Data Communication BLM3051

Furkan ÇAKMAK

Lecture Information Form - Weekly Subjects

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Communication

Week 3

Week	Date	Subjects
1	04.10.2021	Introduction to Data Communication Standards Used on Data Communication, Architectural models
2	11.10.2021	OSI Reference Model , Layers and Their Functions
3	18.10.2021	Signaling and Signal Encoding
4	25.10.2021	Parallel and Serial Transmission, Communication Media and Their Technical Specs., Multiplexing (TDM, FDM)
5	01.11.2021	Error Detection and Error Correction Techniques
6	08.11.2021	Data Link Control Techniques, Flow Control
7	15.11.2021	Asynchronous and Synchronous Data Link Protocols (BSC, HDLC)
8	22.11.2021	Ara Sınav
9	29.11.2021	Synchronous and Asynchronous Data Link Protocols
10	06.12.2021	LAN Technologies Continued, IEEE 802.4, 802.5, 802.11
11	13.12.2021	Connectionless and Connection Oriented Services, Switching
12	20.12.2021	Wide Area Networking Technologies (X.25, ISDN, FR, ATM, xDSL.)
13	27.12.2021	Communications Equipment's, TCP/IP Model, Security Issues
14	03.01.2022	Research Presentation 1

OSI Reference Model - Reminding

7	Application Layer
6	Presentation Layer
5	Session Layer
4	Transport Layer
3	Network Layer
2	Data Link Layer
1	Physical Layer

Signals

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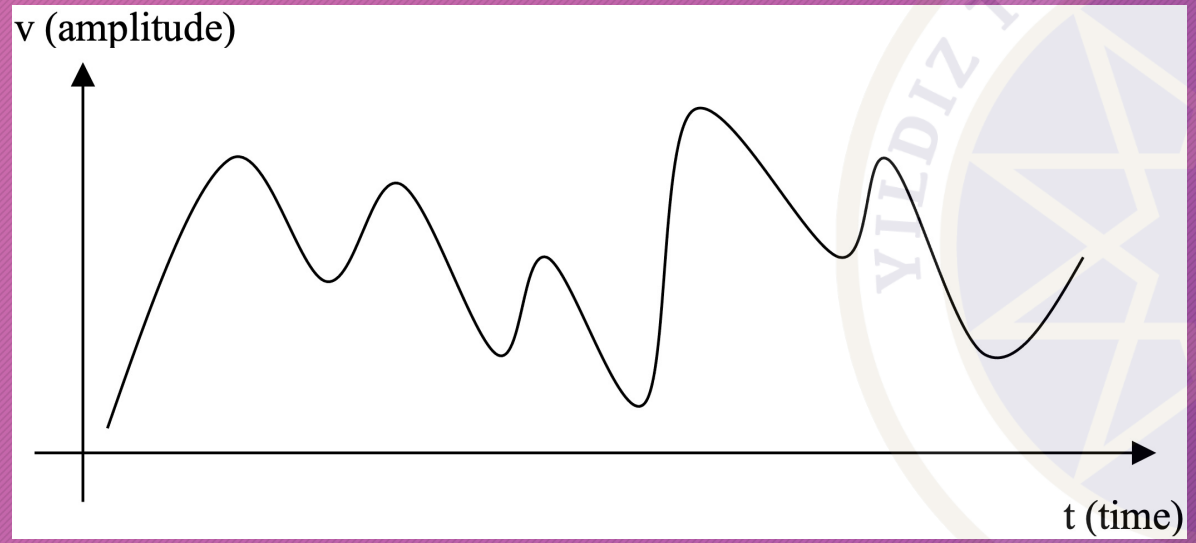
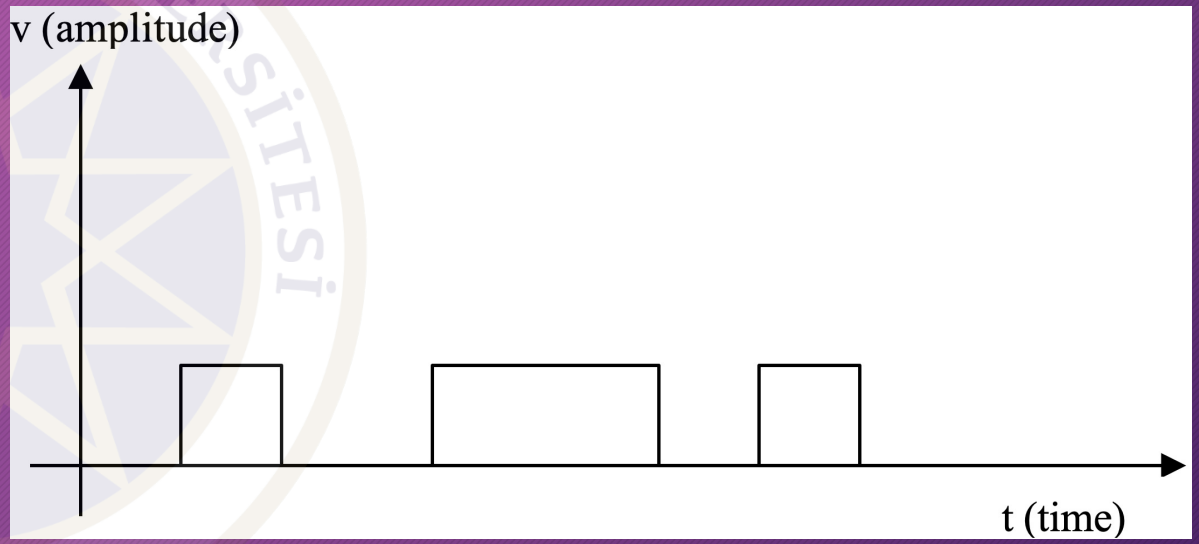
Continious - Analog

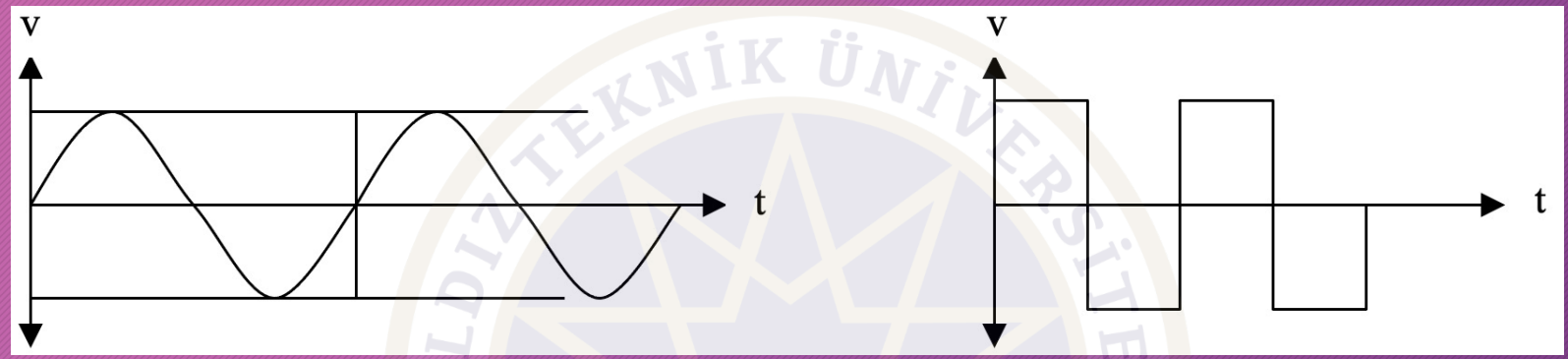


Discrete - Digital

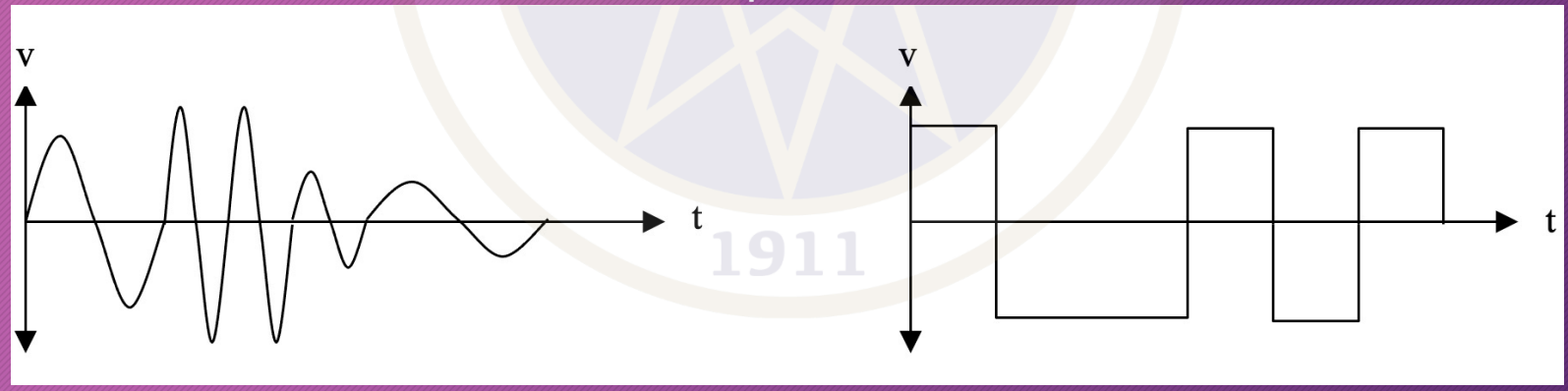


Signals – Con’t

Periodic



Non-periodic



Analog Signals

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Simple Analog Signals

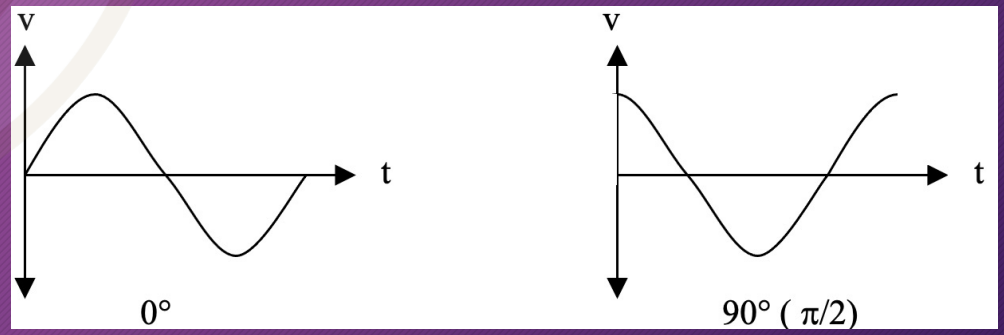
$$f(t) = A\sin(2\pi ft + \phi)$$

Complex Analogue Signals

$$f(t) = \sum_{n=1,3,5..}^{\infty} \frac{1}{n}\sin(2\pi nft)$$

- v – Amplitude
  - Volt - V
  - Amper - A
  - Watt-W
- f – Frequency
  - Cycle
  - Hertz - Hz
- ϕ - Phase
  - Degree - °
  - Radian - π

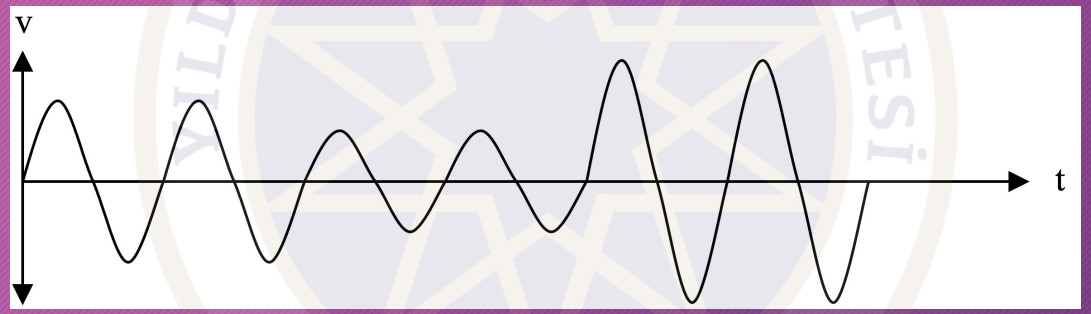
Frequency	Time
Hz	sec (second)
KHz	msec (milli second)
MHz	µsec (micro second)
GHz	nsec (nano second)
THz	psec (pico second)



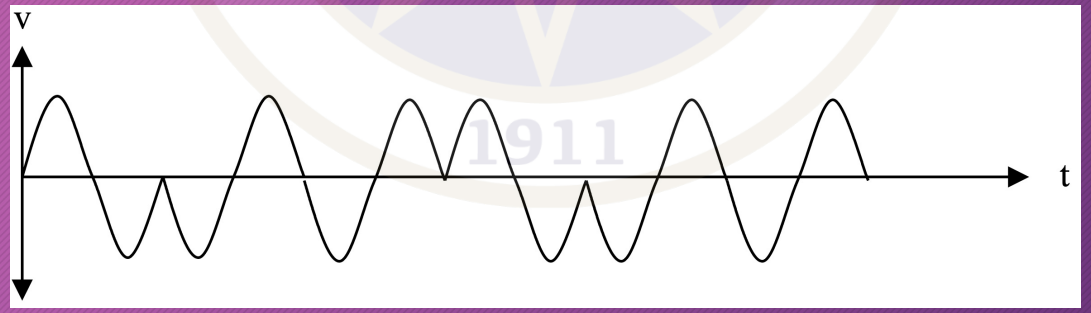
Analog Signals – Con’t

Frequency Change

Amplitude Change

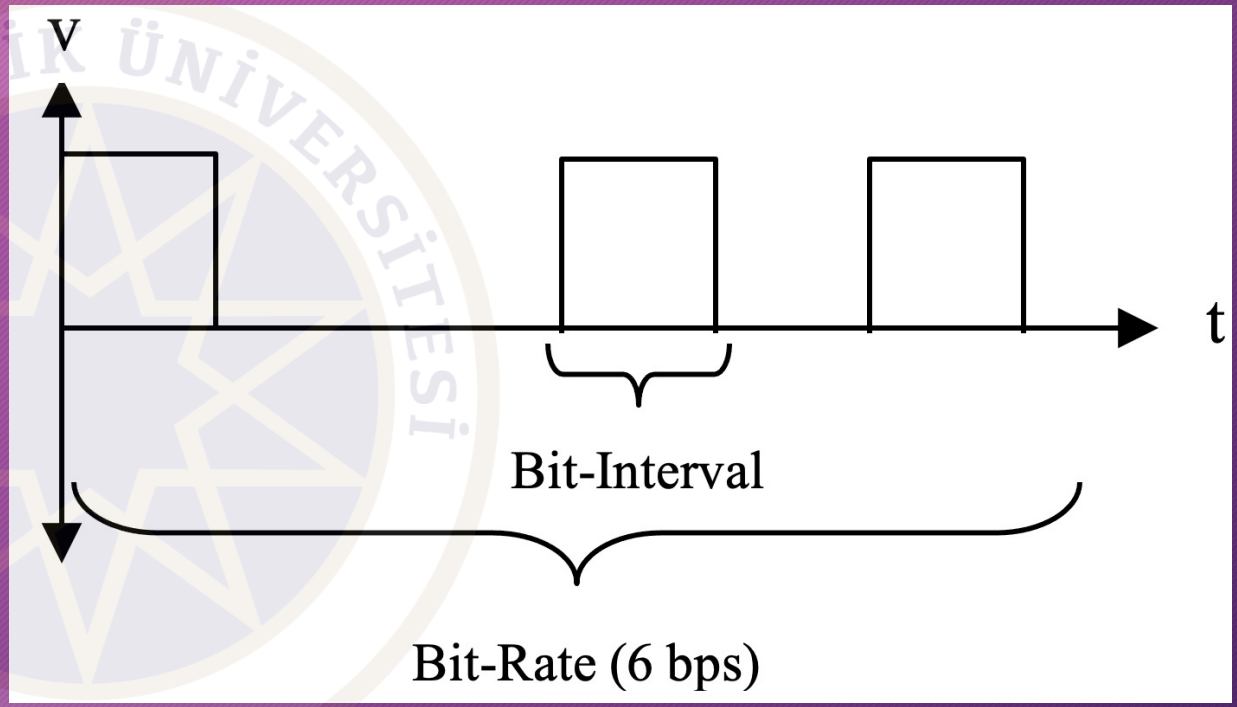


Phase Change



Digital Signals

- Non-periodic
- Bit-rate
  - The number of bits transferred in one second
- Bit-interval
  - The time it takes to transmit one bit (in seconds)



Elements that Negatively Affect Communication

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- Distortion
  - Attenuation
    - dB
    - Solution: Amplifying
      - Analog?
  - Noise
    - Even Idle mode
    - Thermal noise
      - Motion of atomic fragments
    - Impulse noise
      - Random electromagnetic signal
  - Cross talk
  - Delay
  - Propagation: Velocity of a sinusoidal signal in a transmission line

Data Carrying Capacity

- **Nyquist Theorem**
  - The amount of data that can be sent per unit time
  - H: Band width
  - V: Number of discrete voltages
  - Not consider the noise

$$data_{vel} = 2Hlog_2V \ \ bit/sec$$

- Noise (dB)
  - Signal strength (sent): S
  - Strength of the current noise: N

$$SNR = 10log_{10}\frac{S}{N} \ \ dB$$

Data Carrying Capacity – Con't

- Shannon-Hartley
  - Data velocity with noise

$$data_{vel} = Hlog_2(1 + \frac{S}{N})\ bit/sec$$

- First, the highest data rate to be achieved is found according to the Shannon-Hartley formula.
- Then, according to the Nyquist formula, how many discrete voltage levels can be used in this bandwidth is determined.

Example

- Since it is known that the SNR of a transmission channel between 3KHz-4KHz is [redacted] maximum rate that can be obtained and the numb[redacted] that can be used for transmission?

Coding of Signals

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- Digital – Digital
  - Computer – Printer
- Analog – Digital
  - Microphone – Computer
- Digital – Analog
  - Computer – Communication Lines
- Analog – Analog
  - Radio – Radio Signal Lines

Digital – Digital Coding

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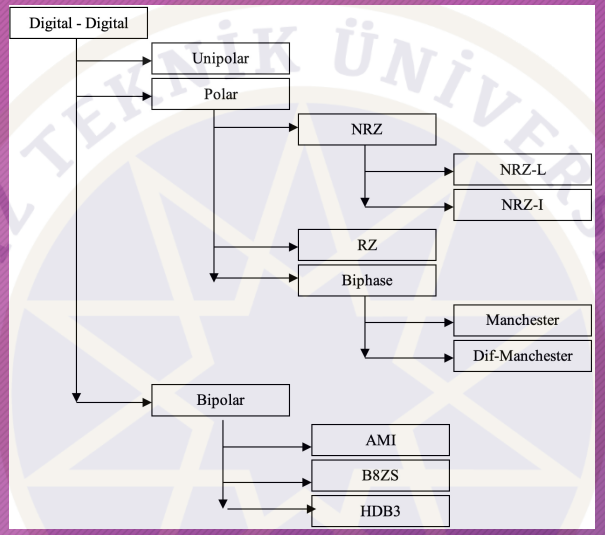
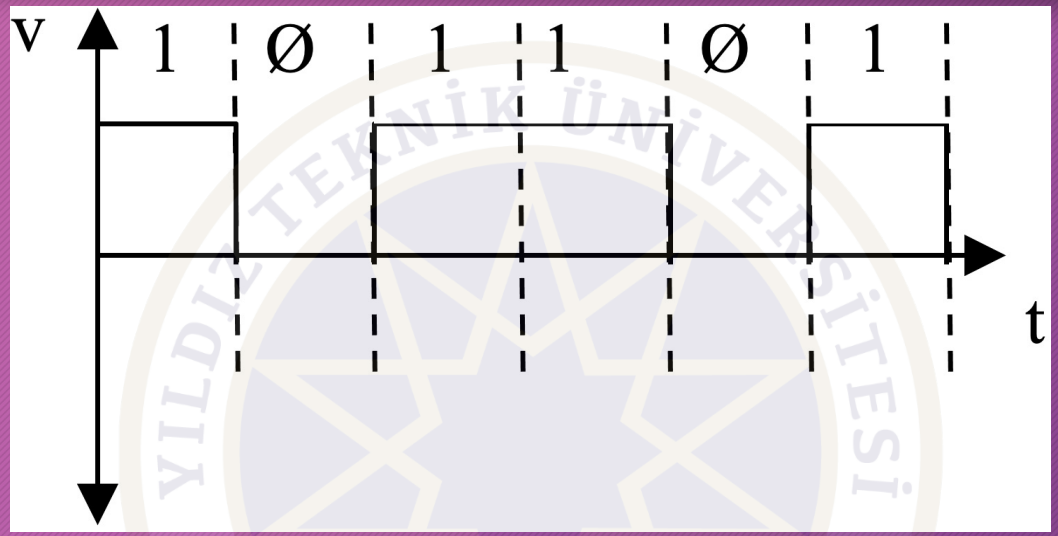
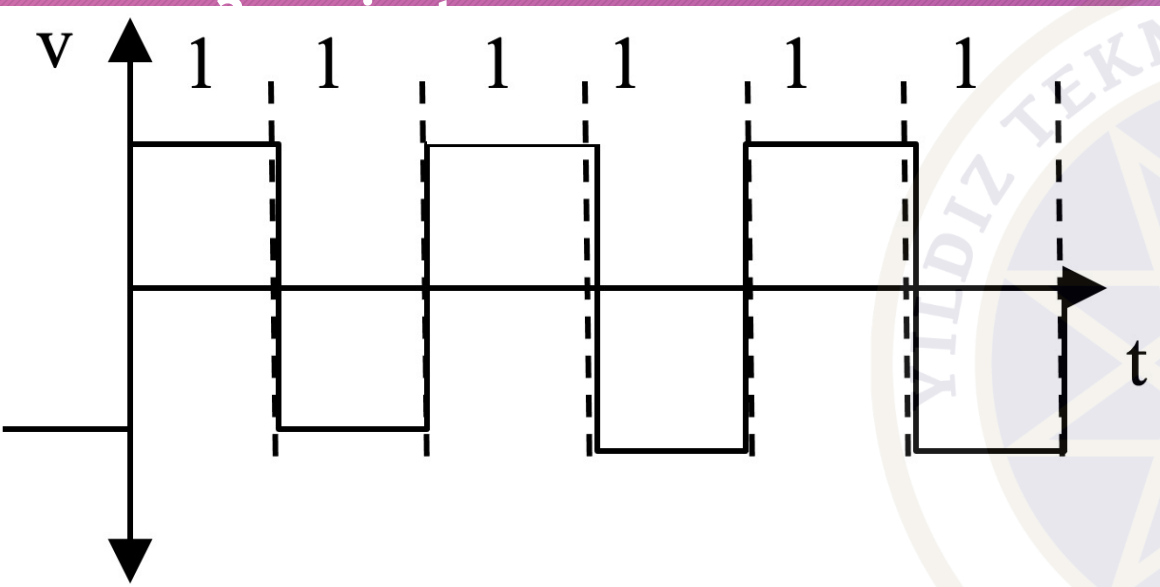


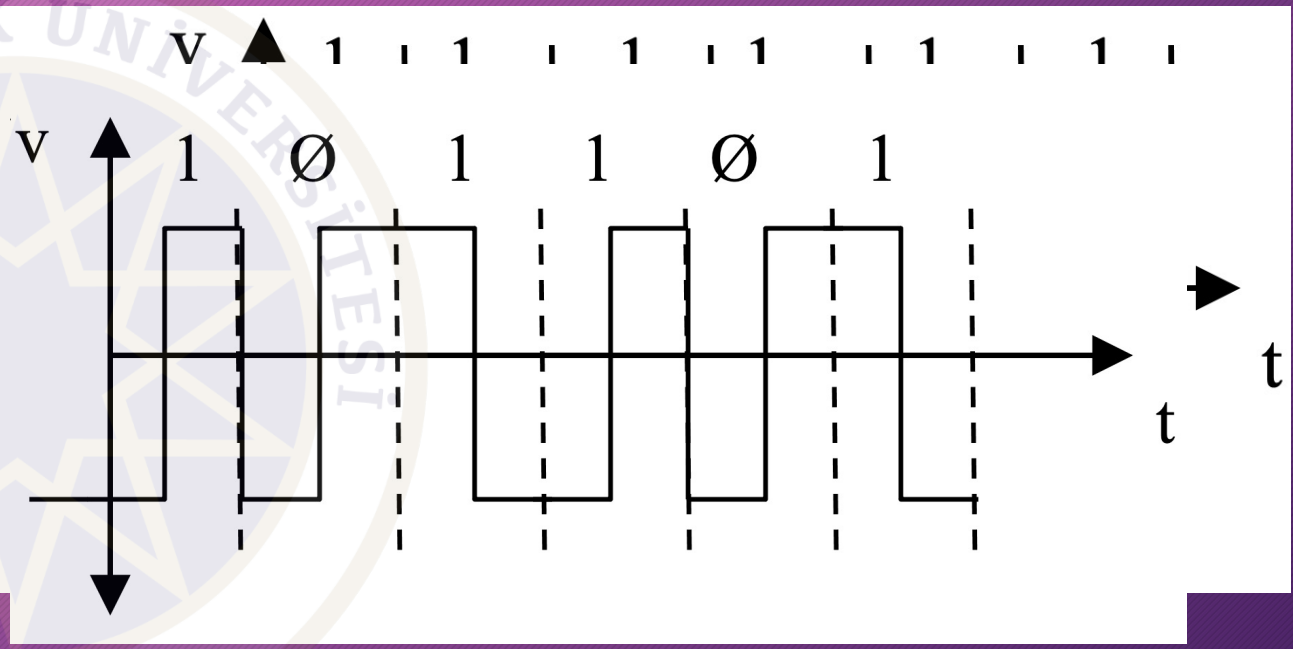
Digital2Digital – Unipolar Coding



- 2 main problems;
  - DC Component
  - Synchronization

Digital2Digital – Polar Coding





+	Ø	Ø	Ø	Ø

→

+	Ø	Ø	Ø	+

If the number of 1s transferred after the last conversion is odd

-	Ø	Ø	Ø	Ø

→

-	Ø	Ø	Ø	-

+	Ø	Ø	Ø	Ø

→

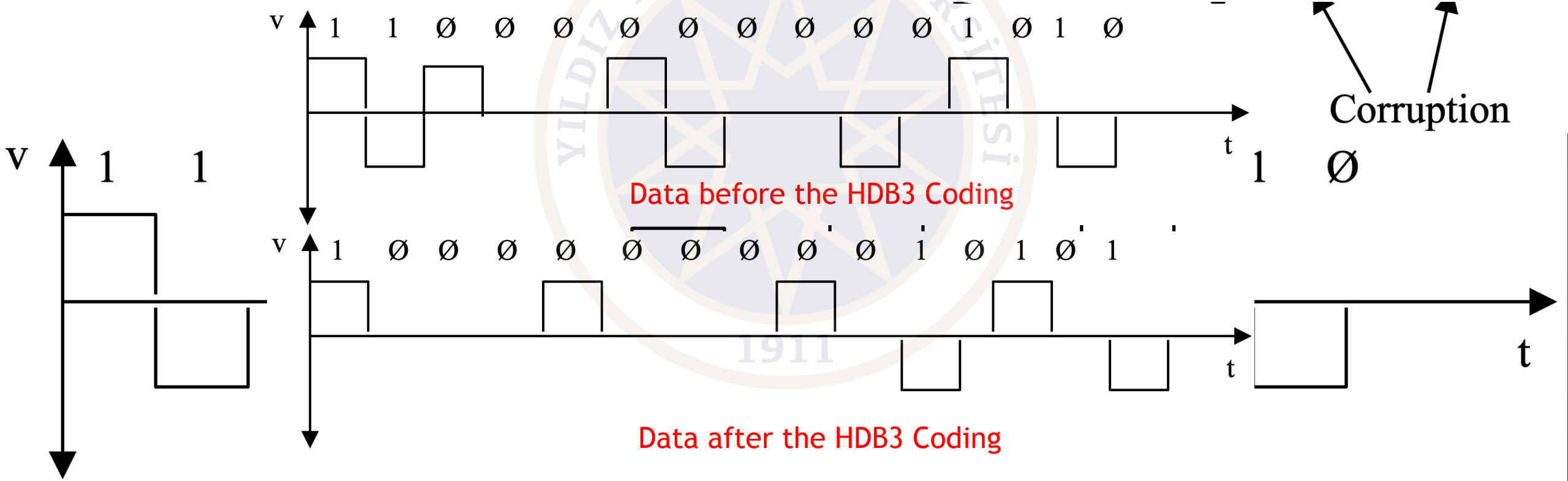
+	-	Ø	Ø	-

If the number of 1s transferred after the last conversion is even

-	Ø	Ø	Ø	Ø

→

-	+	Ø	Ø	+



Analog – Digital Coding

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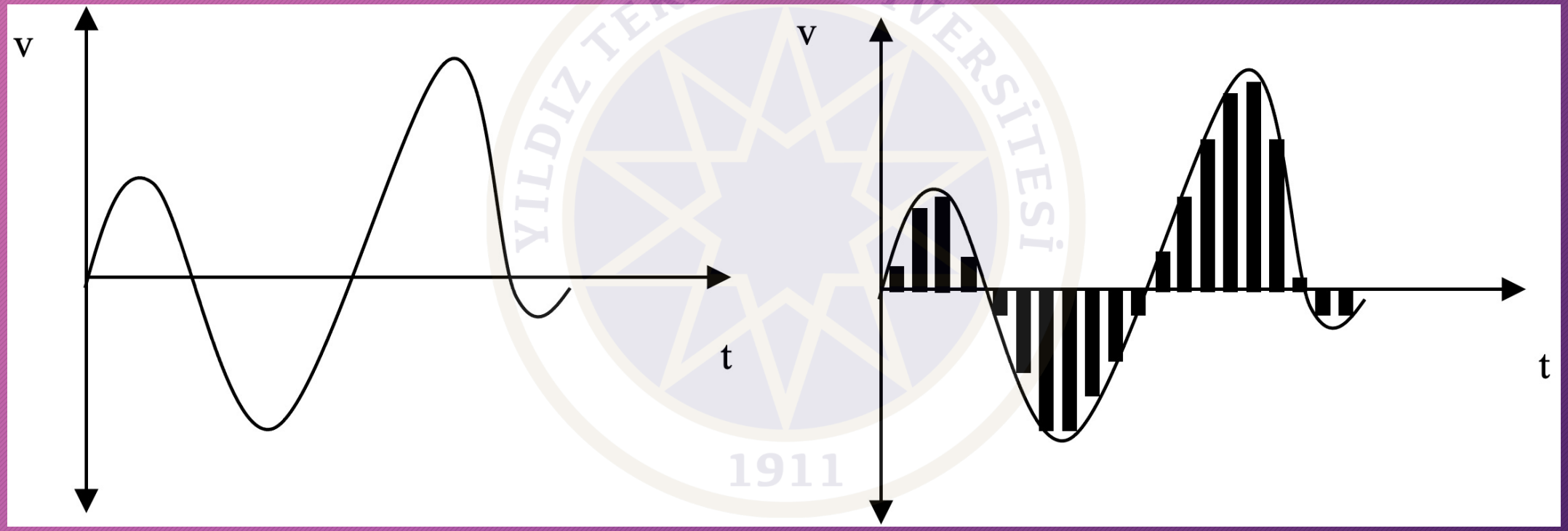
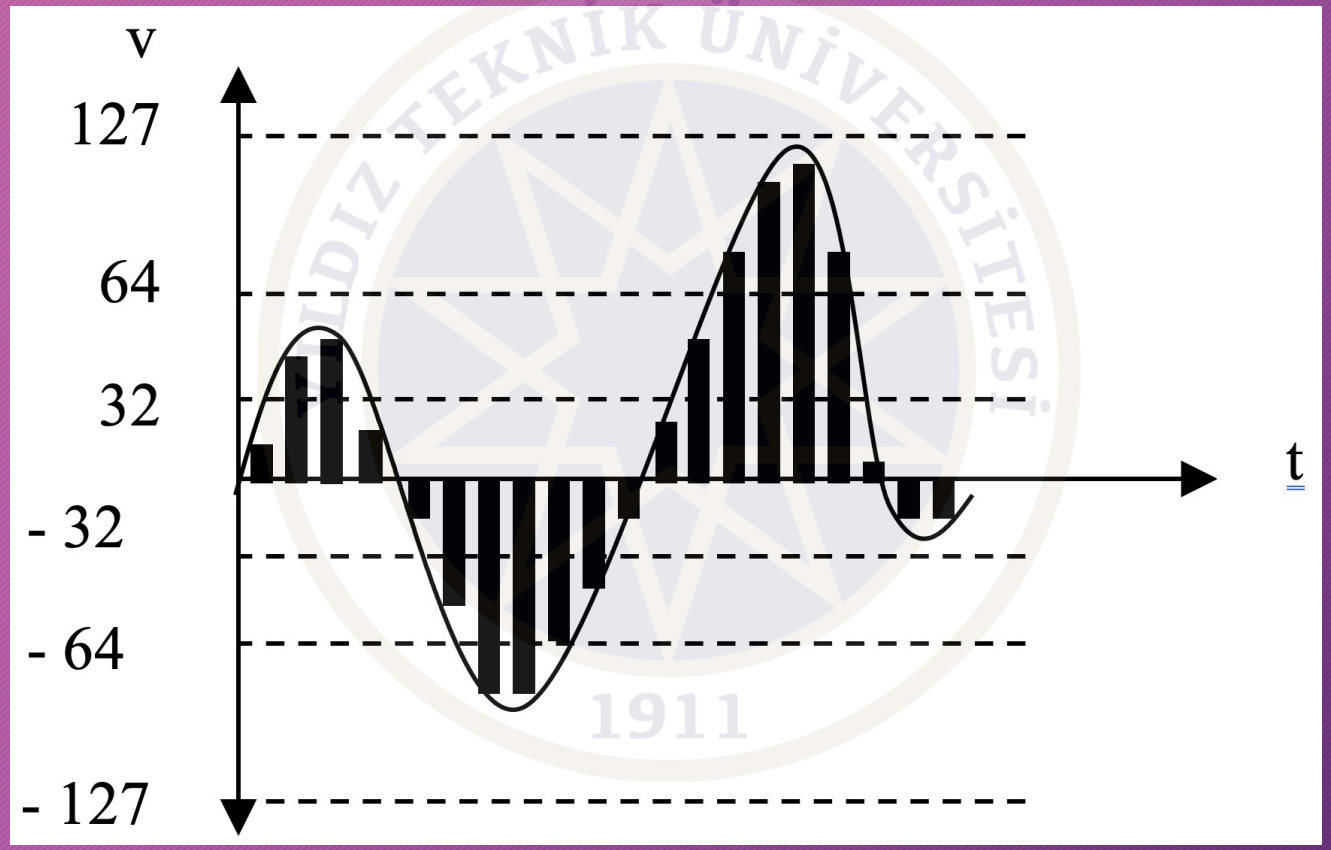
PAM (Pulse Amplitude Modulation)



Analog – Digital Coding – Con't

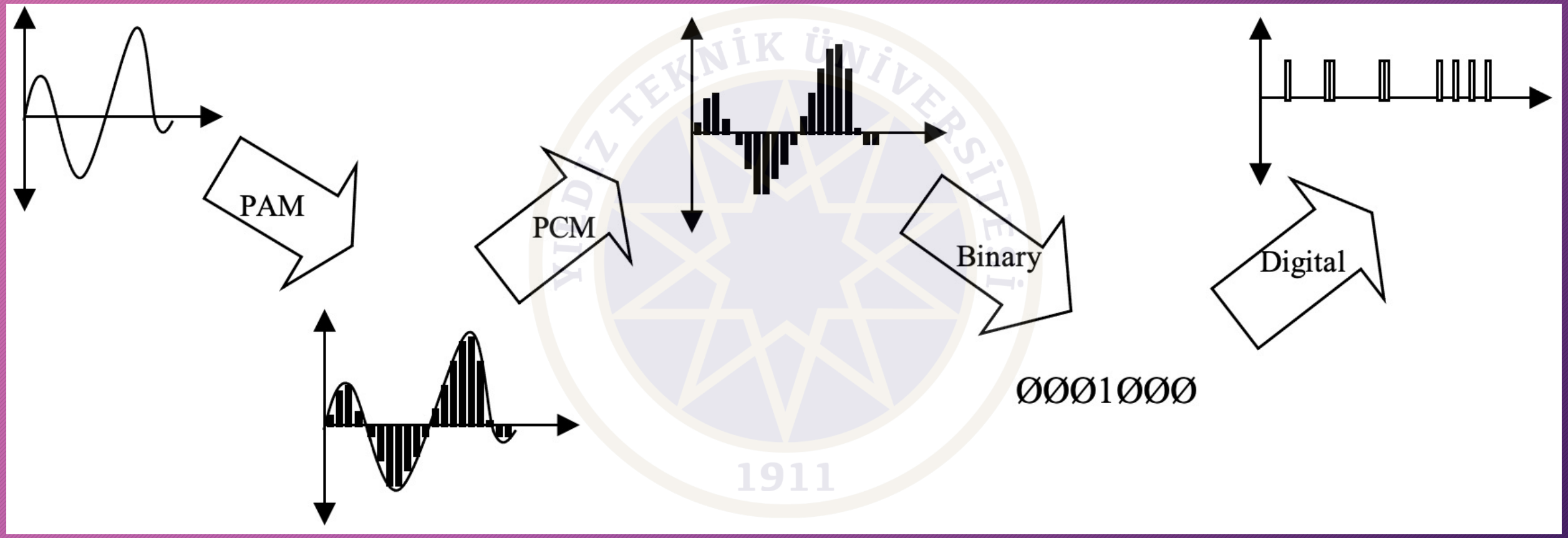
PCM (Pulse Code Modulation)



Analog – Digital Coding - Nyquist Theorem

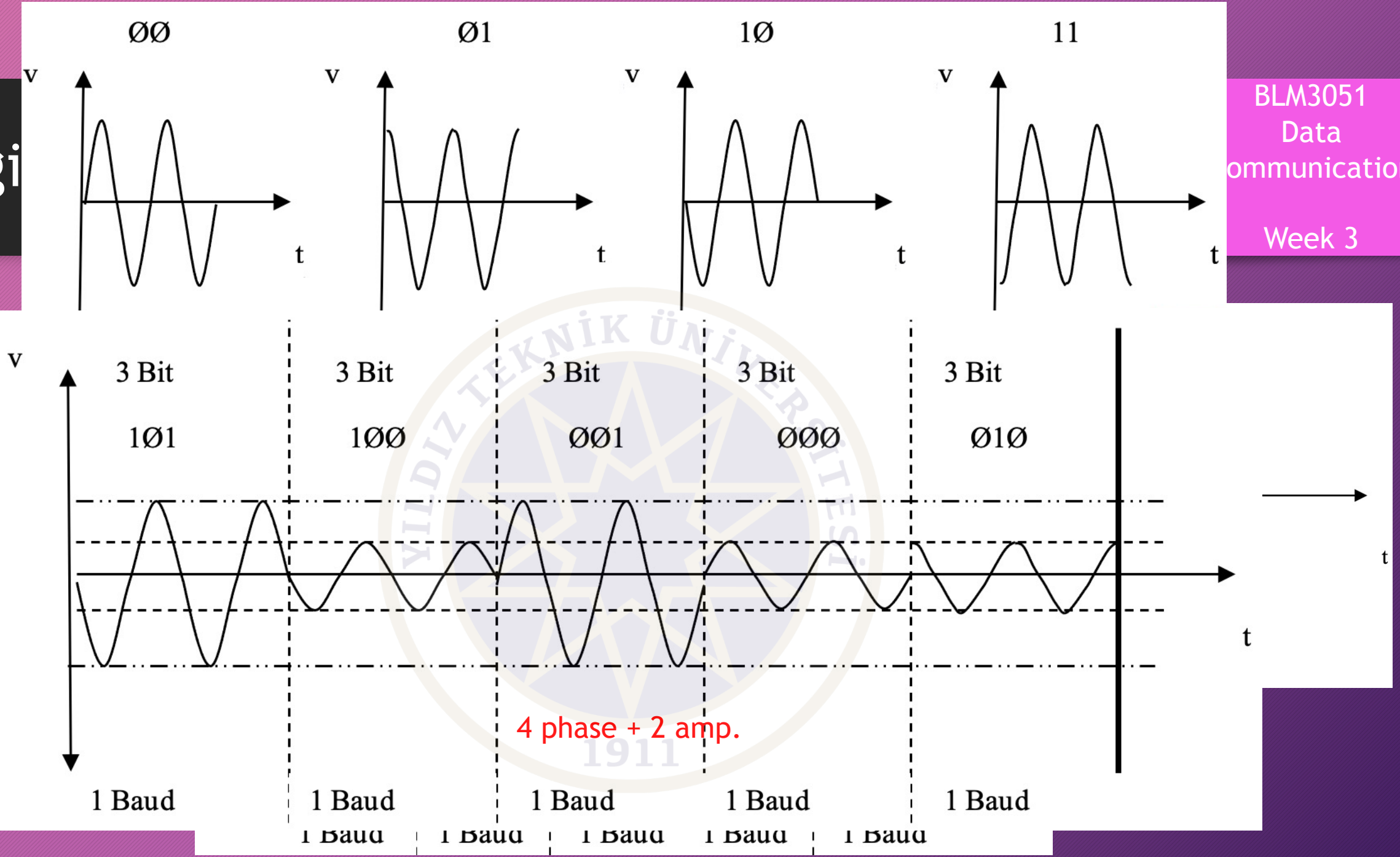
- Sampling at least twice the highest frequency component is required
- Example:
  - If bandwith is 1000-4000Hz, sampling fre. must be 8000

Transmission of the Analog Signal over the Digital Network



Digi

- AS
- FS
- PS
  -
- QA
  Mo
  -



Analog – Digital Coding - Concepts

- **Carrier Signal**
- Bit and Baud Speed
  - Bit Speed ≥ Baud Speed

Coding Technique	Unit	Baud Speed	Bit Speed	Bits / Baud
ASK, FSK, 2PSK	Bit	N	N	1
4PSK, 4QAM	Dibit	N	2N	2
8PSK, 8QAM	Tribit	N	3N	3
16QAM	Quadbit	N	4N	4
32QAM	Pentabit	N	5N	5
64QAM	Hexabit	N	6N	6
128QAM	Septabit	N	7N	7
256QAM	Octabit	N	8N	8

Analog – Analog Coding

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- AM (Amplitude Modulation)
- FM (Frequency Modulation)
- PM (Phase Modulation)

Thank you for your listening.

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