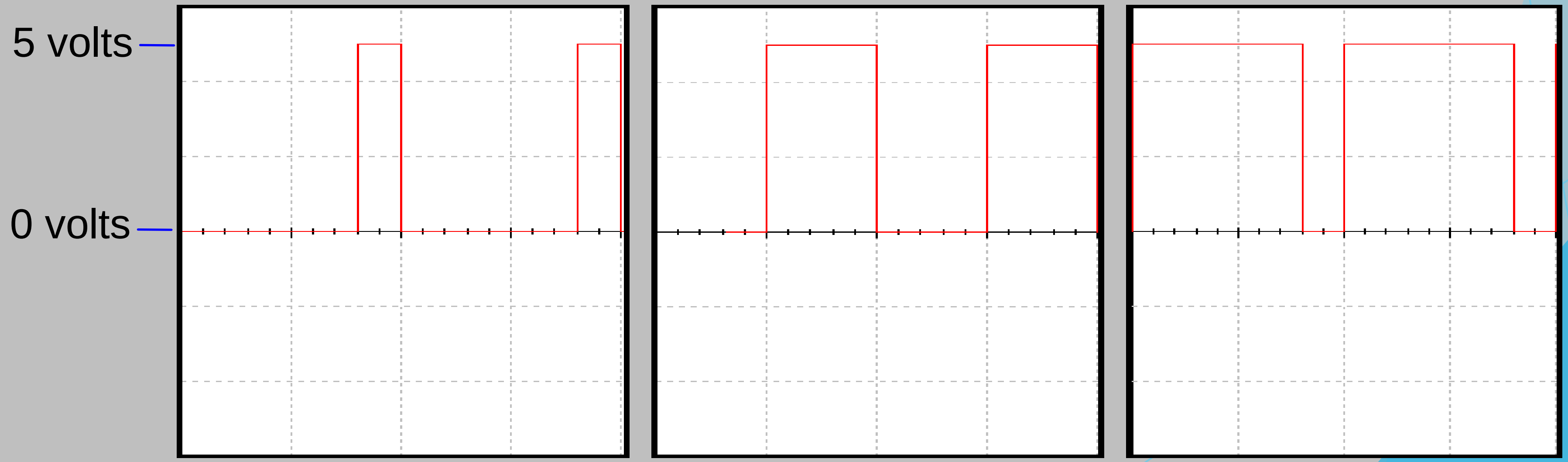
Characteristics of Digital Signal:

- Digital signal are commonly referred to as square waves or clock signals.
- Their minimum value must be 0 volts, and their maximum value must be 5 volts.
- They can be periodic (repeating) or non-periodic.
- The time the signal is high (t_H) can vary anywhere from 1% of the period to 99% of the period.



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Parts of Digital Signal:

Amplitude:
For digital signals, this will ALWAYS be 5 volts.

Period:
The time it takes for a periodic signal to repeat. (seconds)

Frequency:
A measure of the number of occurrences of the signal per second. (Hertz, Hz)

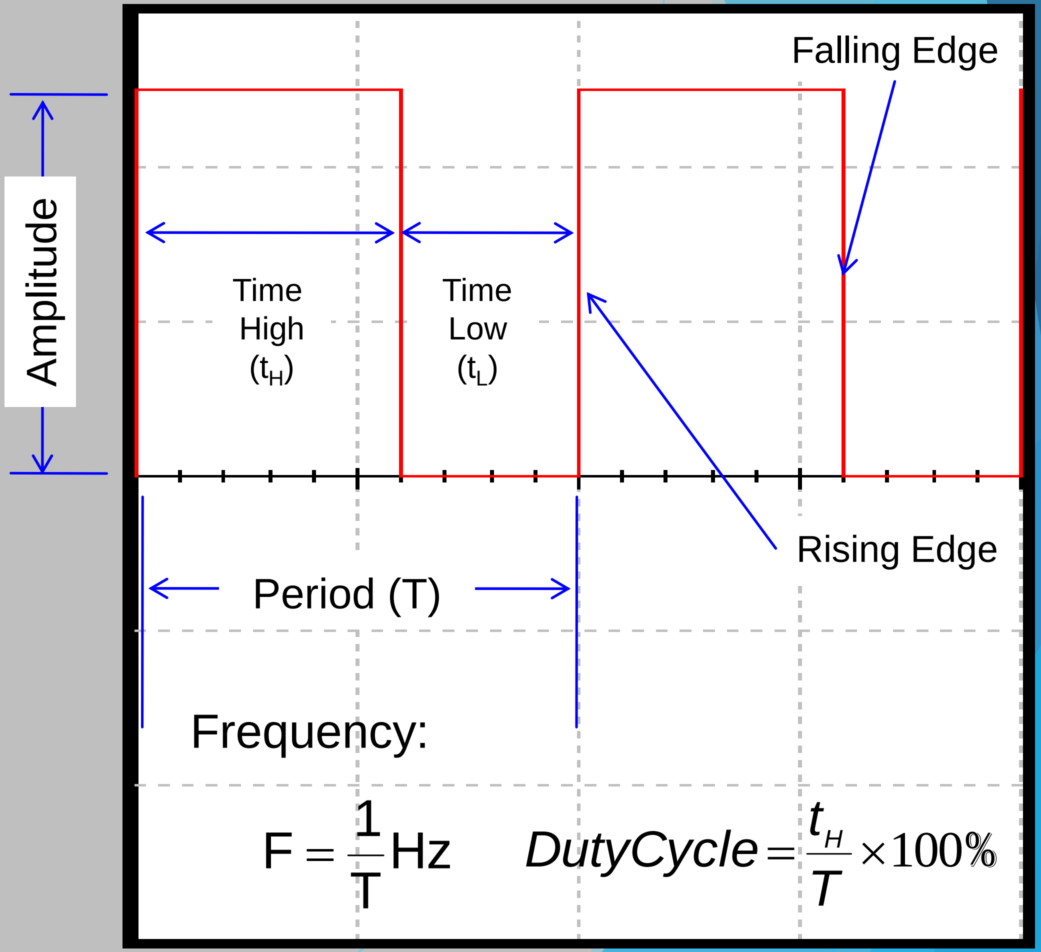
Time High (t_H):
The time the signal is at 5 v.

Time Low (t_L):
The time the signal is at 0 v.

Duty Cycle:
The ratio of t_H to the total period (T).

Rising Edge:
A 0-to-1 transition of the signal.

Falling Edge:
A 1-to-0 transition of the signal.



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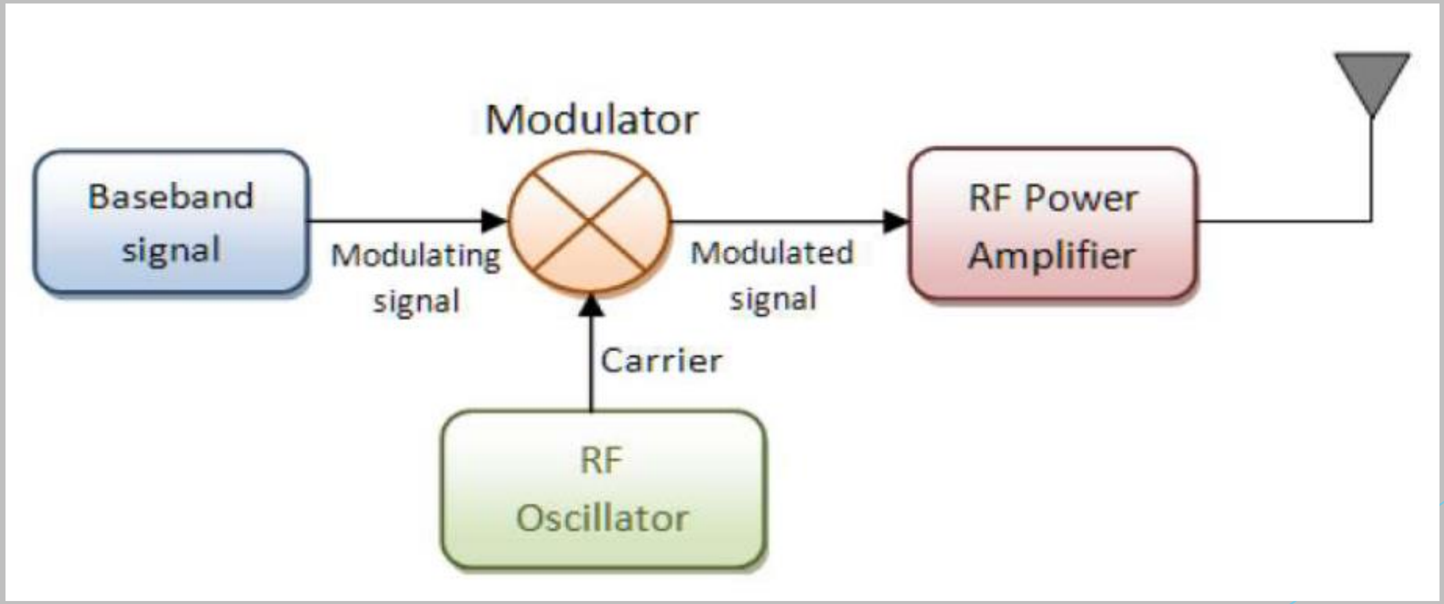
Modulation:

Operation of varying amplitude, frequency or phase of carrier signal accordingly with the instantaneous amplitude of the message signal is called modulation

Modulation = Adding information to a carrier signal



Modulation:

Modulation:

↳ merging of an actual message signal with the carrier signal.

or

process where one of the property (→ parts) of the carrier signal like Amplitude, Freq., phase is changed according to the Amplitude of inform^n or message signal.

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Need for Modulation:

- To transmit voice signal a large size antenna is required as antenna length is proportional to half of wavelength. The size of the antenna will be more than the distance between transmitter and receiver.
- Again when more than one transmitter is involved all station will overlap in one frequency band.
- For those above reasons we choose a carrier, which is a high frequency radio wave, can travel long distance without attenuation and as the frequency is high smaller antenna is required. Selecting different carrier frequency for different transmitting stations can eliminate overlapping of frequency band.

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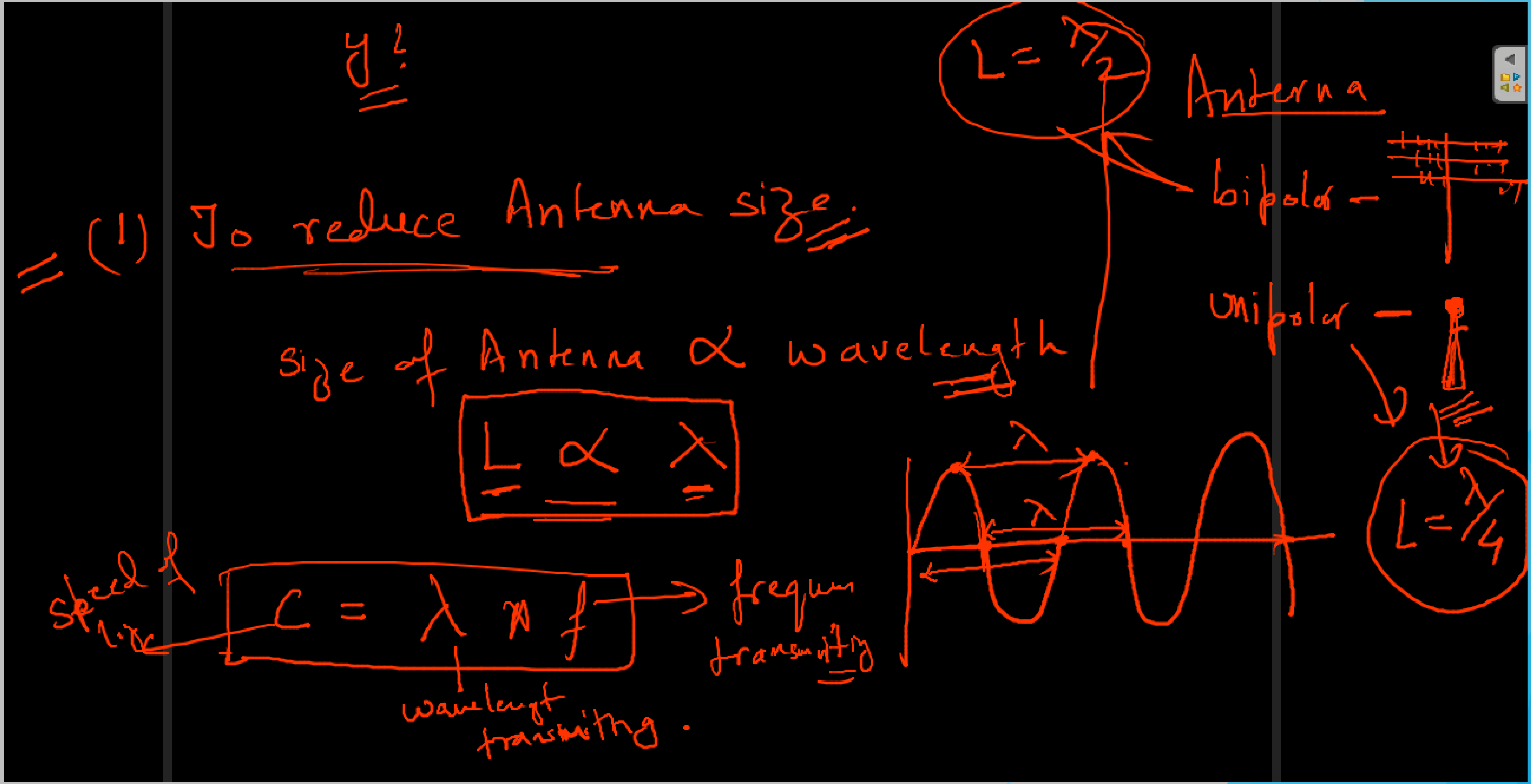
Need for Modulation:



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Need for Modulation:

$f = 10\ kHz$ $\quad c = \lambda f$ $\quad 1k = 10^3\ Hz$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^{\cancel{8}\,4}\ m/s}{1\cancel{0} \times \cancel{10^3}\ Hz}$$

$$= 30000\ \text{meter.}$$

$$L = \frac{\lambda}{4} = \frac{30000}{4} = \boxed{7500\,m} \,/\, 7.5\,km$$

practically possible

$f = 10\ MHz$ $\quad 1\ MHz = 10^6\ Hz$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^{\cancel{8}}}{1\cancel{0} \times 10^{\cancel{6}}}$$

$$= 30\ m$$

$$L = \frac{\lambda}{4} = \frac{30}{4} = 7.5\ m \rightarrow \text{manageable}$$

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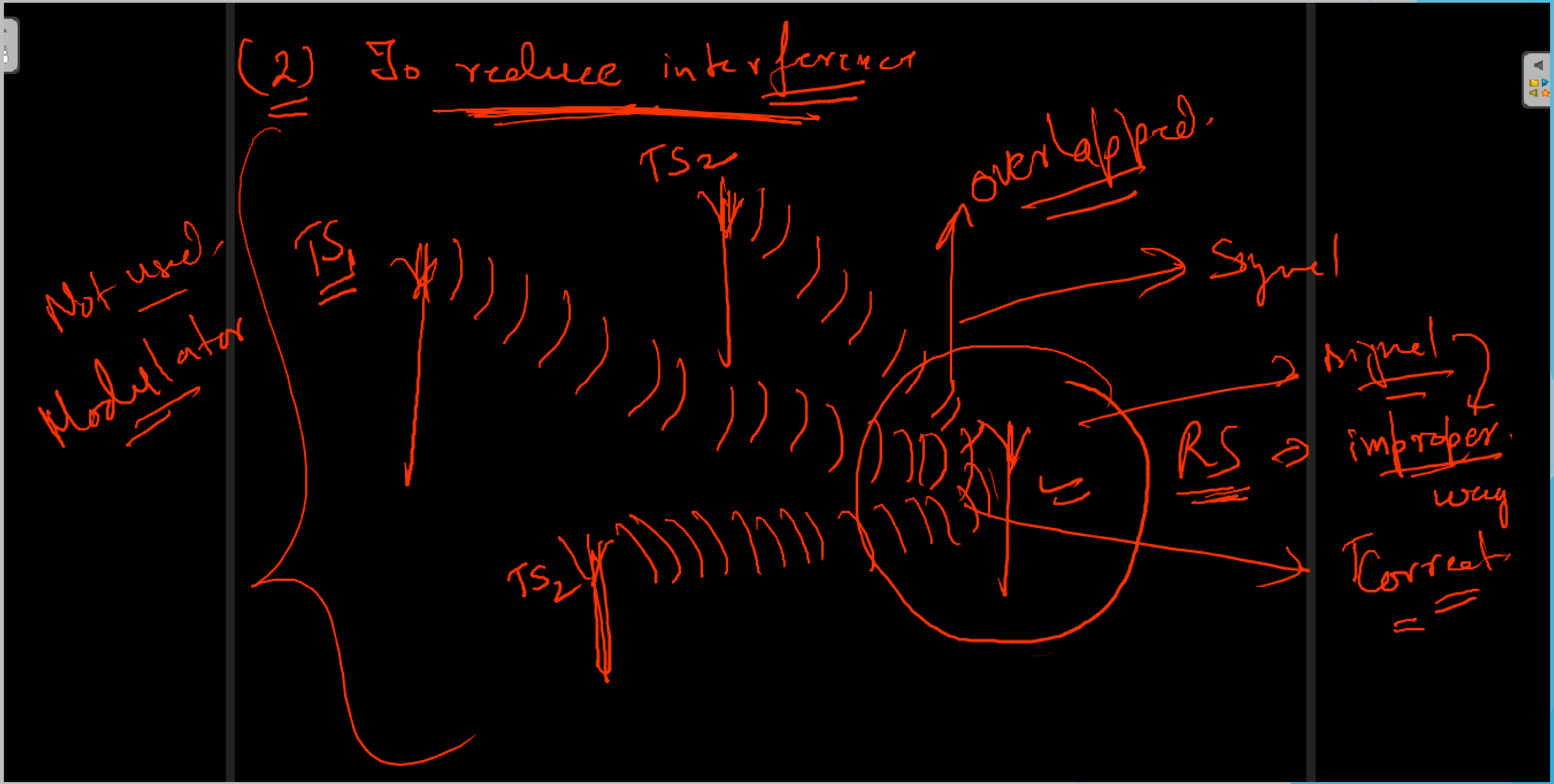
Need for Modulation:



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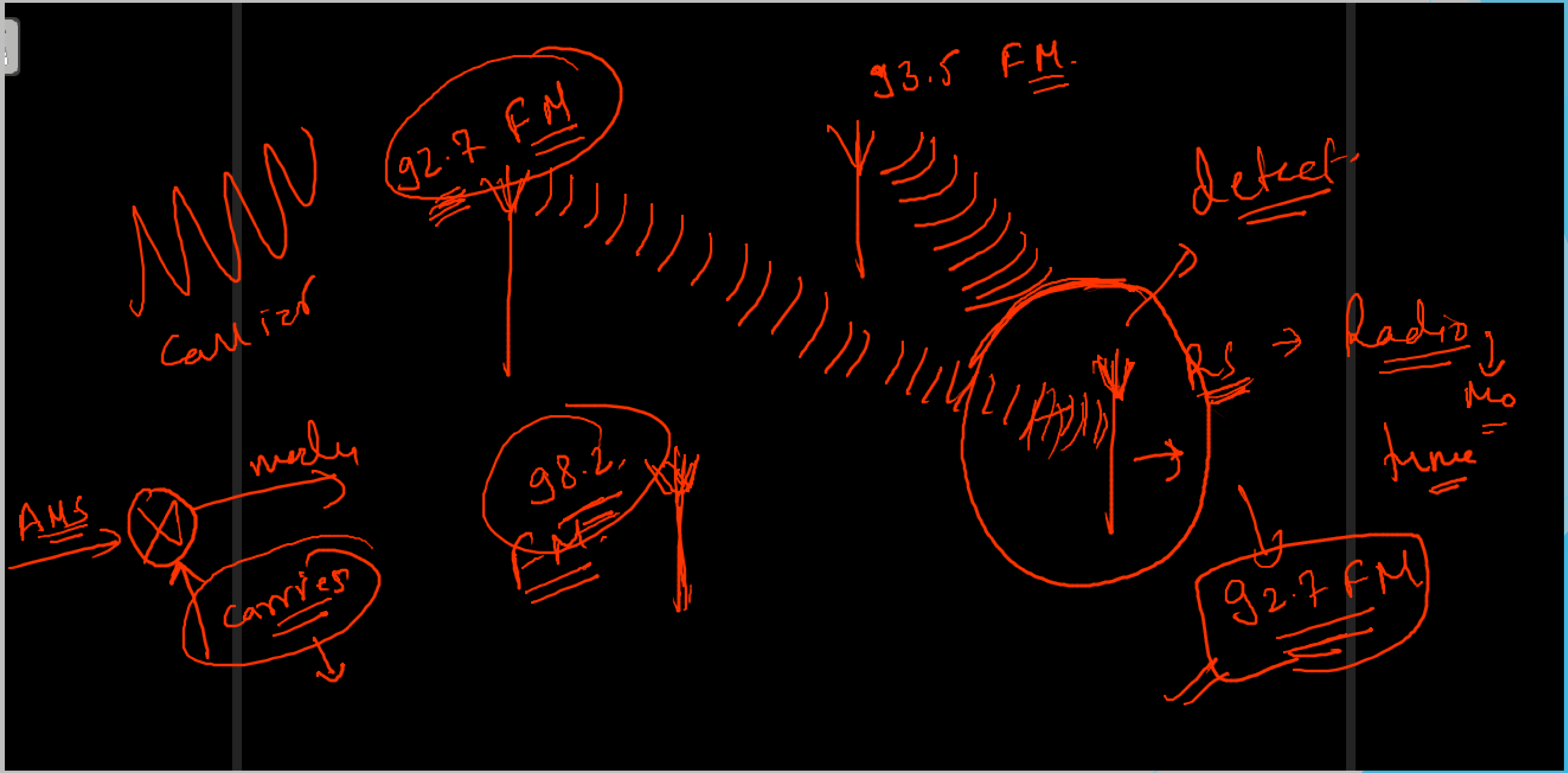
Need for Modulation:



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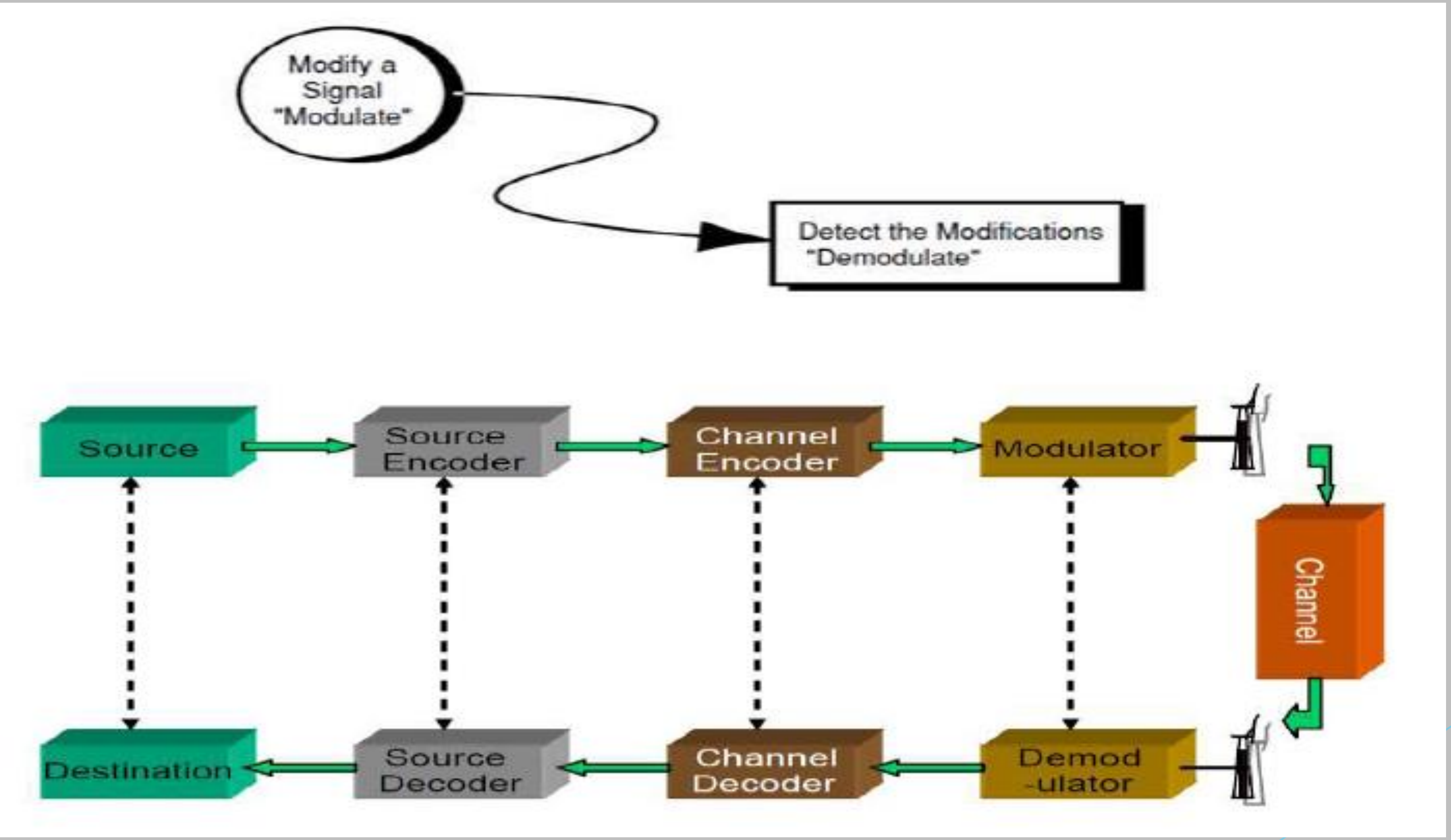
Modulation System:



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Signal to Signal Conversions:

Modulation Techniques:

- Analog Modulation: Analog to Analog
- Digital Modulation: Digital to Analog

Encoding Techniques:

- Line Coding: Digital to Digital
- Pulse Code Modulation Encoding: Analog to Digital

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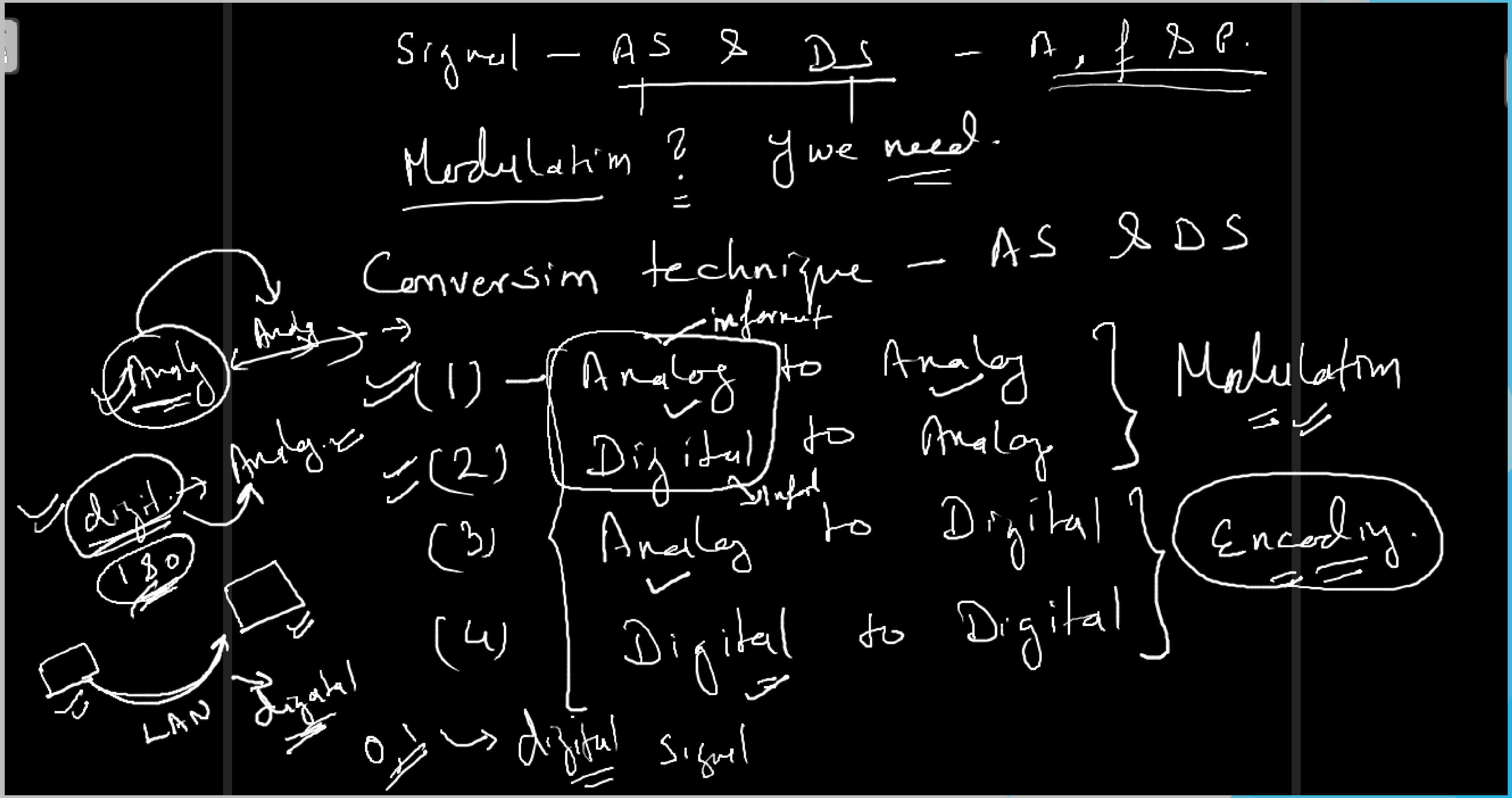
Signal to Signal Conversions:



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Analog Modulation:

If the variation in the parameter of the carrier is continuous in accordance to the input analog signal the modulation technique is termed as analog modulation scheme. It is classified as:

1. Amplitude Modulation
2. Frequency Modulation
3. Phase Modulation

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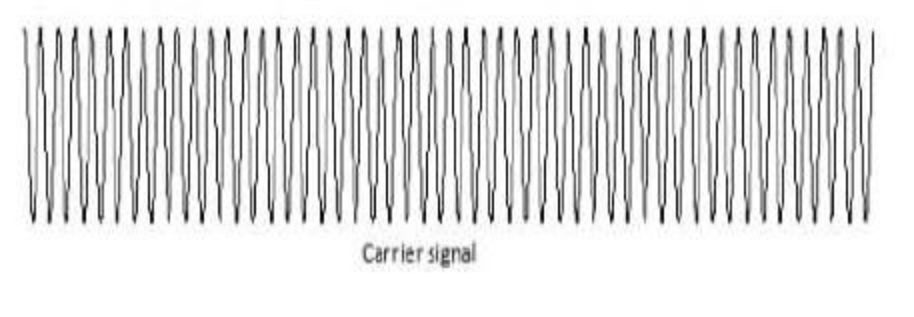
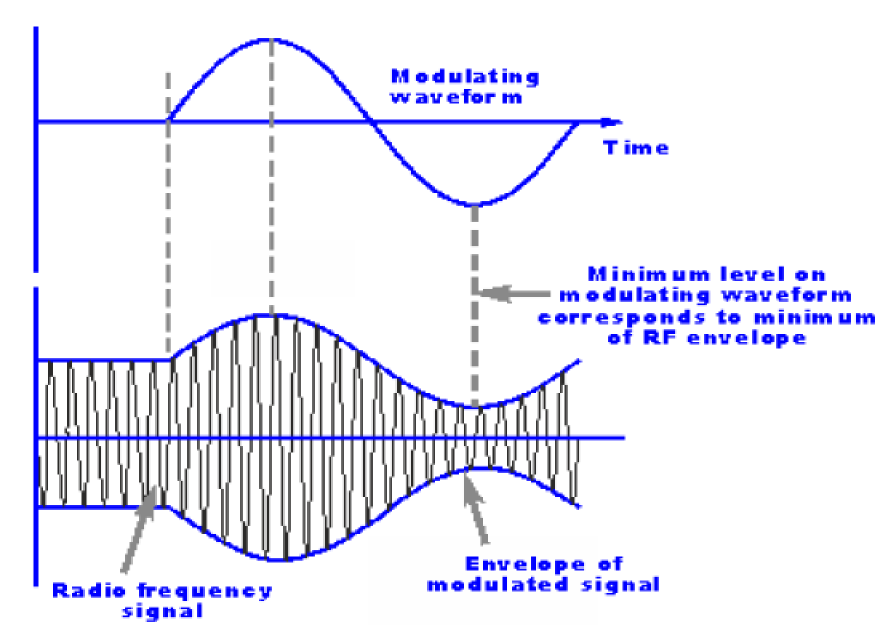
Analog Modulation: Amplitude Modulation

AM is the process of varying the instantaneous amplitude of carrier signal accordingly with instantaneous amplitude of message signal

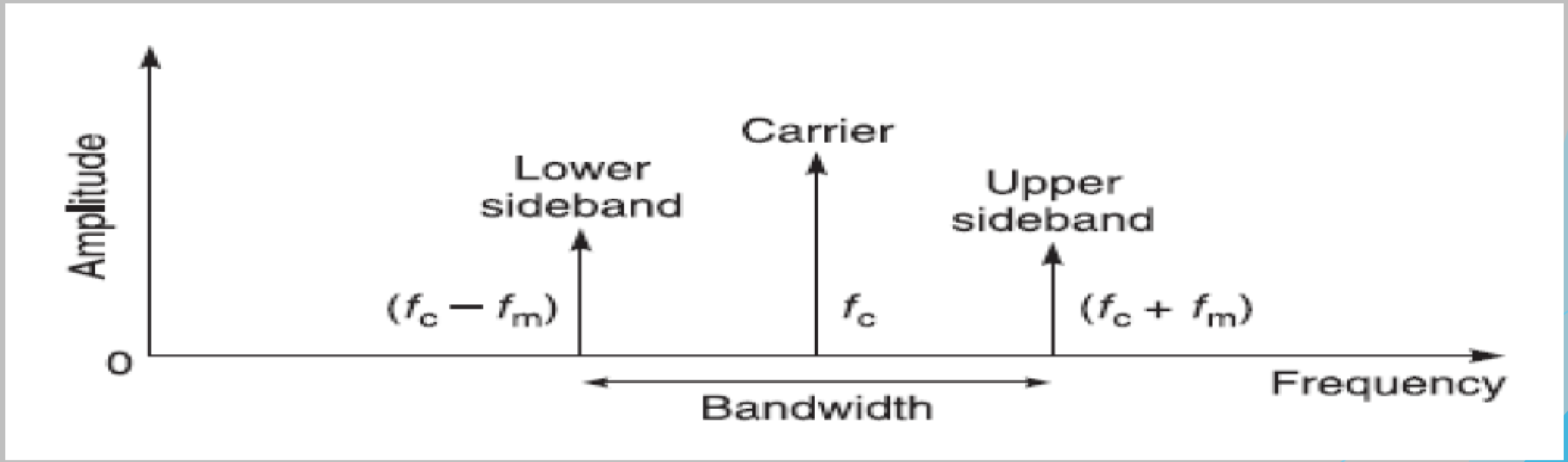




Analog Modulation: Amplitude Modulation

Frequency spectrum of AM comprises of:

- A lower side band whose highest frequency component is present at fc-fm
- An upper side band whose highest frequency component is present at fc+fm
- Carrier frequency fc



This type of amplitude modulation is known as double side band-full carrier(DSB-FC)

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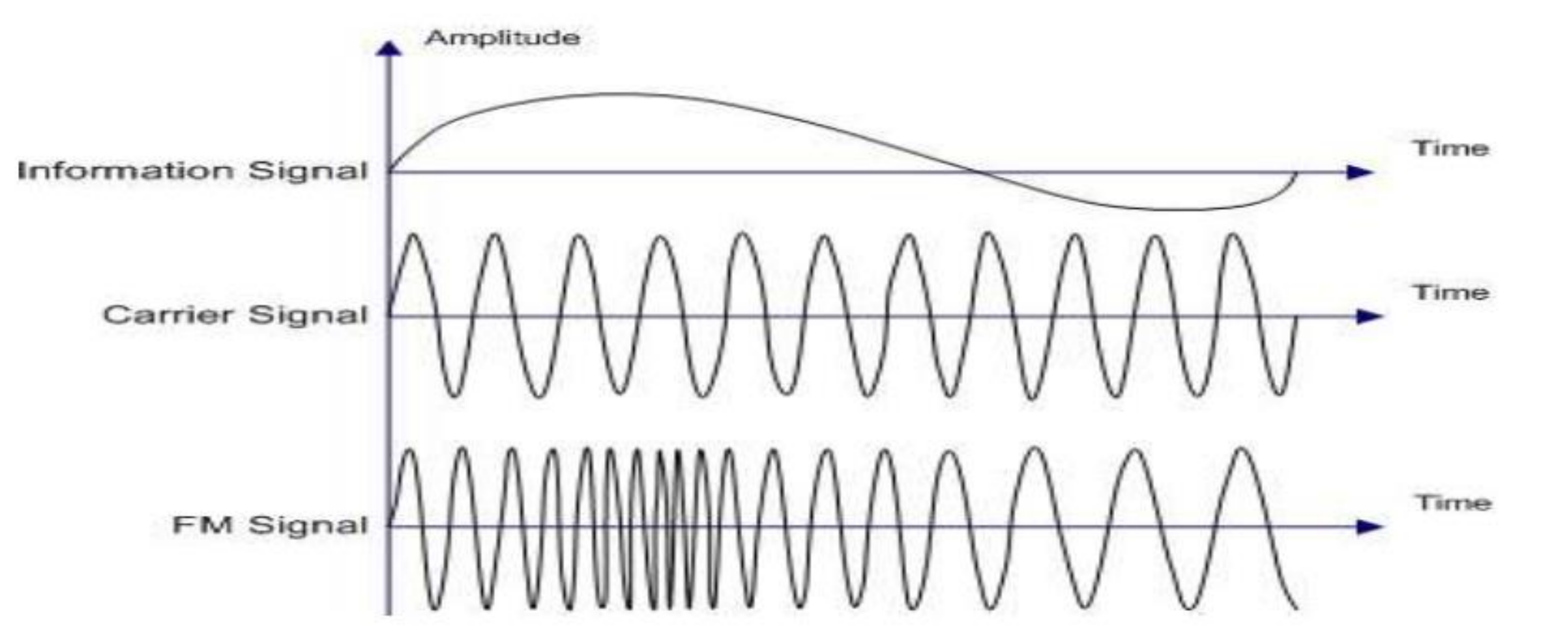
Analog Modulation: Frequency Modulation

FM is the process of varying the instantaneous frequency of carrier signal accordingly with instantaneous amplitude of message signal.



Analog Modulation: Frequency Modulation

- The FM wave is comprised of an infinite number of sideband components
- Bandwidth of a FM signal must be wider than that of an AM signal
- As the modulation index increases from mf = 0, the spectral energy shifts from the carrier frequency to an increasing number of significant sidebands.
- The higher the modulation index, the greater the required system bandwidth

$$BW = 2(n \times f_m)$$

where n is the highest number of significant sideband components and fm is the highest modulation frequency

- Carson's rule:

$$BW = 2(\delta + f_m) = 2 f_m (1 + m_f)$$

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Analog Modulation: Frequency Modulation

Narrow Band Frequency Modulation(NBFM):

- NBFM uses low modulation index values, with a much smaller range of modulation index across all values of the modulating signal
- An NBFM system restricts the modulating signal to the minimum acceptable value, which is 300 Hz to 3 KHz for intelligible voice
- Used in police, fire, and Taxi radios, GSM, amateur radio, etc.

Wide Band Frequency Modulation(WBFM):

- When better signal quality is required Wideband FM (WBFM) is used at the expense of greater spectrum usage. The term WBFM is used in applications where the modulation index is equal to or larger than 1
- In such applications spectral efficiency is less important and sometimes large spectral spread is actually desired

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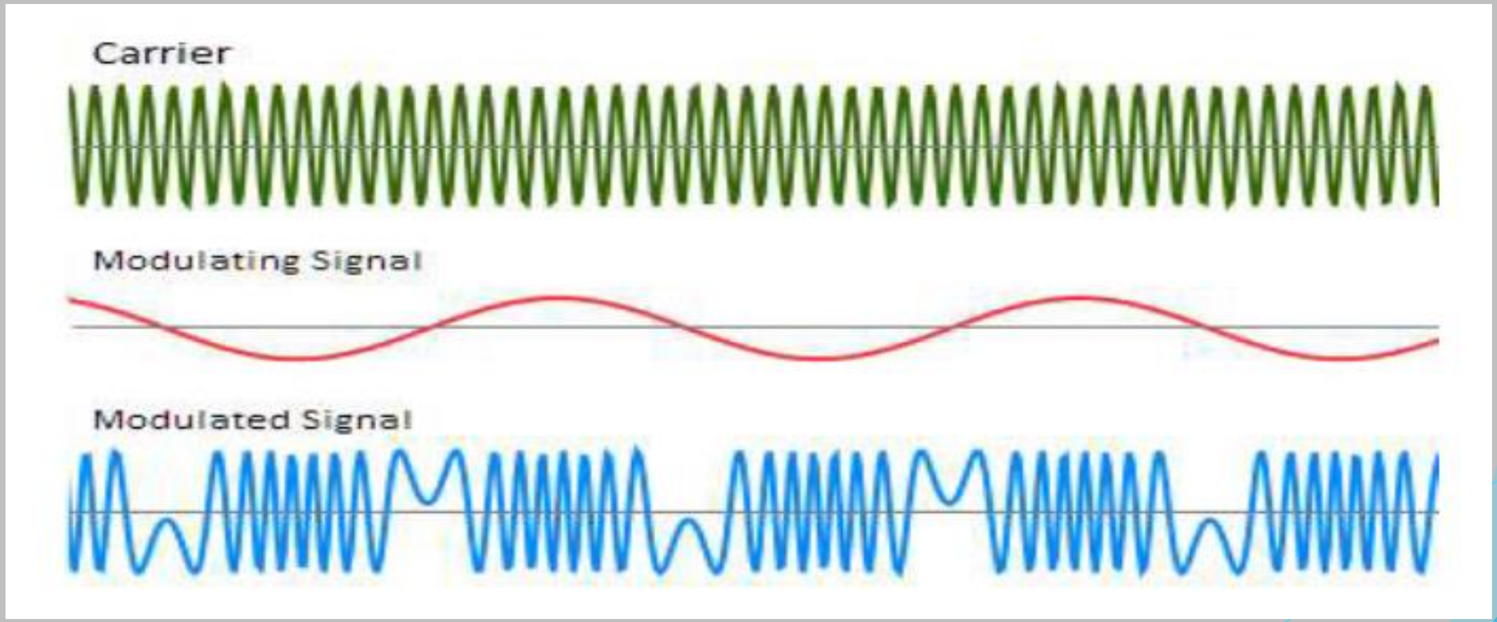
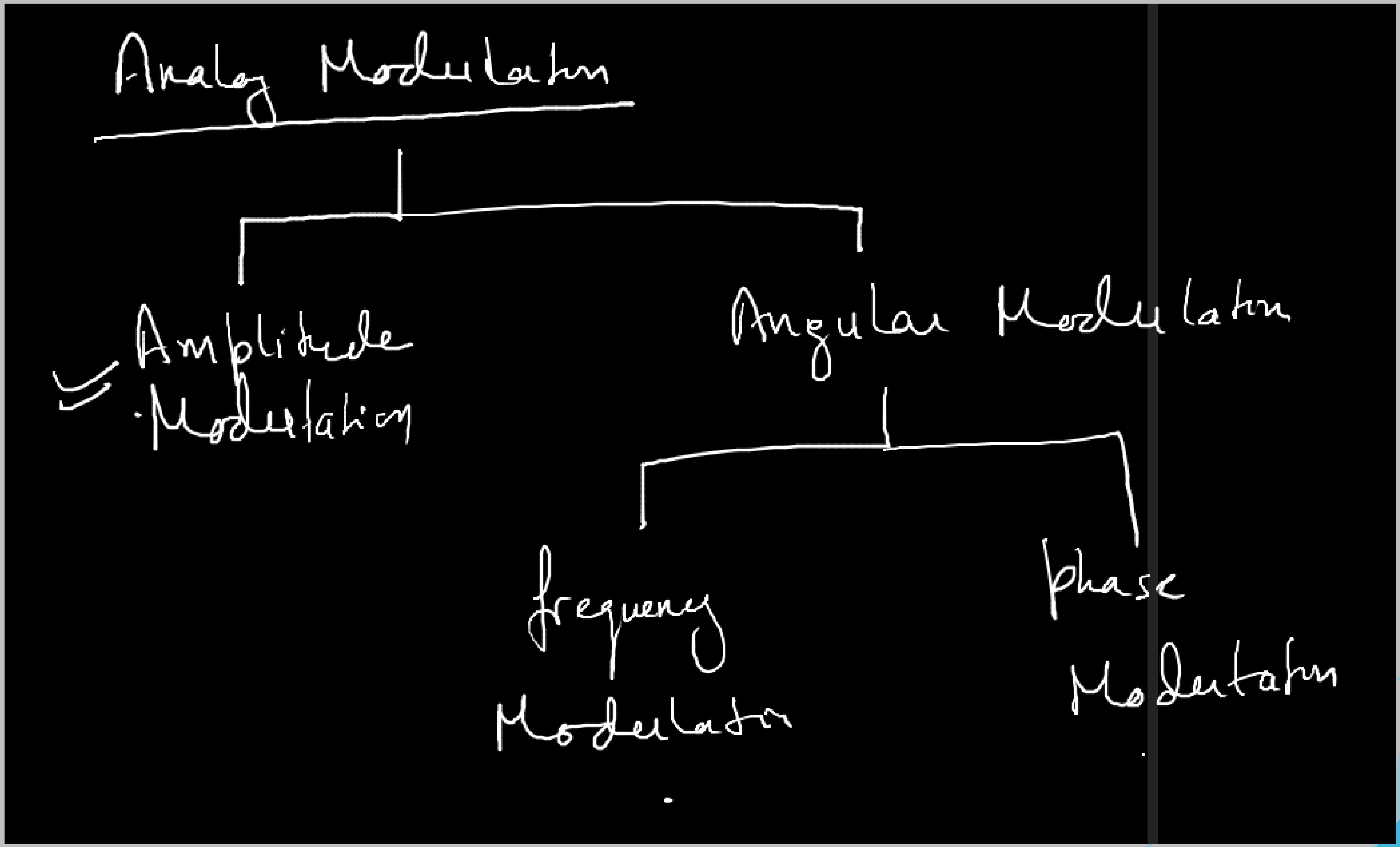
Analog Modulation: Phase Modulation

PM is the process of varying the instantaneous phase of Carrier signal accordingly with instantaneous amplitude of message signal.



Analog Modulation



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Analog Modulation: Amplitude Modulation

AM: → Vary the Amplitude of CW according to the Amplitude of Message signal

$$A\cos(\omega t + \theta)$$

Amplitud

frequen

phase

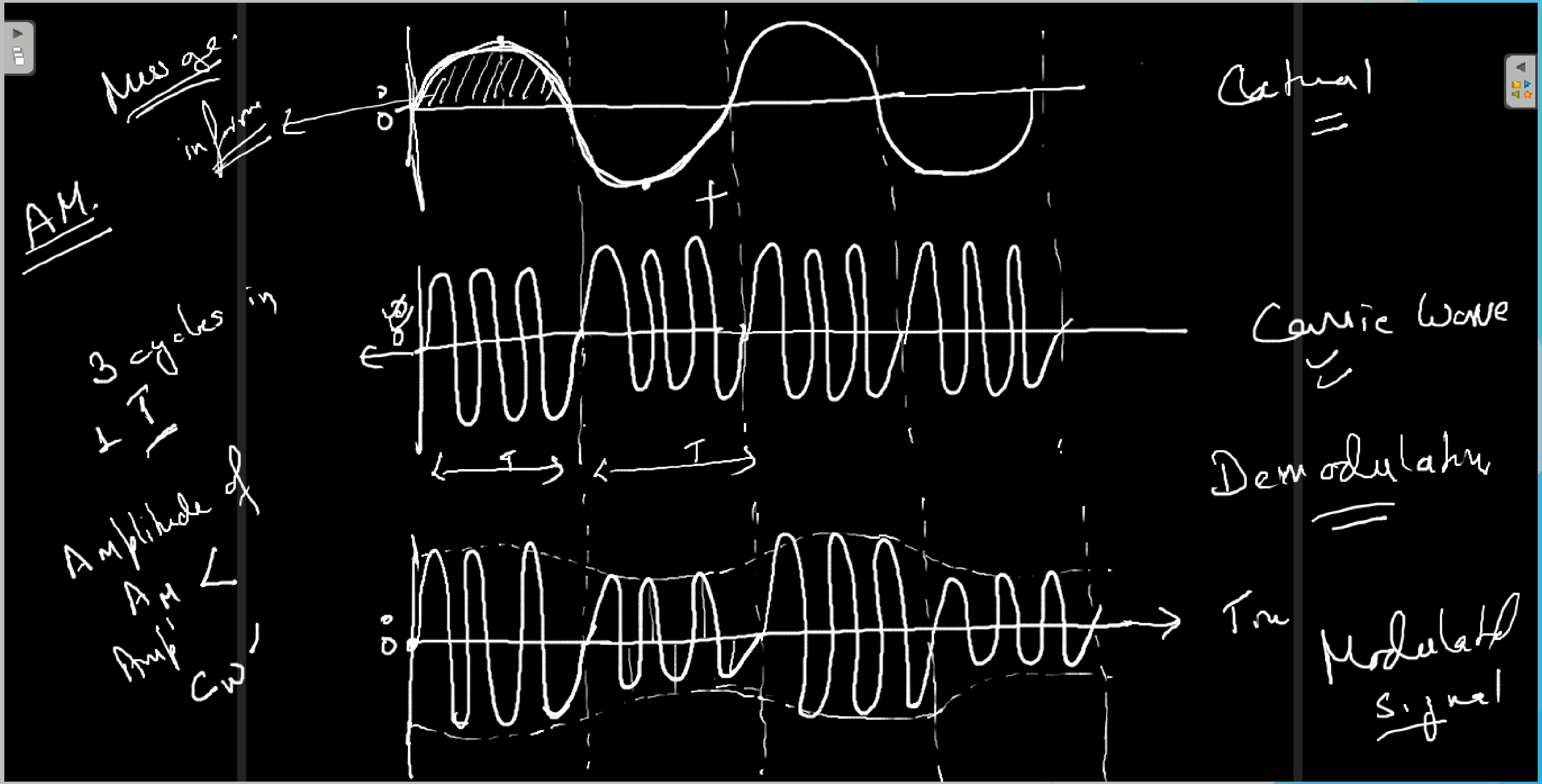
Constant.

Mod data signal with f

Carrier Signal

Analog.

Analog Modulation: Amplitude Modulation



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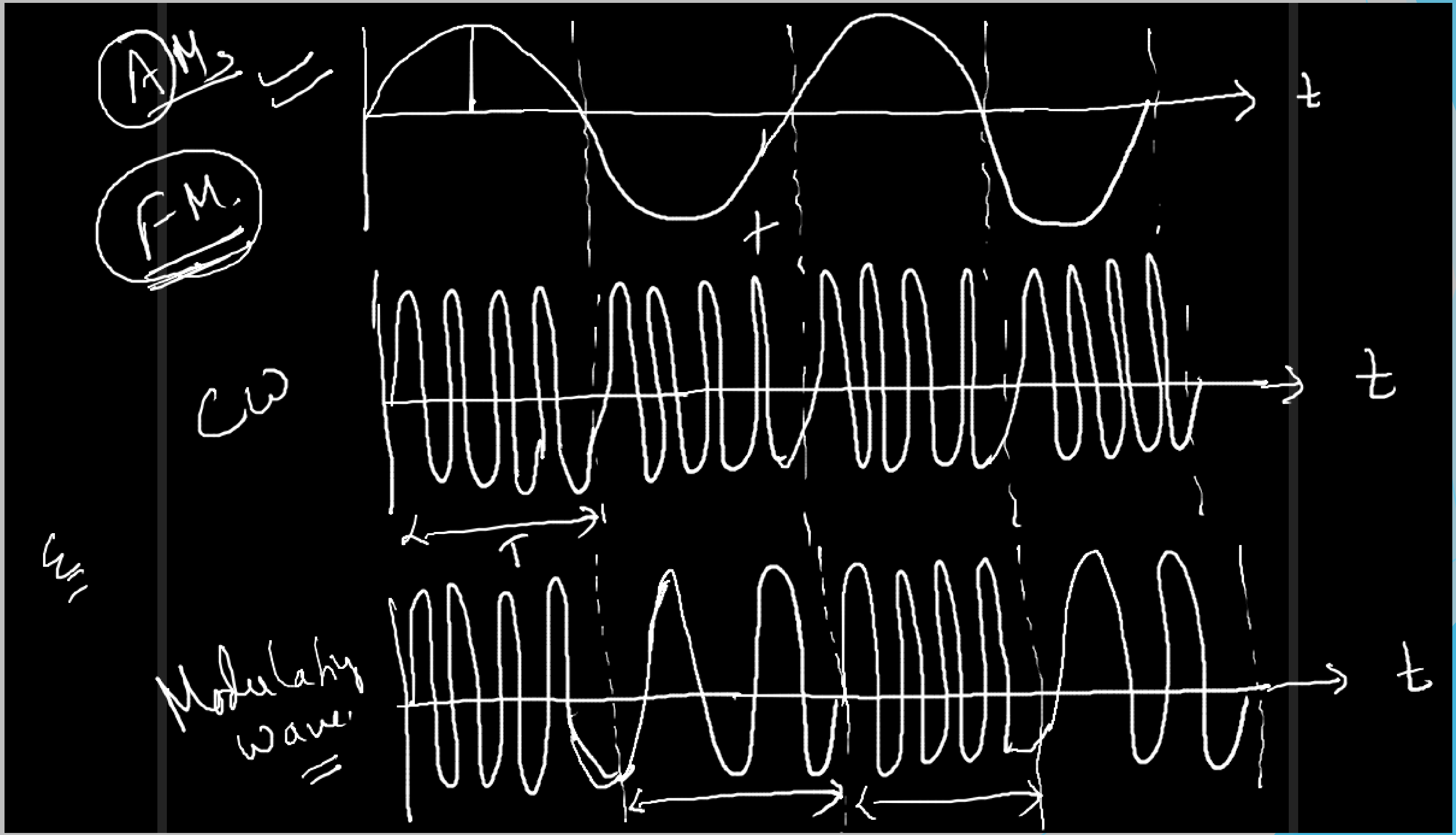
Analog Modulation: Frequency Modulation

FM. $= A\cos(\omega t + \theta) \Rightarrow$ we will change the frequency of Carrier wave according to the Amplitude of actual message signal

Analog Modulation: Frequency Modulation



Analog Modulation: Phase Modulation

PM. $= A \cos(\omega t + \theta)$

We will change the phase of carrier wave with respect to the Amplitude of Actual signal.

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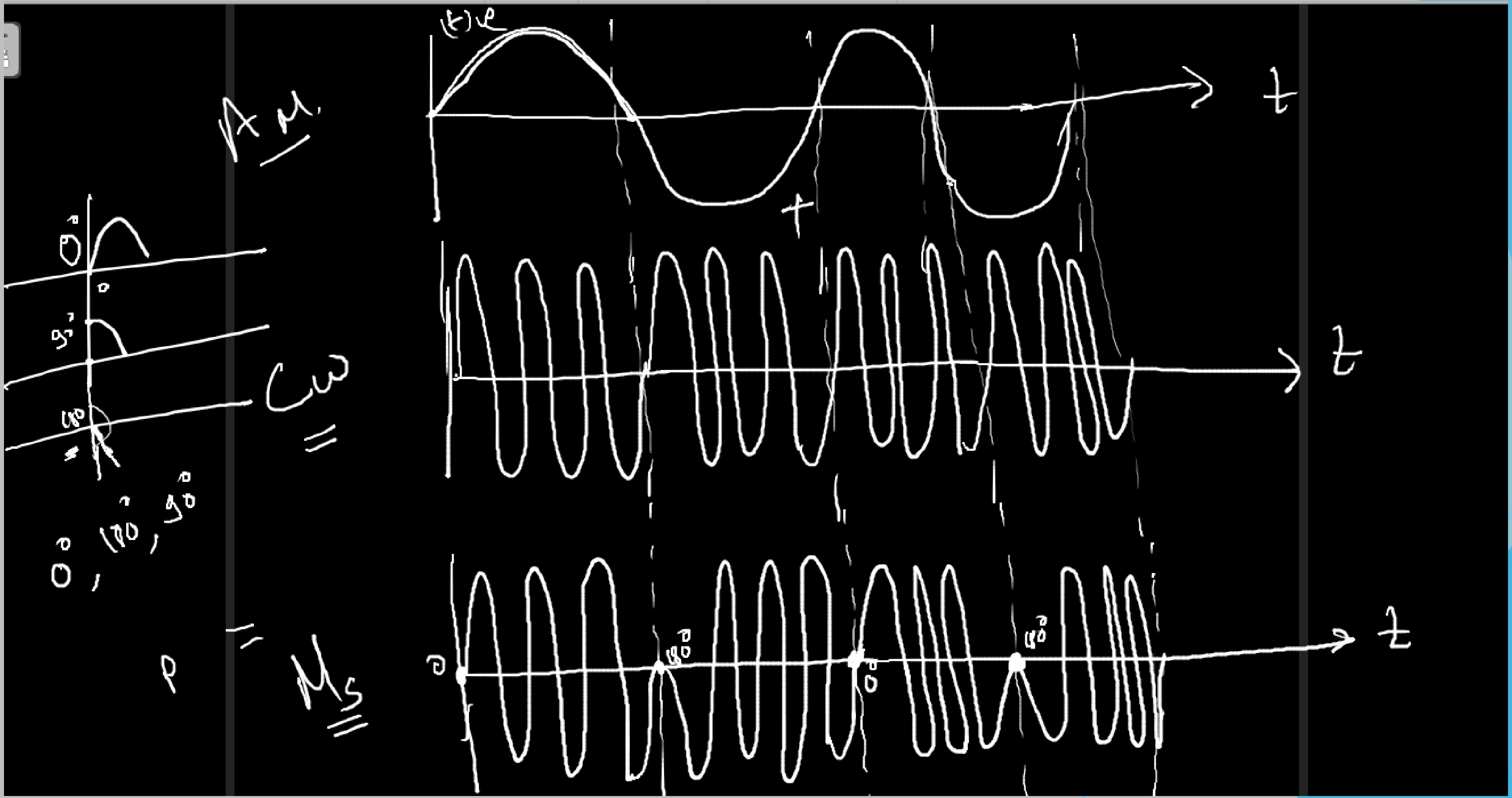
Analog Modulation: Phase Modulation



Digital Modulation:

If the variation in the parameters of the carrier wave is done in accordance to the amplitude of input digital signal the modulation technique is termed as digital modulation scheme. It is classified as:

1. Amplitude Shift Keying
2. Frequency Shift Keying
3. Phase Shift Keying

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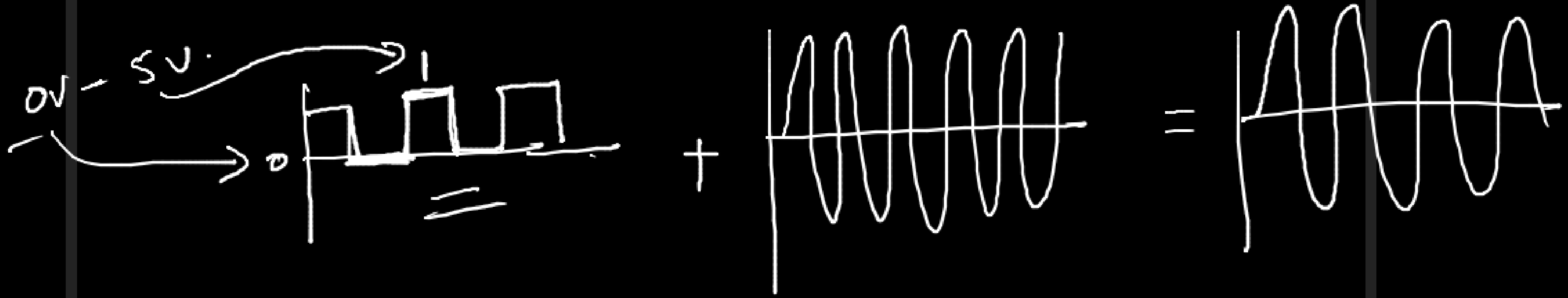
Digital Modulation



(1) Amplitude Shift keying
(2) frequency Shift keying
(3) Phase shift keying.

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Digital Modulation: Amplitude Shift Keying

ASK :→ $A \cos(\omega t + \theta)$

We will vary Amplitude of Carrier wave with respect to Amplitude of digital data signal.

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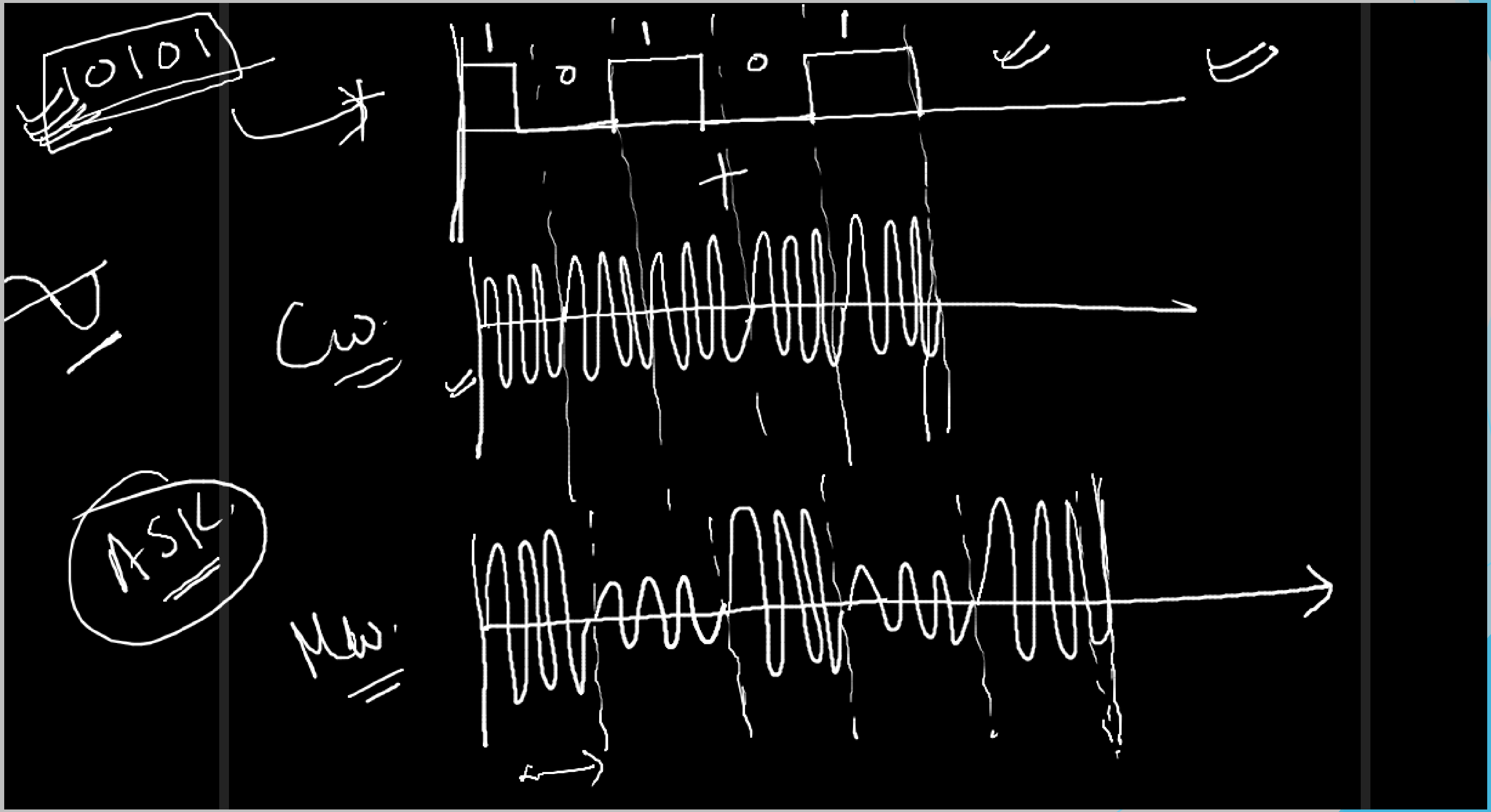
Digital Modulation: Amplitude Shift Keying



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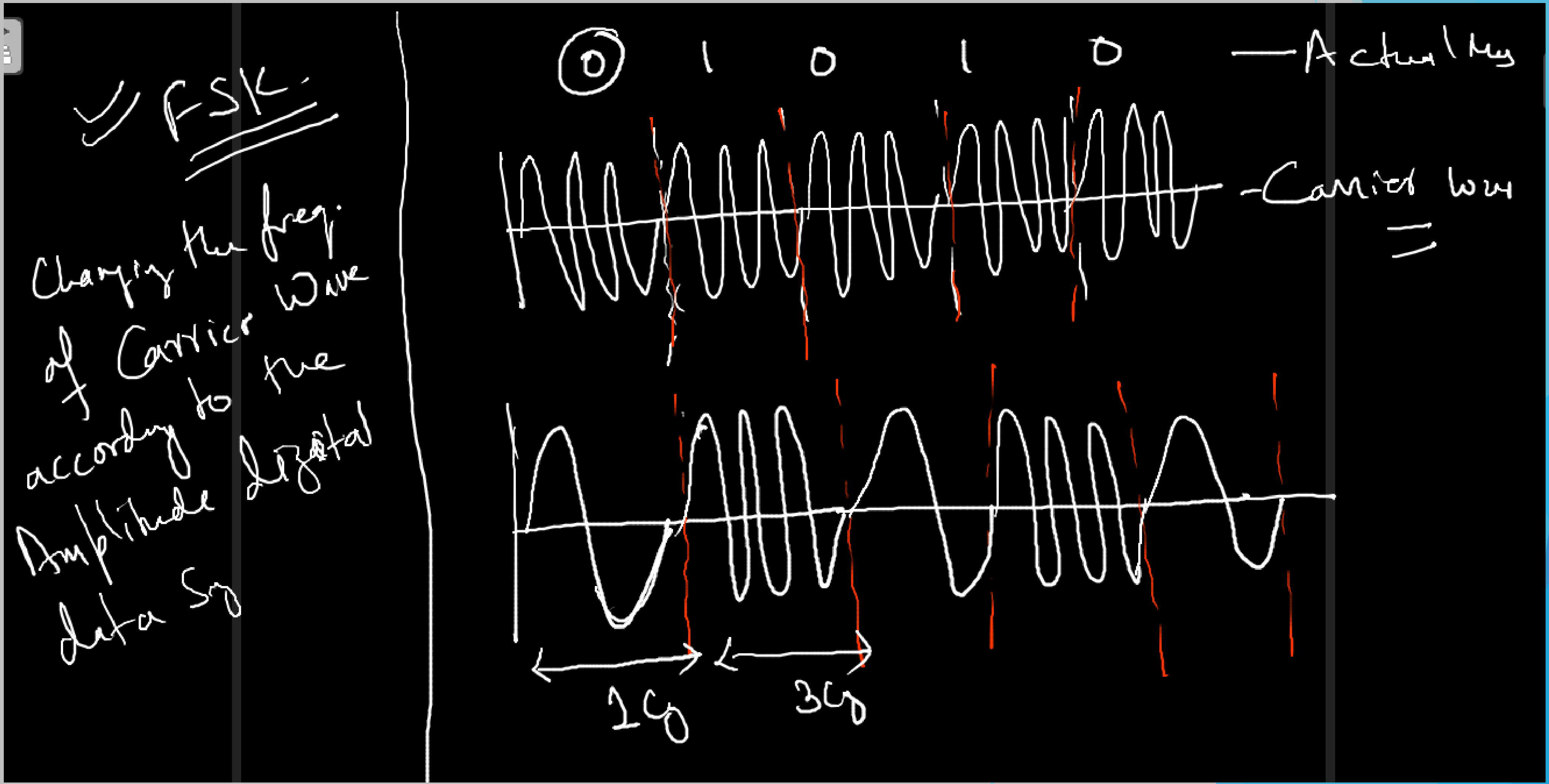
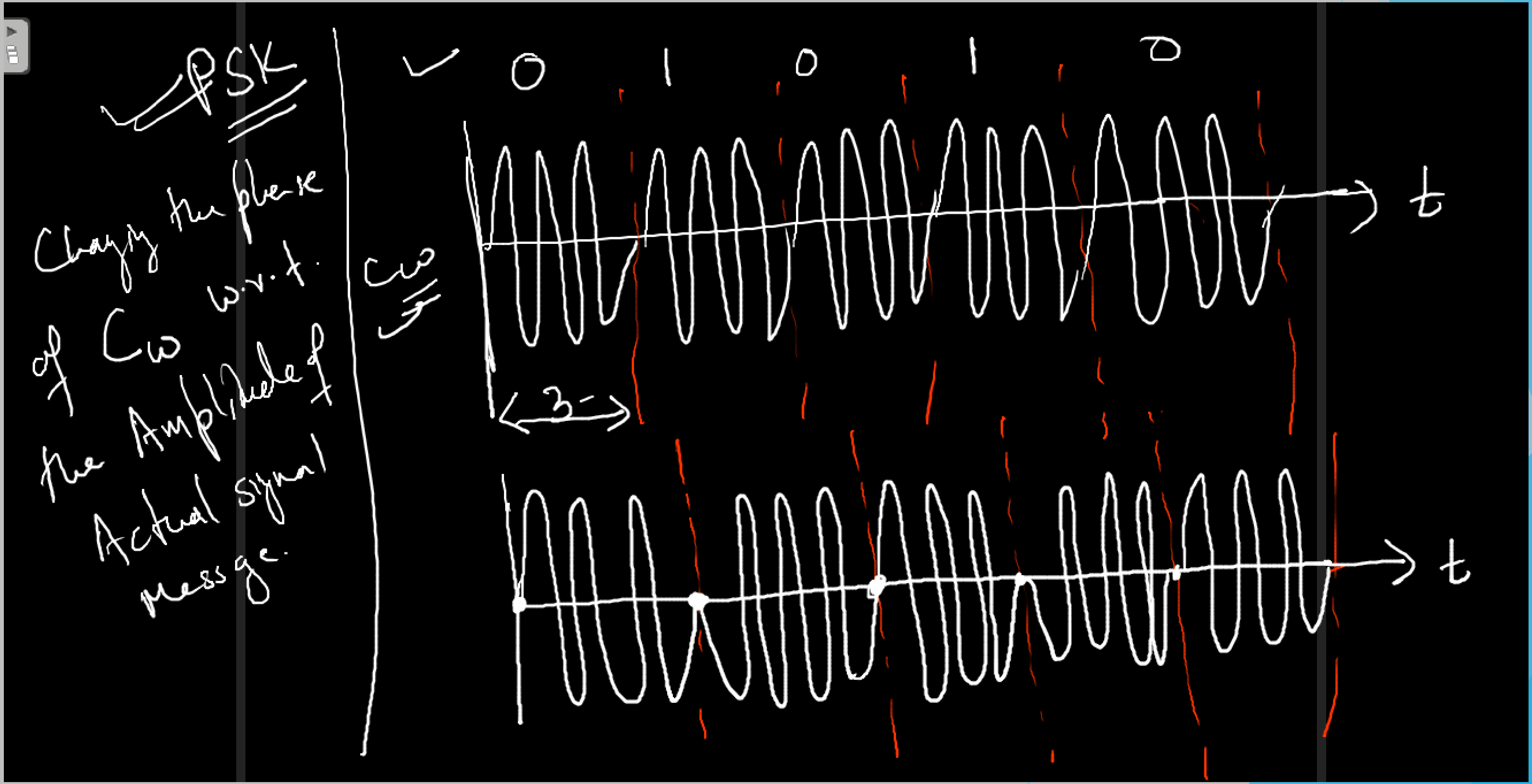
Digital Modulation: Frequency Shift Keying



Digital Modulation: Phase Shift Keying



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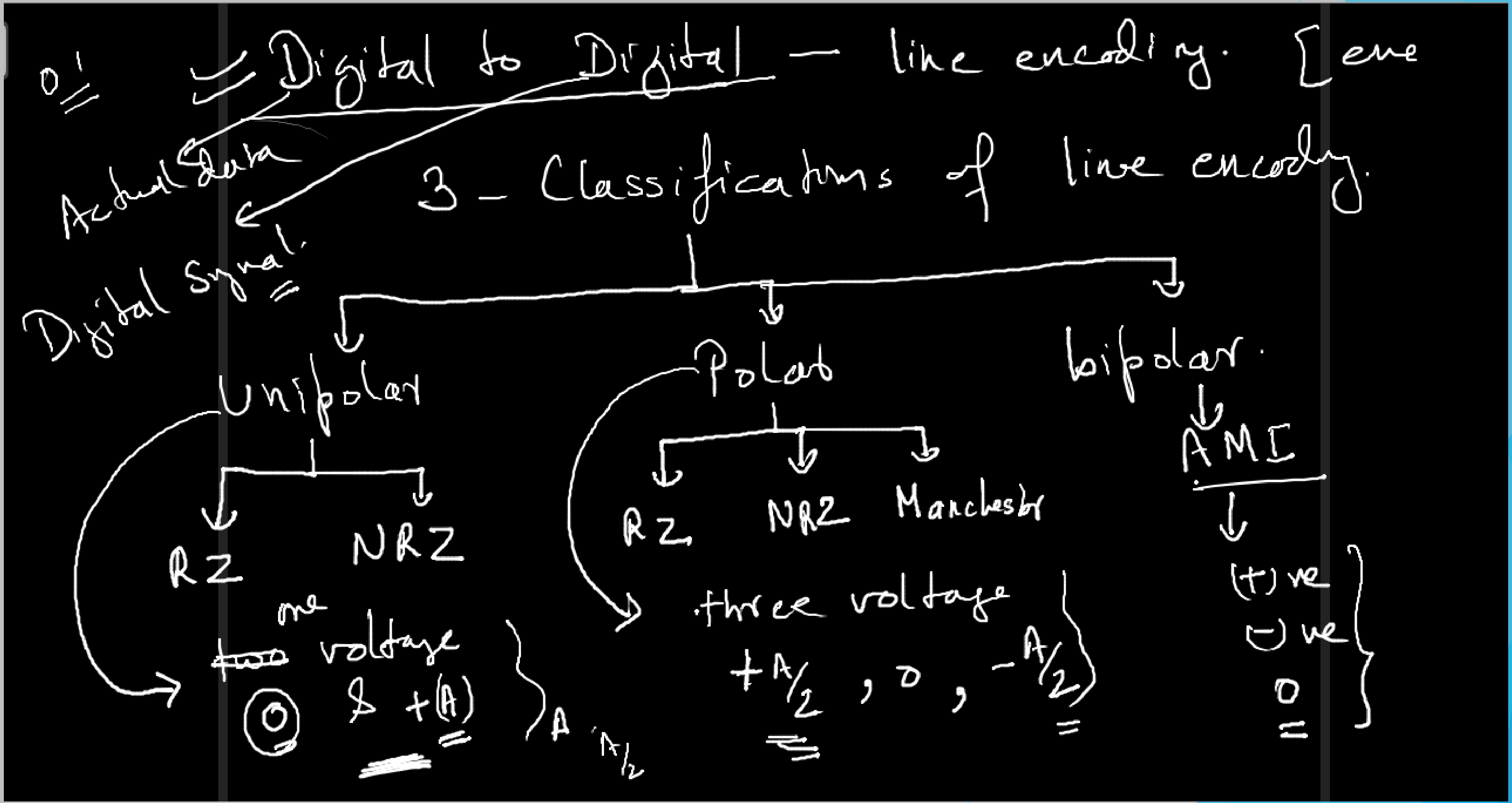
Digital Signal to Digital Signal: Line Encoding



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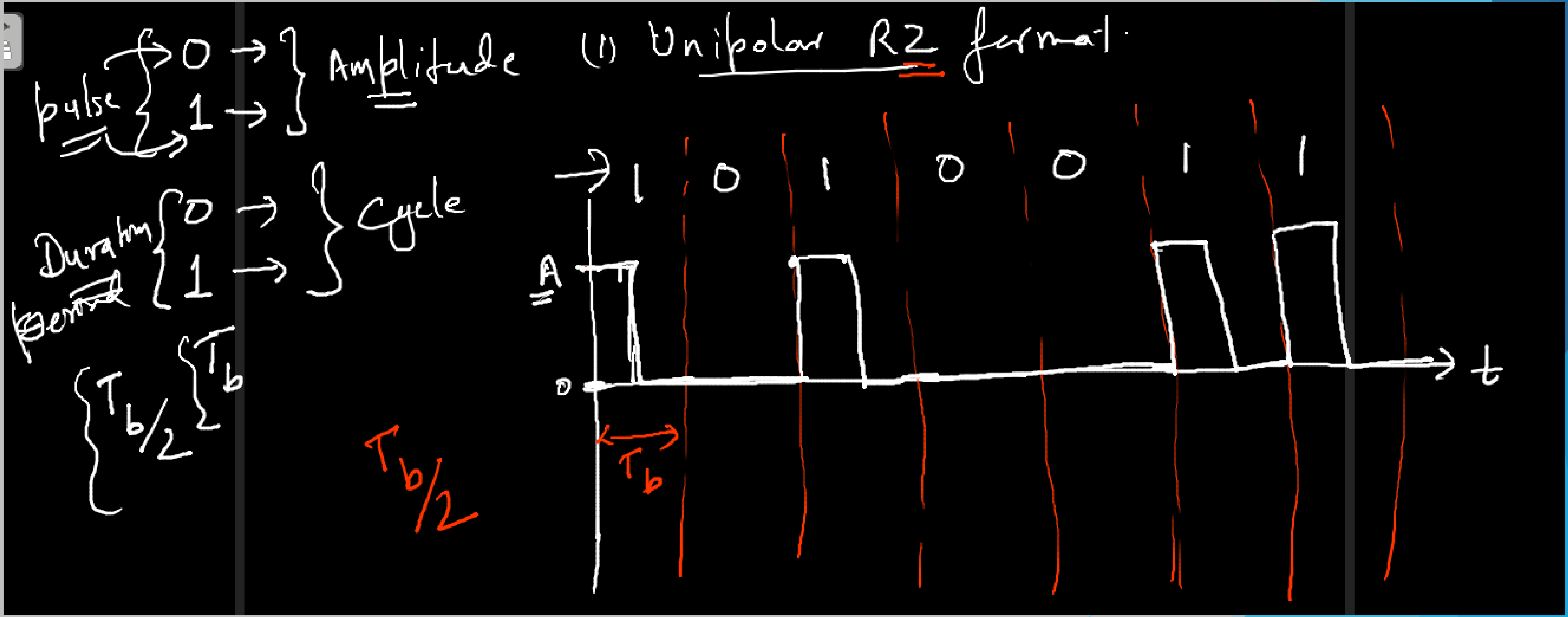
Line Encoding: Unipolar RZ



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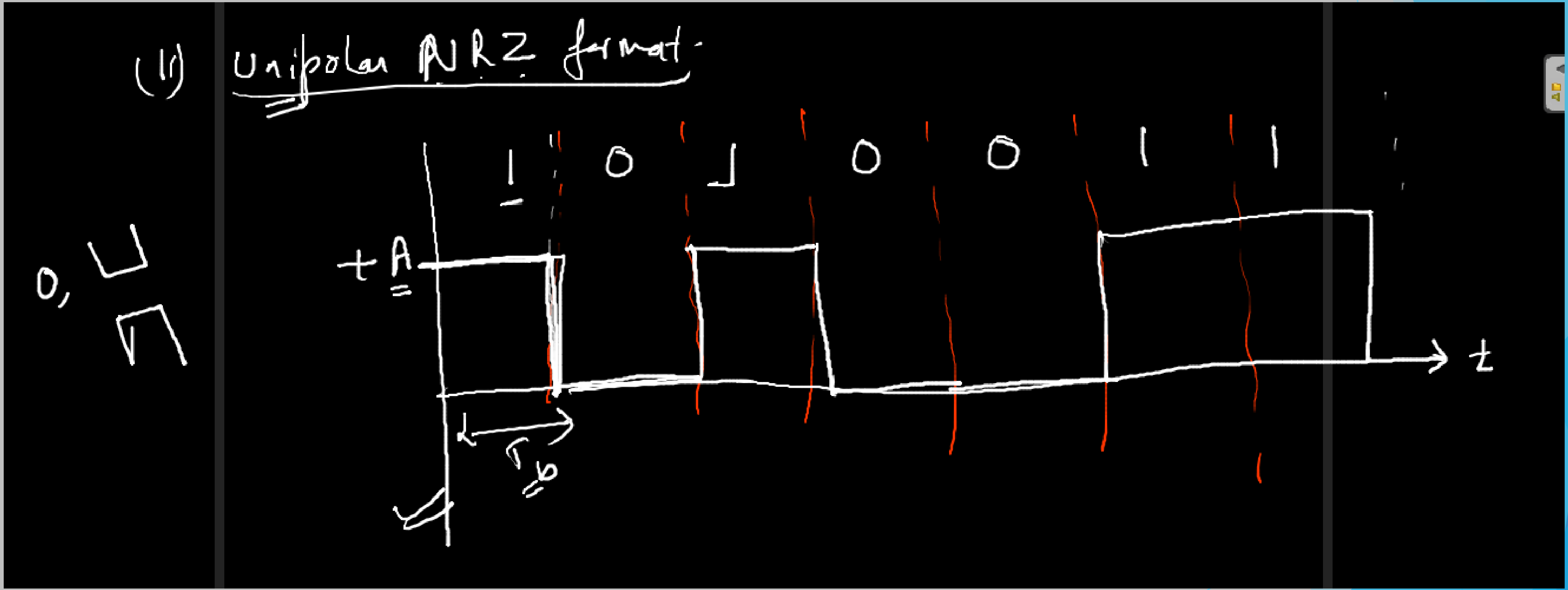
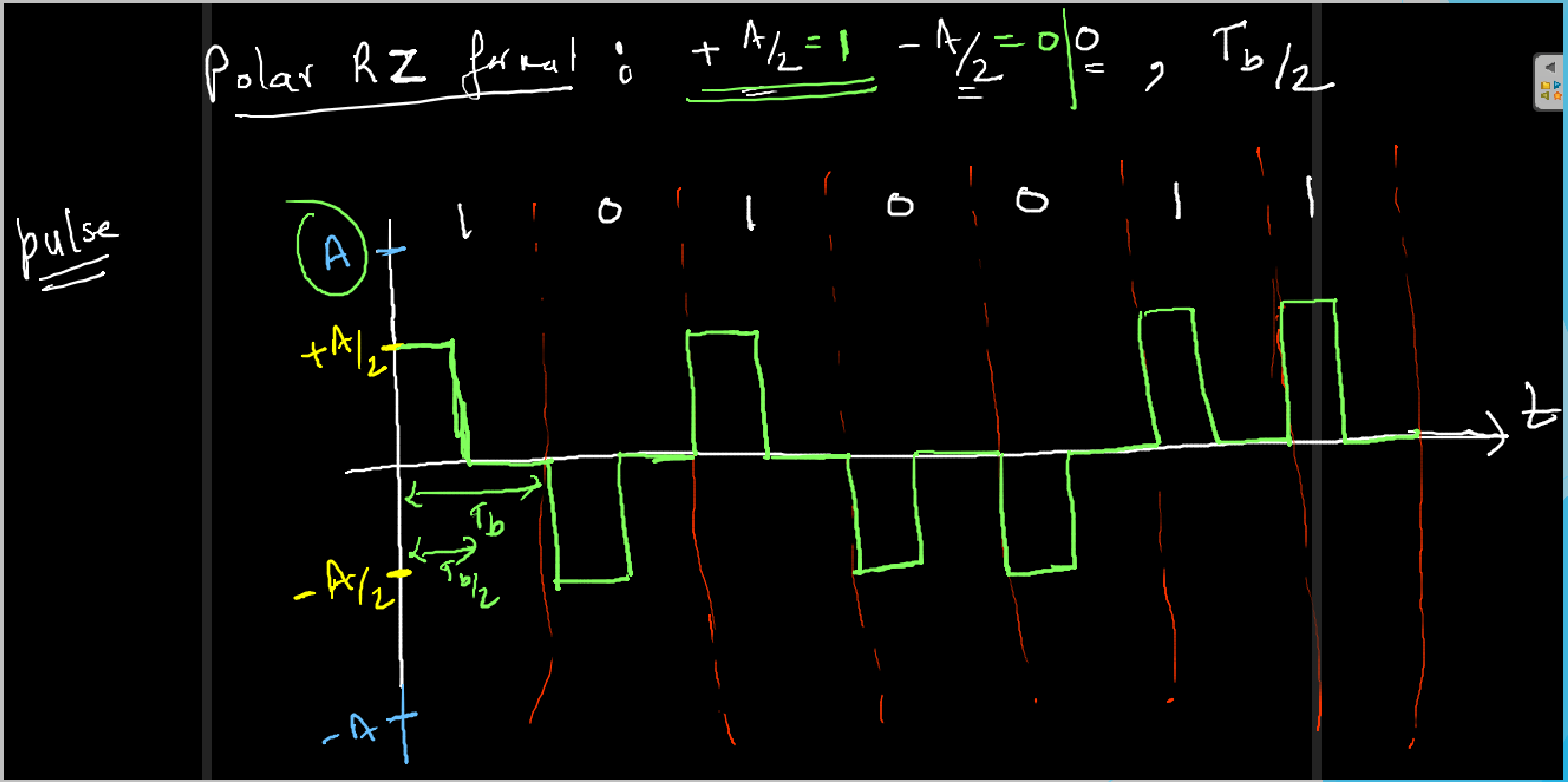
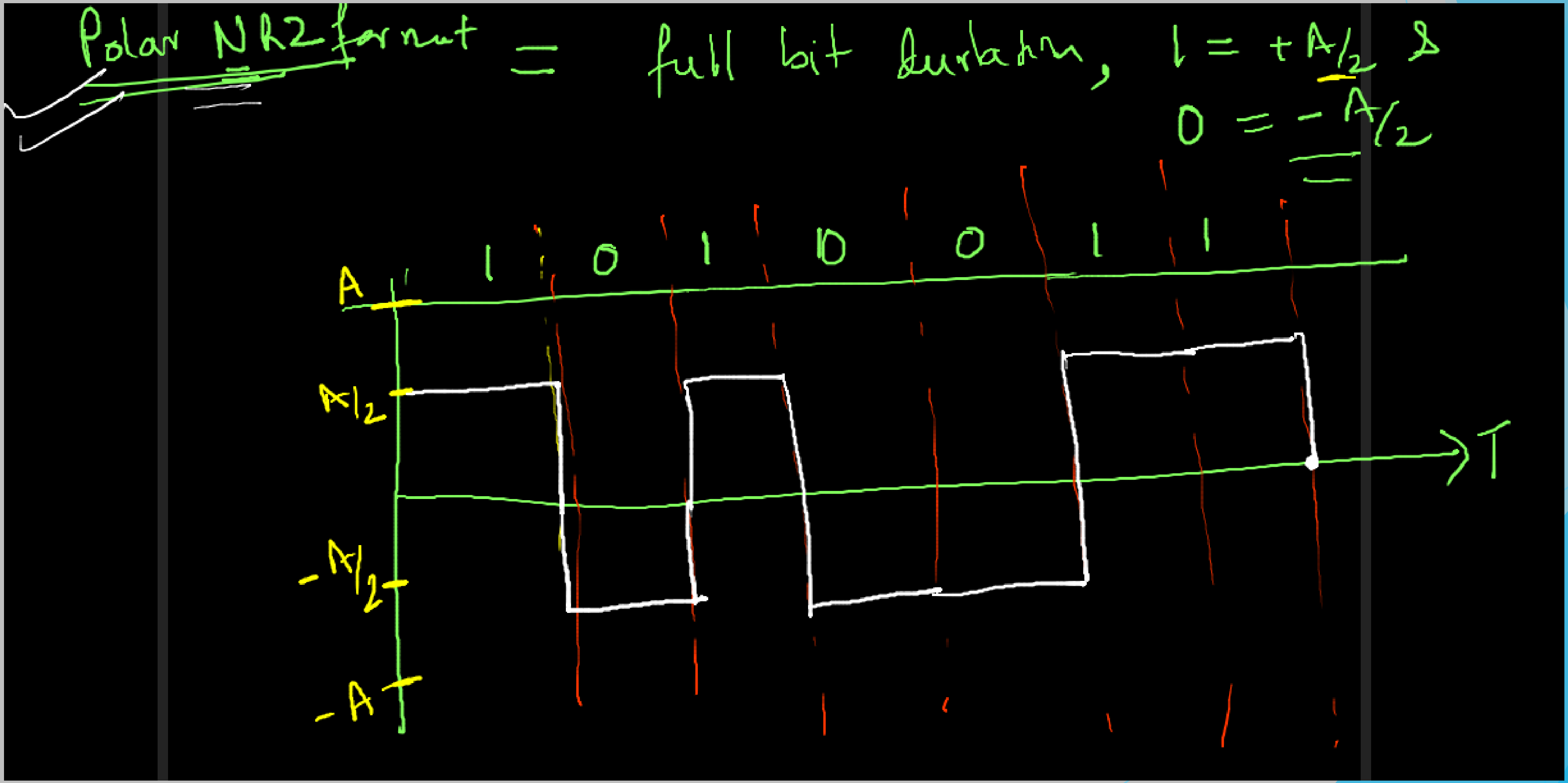
Line Encoding: Unipolar NRZ



Line Encoding: Polar RZ



Line Encoding: Polar NRZ



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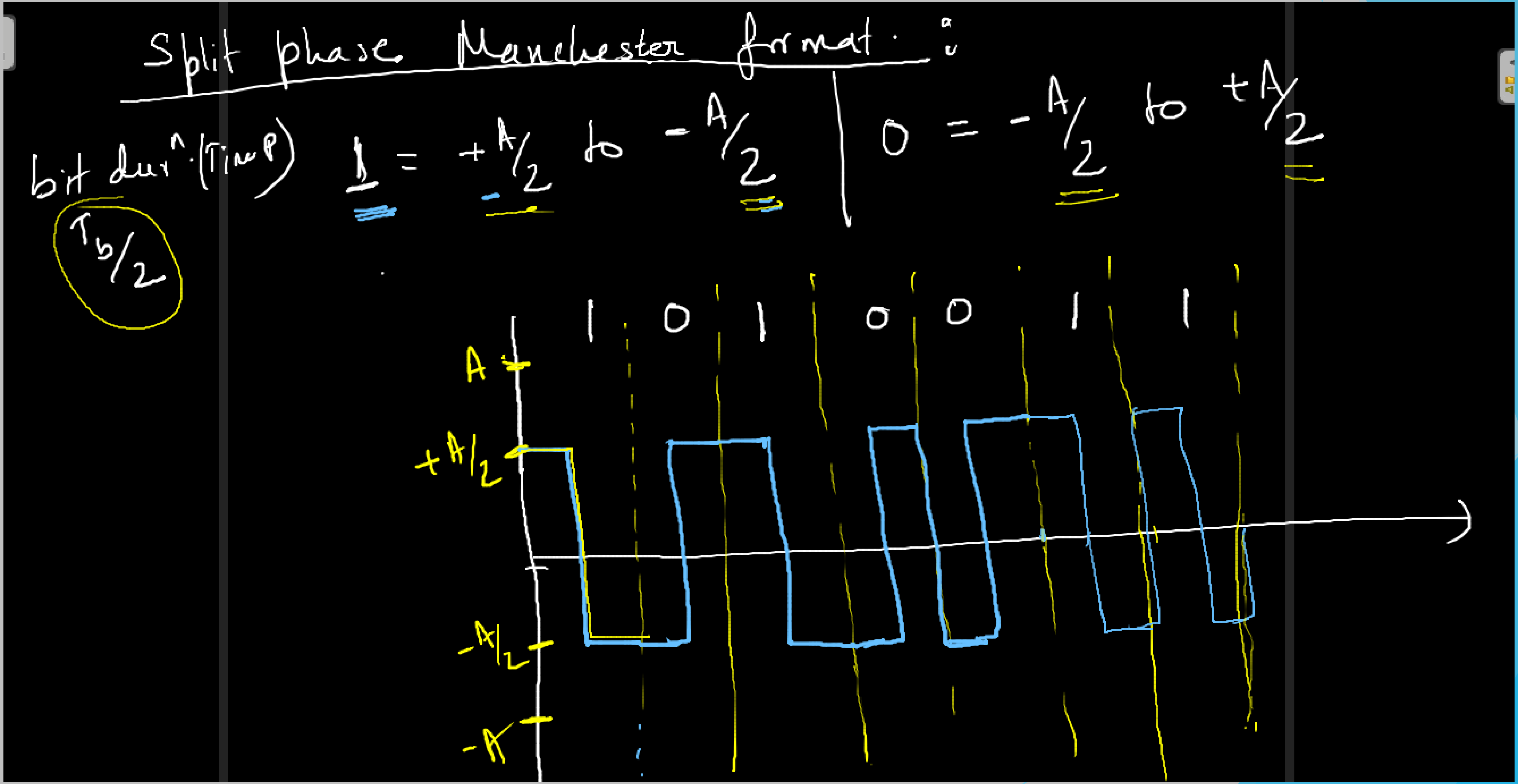
Line Encoding: Polar Manchester



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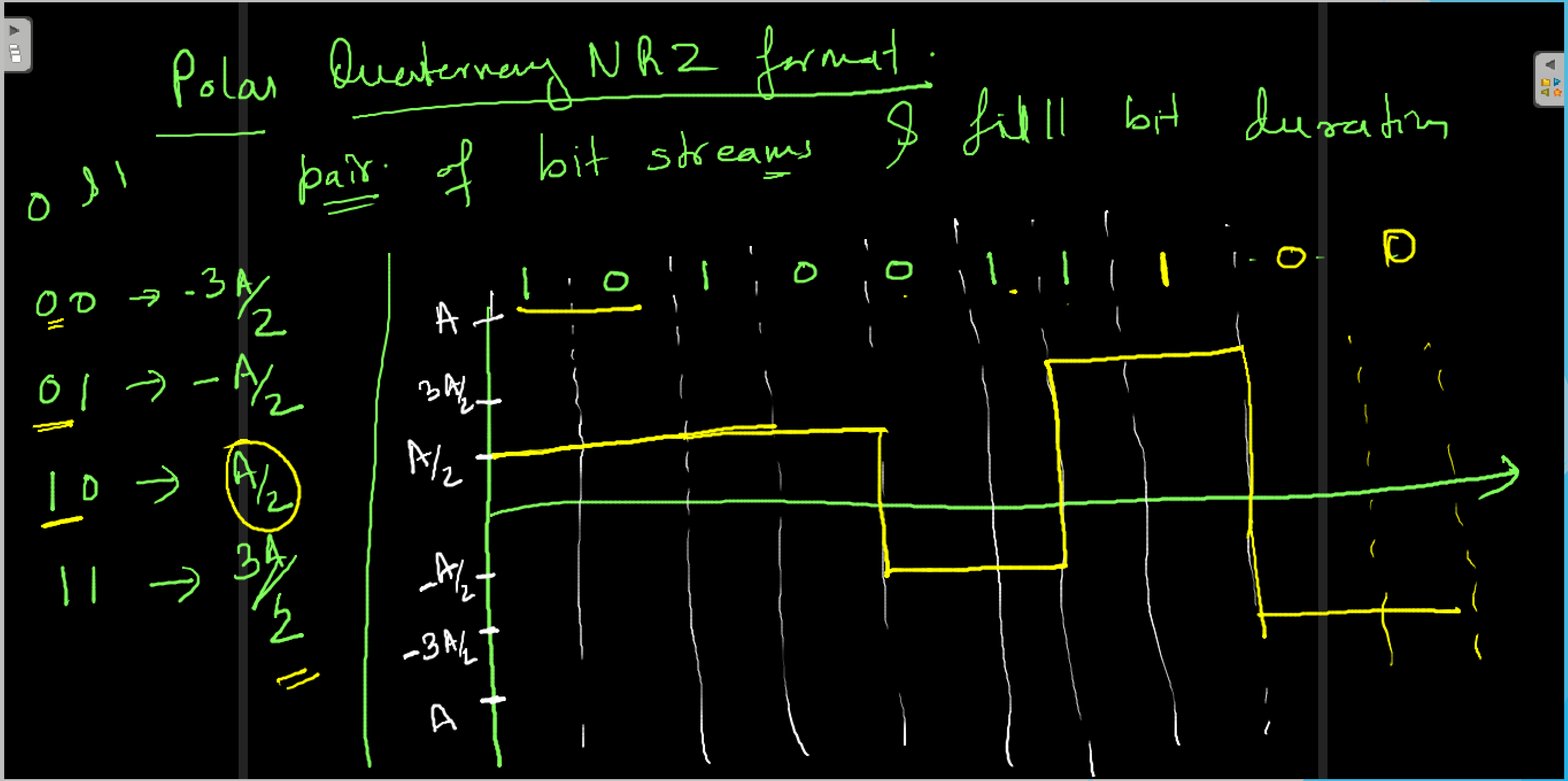
Line Encoding: Polar Quaternary NRZ



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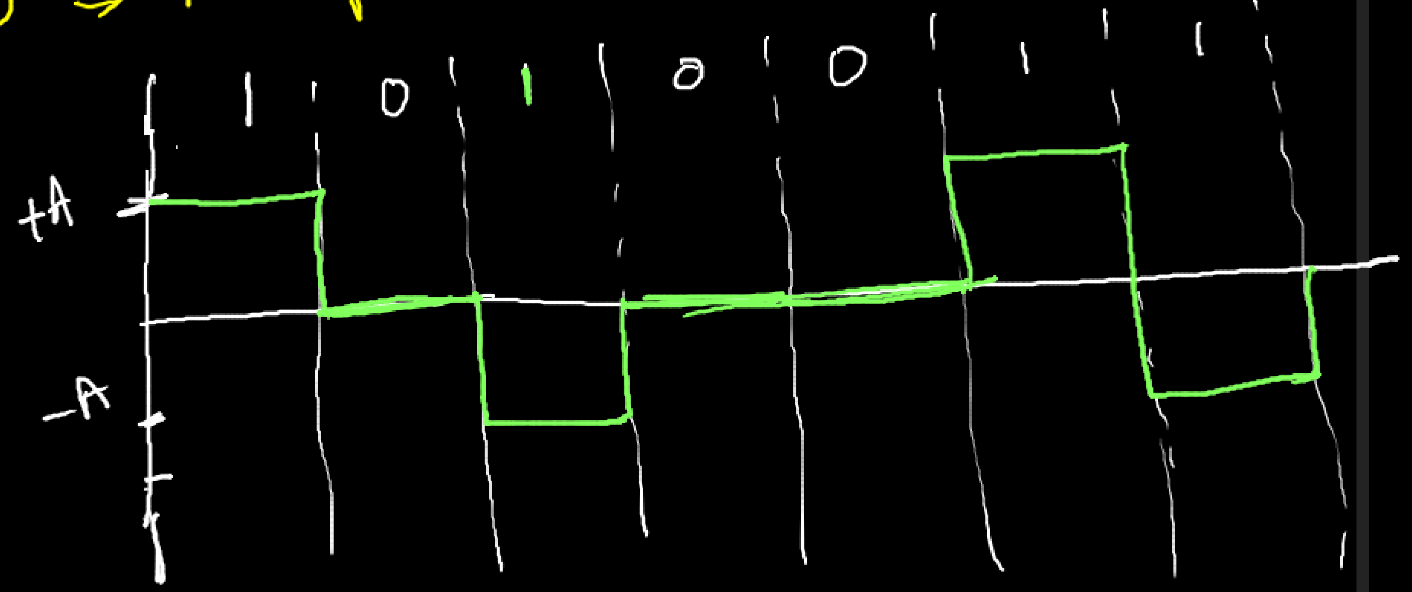
Line Encoding: Bipolar NRZ

✓ Bipolar NRZ format — (+A) & (-A)

for 1 ⇒ Successive 1's are represented by pulses with
= alternating polarity, } full bit duration.

for 0 ⇒ no pulse transmitted.



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