

# Data Communication BLM3051



Furkan ÇAKMAK

1

## Lecture Information Form - Weekly Subjects

BLM3051  
Data  
Communication  
Week 3

Week	Date	Subjects
1	04.10.2022	Introduction to Data Communication Standards Used on Data Communication, Architectural models
2	11.10.2022	OSI Reference Model , Layers and Their Functions
3	18.10.2022	Signaling and Signal Encoding
4	25.10.2022	Parallel and Serial Transmission, Communication Media and Their Technical Specs., Multiplexing (TDM, FDM)
5	01.11.2022	Error Detection and Error Correction Techniques
6	08.11.2022	Data Link Control Techniques, Flow Control
7	15.11.2022	Asynchronous and Synchronous Data Link Protocols (BSC, HDLC)
8	22.11.2022	1. Vize Haftası
9	29.11.2022	LAN Technologies Continued, IEEE 802.4, 802.5, 802.11
10	06.12.2022	Connectionless and Connection Oriented Services, Switching
11	13.12.2022	Wide Area Networking Technologies (X.25, ISDN, FR, ATM, xDSL.)
12	20.12.2022	Communications Equipment's, TCP/IP Model, Security Issues
13	27.12.2022	Research Presentation 1
14	03.01.2022	Research Presentation 2

Furkan ÇAKMAK

2

## OSI Reference Model - Reminding

BLM3051  
Data  
Communication  
Week 3

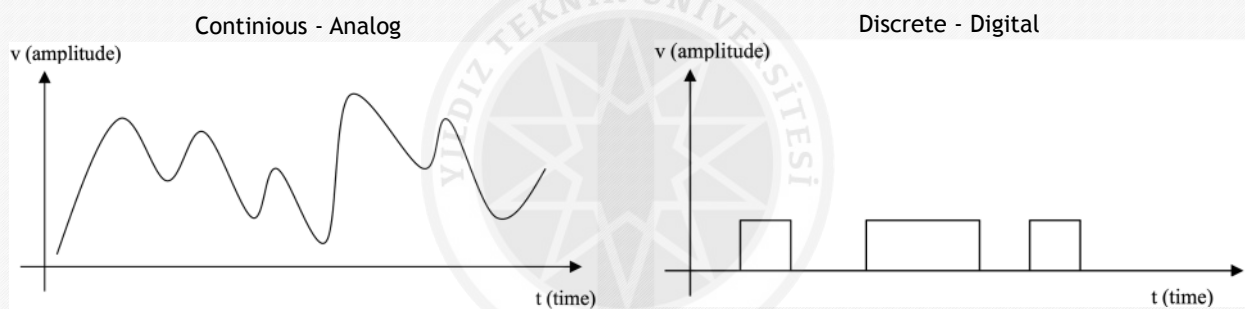
7	Application Layer
6	Presentation Layer
5	Session Layer
4	Transport Layer
3	Network Layer
2	Data Link Layer
1	Physical Layer

Furkan Çakmak

3

## Signals

BLM3051  
Data  
Communication  
Week 3



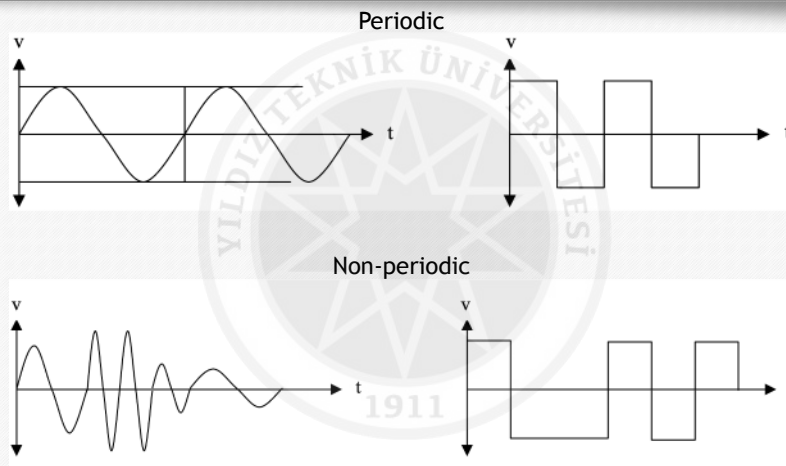
Furkan Çakmak

4

## Signals - Con't

BLM3051  
Data  
Communication

Week 3



Furkan Çakmak

5

## Analog Signals

BLM3051  
Data  
Communication

Week 3

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

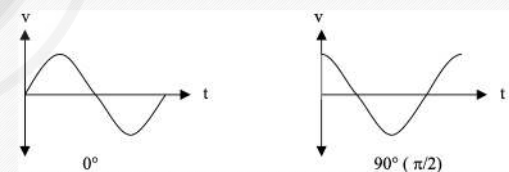
• f - Frequency

- Cycle
- Hertz - Hz

•  $\phi$  - Phase

- Degree - °
- Radian -  $\pi$

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

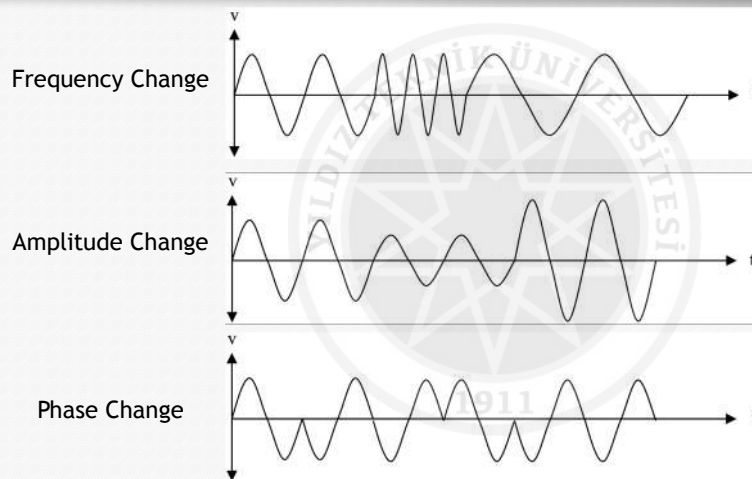


Furkan Çakmak

6

## Analog Signals - Con't

BLM3051  
Data  
Communication  
Week 3



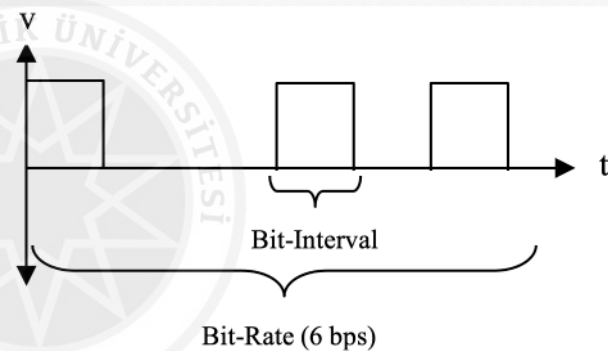
Furkan Çakmak

7

## Digital Signals

BLM3051  
Data  
Communication  
Week 3

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



Furkan Çakmak

8

## Elements that Negatively Affect Communication

BLM3051  
Data  
Communication  
Week 3

- 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

Furkan Çakmak

9

## Data Carrying Capacity

BLM3051  
Data  
Communication  
Week 3

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

$$data_{vel} = 2H \log_2 V \text{ bit/sec}$$

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

Furkan Çakmak

10

## Data Carrying Capacity - Con't

BLM3051  
Data  
Communication  
Week 3

- **Shannon-Hartley**
  - Data velocity with noise

$$data_{vel} = H \log_2 \left( 1 + \frac{S}{N} \right) \text{ bit/sec}$$

- 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.

Furkan Çakmak

11

## Example

BLM3051  
Data  
Communication  
Week 3

- Since it is known that the SNR value on a transmission channel between 3KHz-4KHz is 24dB, what is the maximum rate that can be obtained and the number of discrete levels that can be used for transmission?

$$data_{vel} = 2H \log_2 V \text{ bit/sec}$$

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

$$data_{vel} = H \log_2 \left( 1 + \frac{S}{N} \right) \text{ bit/sec}$$

$$10 \log_{10} \frac{S}{N} = 24 \text{ dB}$$

$$\frac{S}{N} = 10^{2.4} \cong 251$$

$$veri\_hizi = 1000 \log_2^{(1+251)} \text{ bit/sec} \cong 8000 \text{ bit/sec}$$

$$veri\_hizi = 8000 \text{ bit/sec} = 2 * 1000 \log_2^v \text{ bit/sec}$$

$$4 = \log_2^v$$

$$v = 2^4 = 16$$

Furkan Çakmak

12



## Coding of Signals

BLM3051  
Data  
Communication

Week 3

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

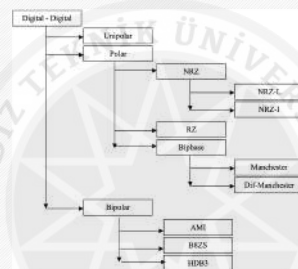
Furkan Çakmak

13

## Digital - Digital Coding

BLM3051  
Data  
Communication

Week 3



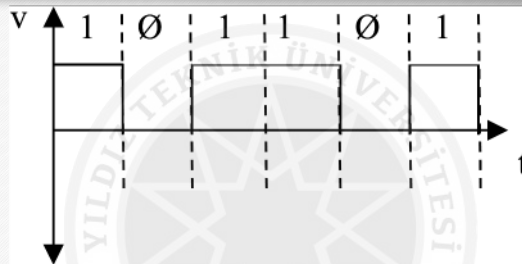
Furkan Çakmak

14

## Digital2Digital - Unipolar Coding

BLM3051  
Data  
Communication

Week 3



- 2 main problems;
  - DC Component
  - Synchronization

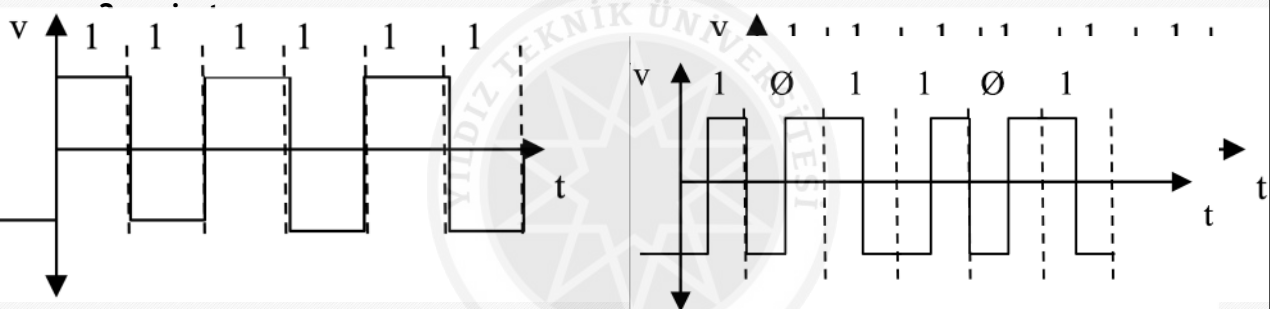
Furkan Çakmak

15

## Digital2Digital - Polar Coding

BLM3051  
Data  
Communication

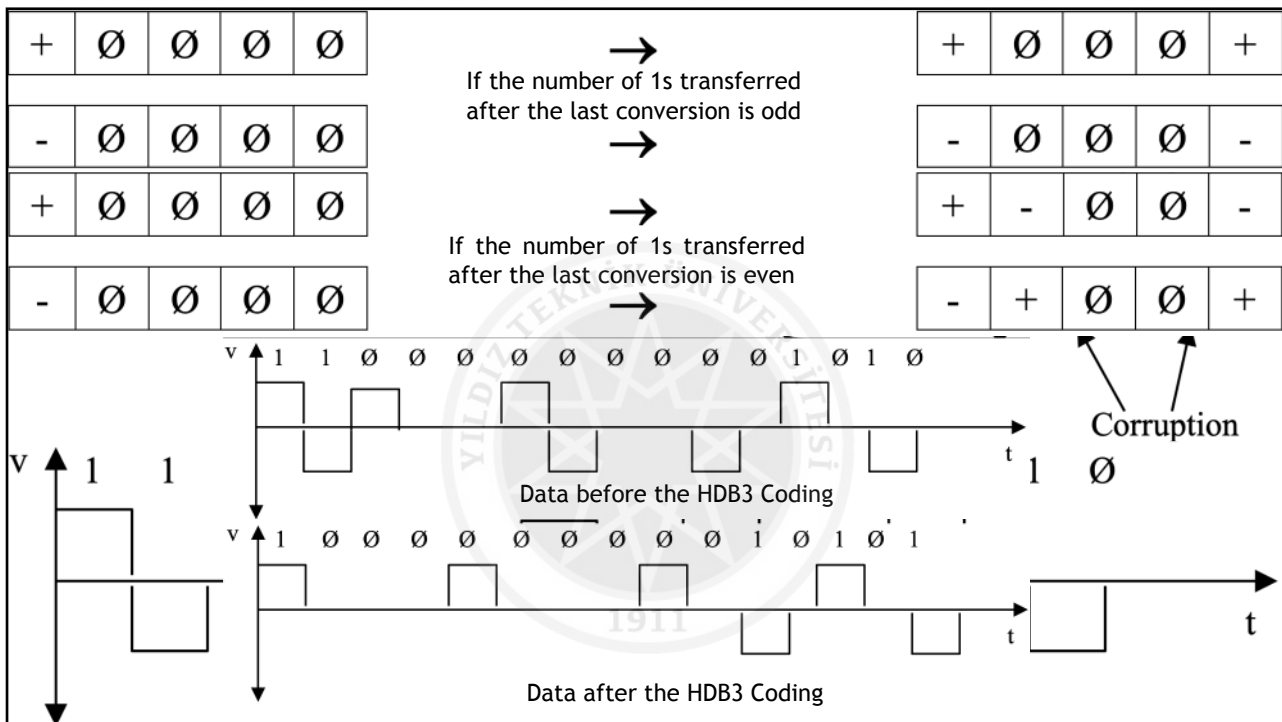
Week 3



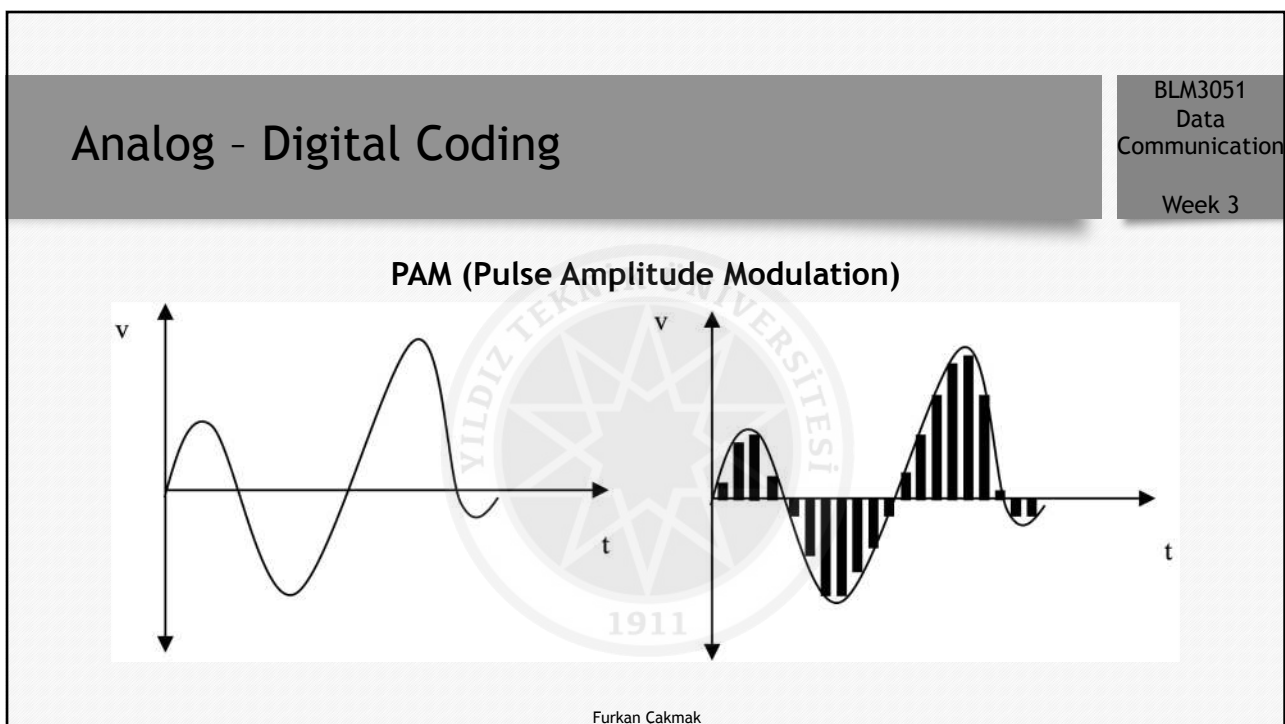
Furkan Çakmak

16





17

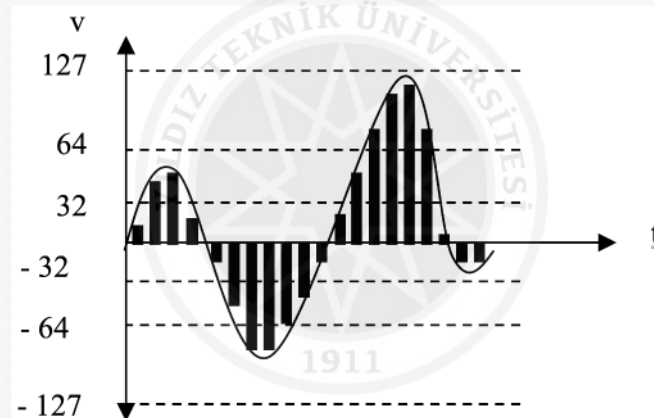


18

## Analog - Digital Coding - Con't

BLM3051  
Data  
Communication  
Week 3

### PCM (Pulse Code Modulation)



Furkan Çakmak

19

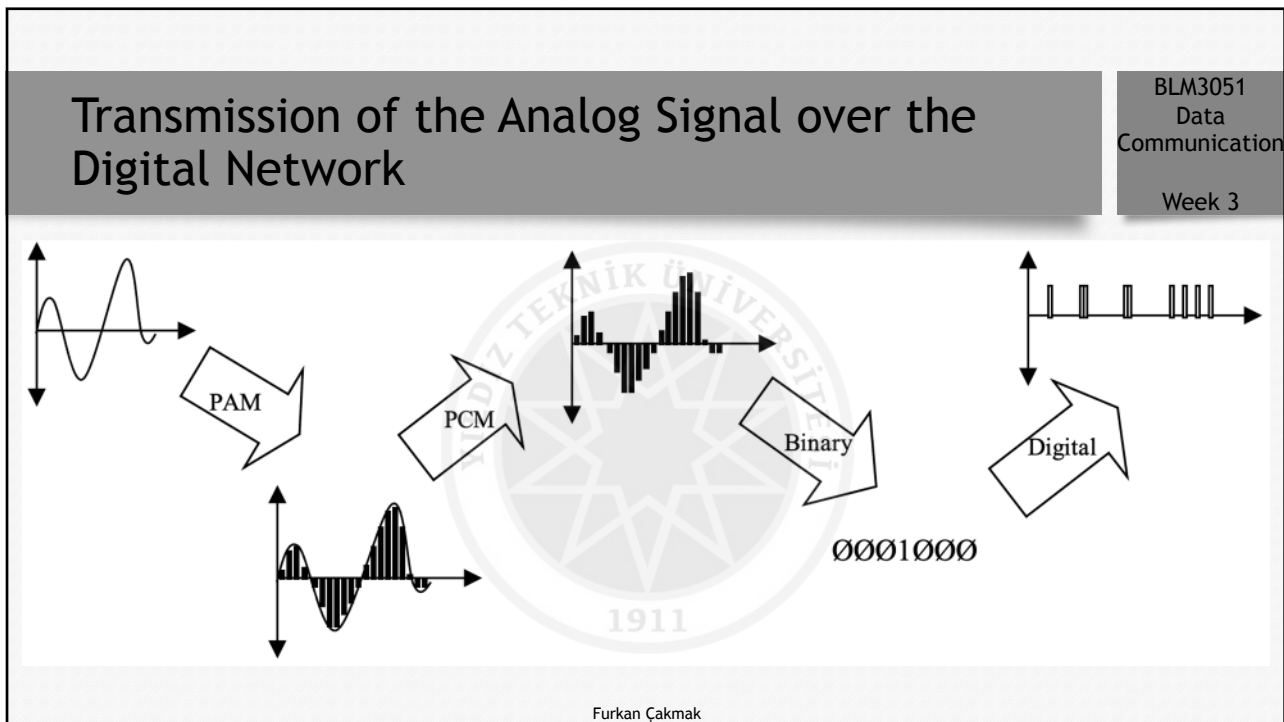
## Analog - Digital Coding - Nyquist Theorem

BLM3051  
Data  
Communication  
Week 3

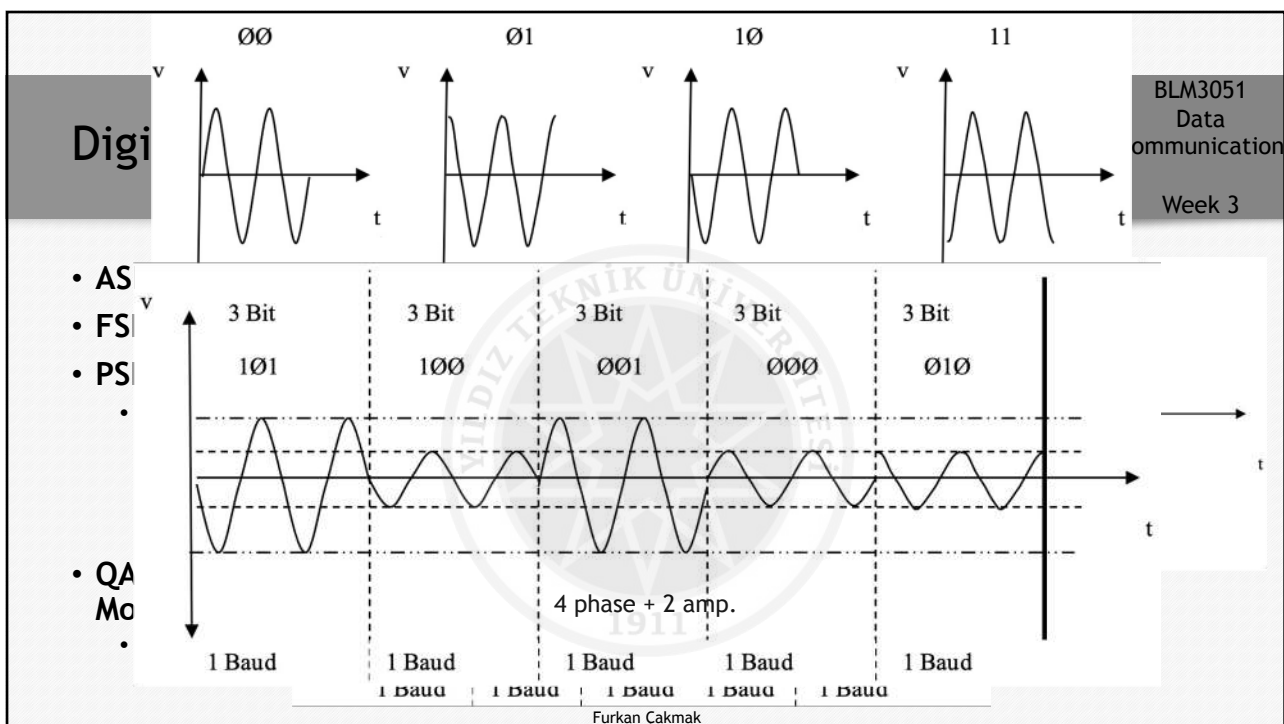
- Sampling at least twice the highest frequency component is required
- Example:
  - If bandwidth is 1000-4000Hz, sampling fre. must be 8000

Furkan Çakmak

20



21



22

## Analog - Digital Coding - Concepts

BLM3051  
Data  
Communication

Week 3

- Carrier Signal
- Bit and 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

Furkan Çakmak

23

## Analog - Analog Coding

BLM3051  
Data  
Communication

Week 3

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

Furkan Çakmak

24

Thank you for your listening.

BLM3051  
Data  
Communication  
Week 3



Furkan Çakmak