Lecture Notes on Communication Engineering

For 3rd Year

In Electrical Engineering Department

2023-2024

Chapter 1

Basic Definitions and Terms

Communication:

Conveying or transmission of information from one place and/or time to another.

Electrical communication system:

The system that uses electrical signals for the purpose of information transmission. It is reliable and economical communication technology for transmitting information for long distances. Typical electrical communication system shown in the figure (1.1). The function of each element is listed below:

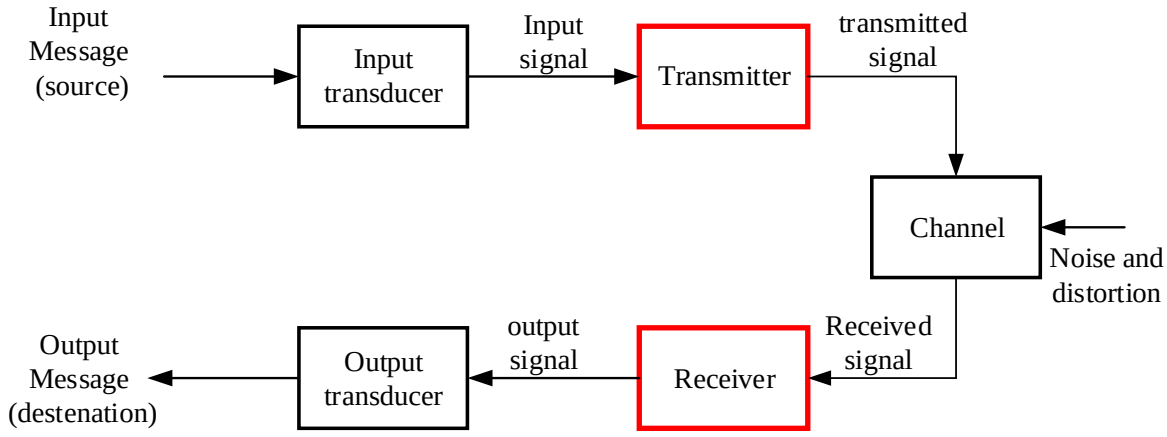


Figure (1.1)

Source: Originates the message (e.g. human voice, TV picture, teletype message or data).

Input transducer: Convert physical message into electrical signal called "baseband signal".

Transmitter: Modifies the baseband signal for efficient transmission.

Channel: Is medium such as wire, coaxial cable

Receiver: Reprocesses the signal from the channel by undoing the signal modifies made at the transmitter and the channel.

Output transducer: converts the electrical signal to its original form - the message.

Destination: the unit to which the message is communicated.

The transmission of information using electrical signals (current or voltage) performed by varying these signals with time (e.g. changing the amplitude, phase or frequency of a sinusoidal signal).

At the transmission channel, the transmitted signal suffering from:

1. Attenuation: increases as the length of channel increases.
2. Distortion: Caused by transmitting equipment and can be corrected at the receiver by an equalizer.
3. Interference: caused by some other existing signals.
4. Additive noise: Random and unpredictable electric signal generated naturally from cases external and internal.

Signal –to –Noise Ratio (SNR):

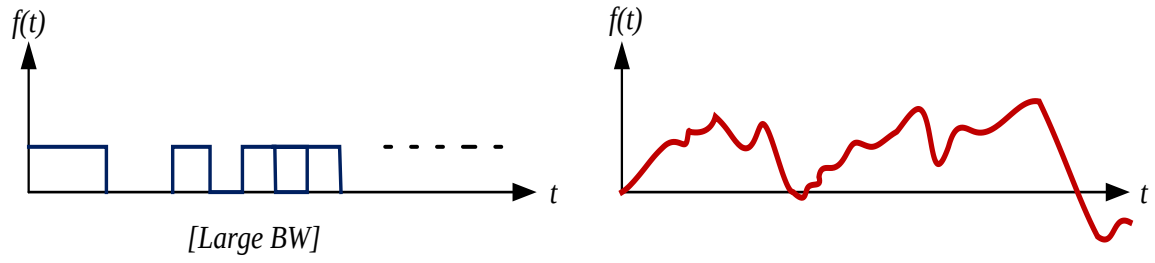
The ratio of the signal power (S) to the noise power (N);

$$SNR = \frac{S}{N} \qquad (1\text{-}1)$$

$$SNR(dB) = 10\ log_{10}(\frac{S}{N}) \qquad (1\text{-}2)$$

Analogue and Digital Messages:

1. Digital messages: Constructed with a finite number of symbols (e.g. 26 letters, binary information).
2. Analogue messages: characterized by data whose value varies over a continues range (e.g. the temperature, pressure speech).



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For the purpose of comparison, the digital message is easier to extract and high noise immunity than the analogue one.

Bandwidth (B): The range of frequencies that it can transmit with reasonable fidelity (e.g. from 0 Hz d.c. to 5 kHz) yields bandwidth = 5kHz.

$$W = 2\pi B \qquad (1\text{-}3)$$

Where W is the bandwidth (BW) in rad/sec, while B is the bandwidth in Hertz.

Basic transmitter components:

Encoder: choses the best form for the signal in order to optimize its detection at the input.

Modulator: produces a varying signal (carrier) proportional to the information signal.

Basic receiver components:

Demodulator: Performs the inverse operation of the modulator to recover the signal in its original form.

Decoder: performs the inverse operation pf the encoder to make the best decision that the message was indeed to send (see Fig. 1.2)

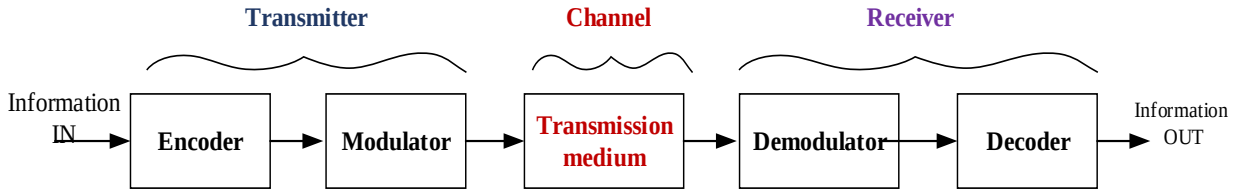

Figure 1.2

Transmission system Types:

1. One way transmission (Simplex SX):

   The flow of informatopn in this system is onley in on-way (i.e from Tx- to-Rx) see Figure 1.2.

2. Two way transmission (duplex DX):

   There are two types in such system, these are:

a) Half Duplex (HDX);

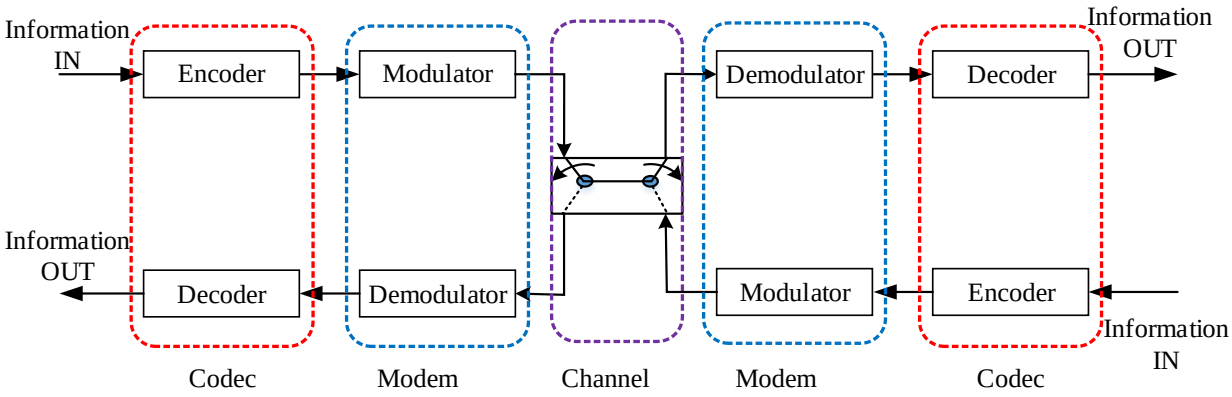

Fig 1.3

Here, although communications flows in both direction: the flow of information is only one-way at a given time.

b) Full duplex (FDX)

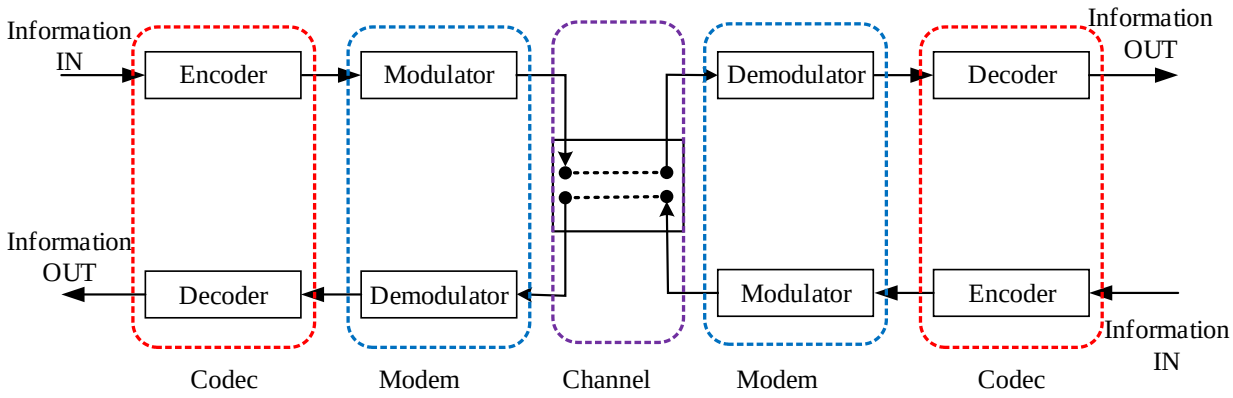

Fig. 4.1

Here, simultaneous communication is accomplished in both directions.

The items of the study in this book will be as follows:

1. Basic definition and terms.
2. Signal analysis.
3. Noise.
4. Linear Modulation- Amplitude Modulation (AM):
5. Angle modulation (FM & PM).
6. Pulse and digital communication.

Useful References:

1) Ferrell G. Stremler, "Introduction to Communication Systems", Edition Wesly publishing company, 1996.
2) B. P. Lathi, "Modern Digital and Analog Communication System", Rinehert and Winston, Inc 1998.
3) R. E. Ziemer and W.H. Tranter, "Principles of Communications", John Wiley and Sons, Inc., 1995.
4) Symon Haykin, "Communication Systems", John Wiley and Sons, Inc., 2001.
5) Hwie P. Hsu, "Analog and Digital Communications", (Schaum's outline Series", McGRAW-Hill International Edition, 1994.

Students Notes:

Chapter 2

Signal Analysis

The signal is that serves to start some action. In communication systems, the signal is an electrical voltage *v(t)* or current *i(t)*.

Signal classification

- A signal is said to be deterministic if it could be expressed mathematically as a function of time (e.g. $f(t)=\cos\omega t$), otherwise it is said to be random (e.g. noise).
- A signal is said to be periodic if it repeats itself after a fixed length of time (i.e. $f(t)=f(t+T)$) when $-\infty<t<\infty$), otherwise it is said to be non-periodic.
- A signal is said to be power, if it has a finite value of average power while it is said to be energy signal if it has a finite value of energy.

Signal power $$P_{av} = \frac{1}{T}\int_0^T |f(t)|^2 dt$$ watt (2-1)

Signal energy $$E = \int_{-\infty}^{\infty} |f(t)|^2 dt$$ joule (2-2)

At R =1 Ω.

Notes:

1. For a given value of resistance R.

$$P_{av} = \frac{1}{TR}\int_0^T |f(t)|^2 dt \ , \ E = \frac{1}{R}\int_{-\infty}^{\infty} |f(t)|^2 dt \ \text{... if f(t) is voltage}$$

$$P_{av} = \frac{R}{T}\int_0^T |f(t)|^2 dt \ , \ E = R\int_{-\infty}^{\infty} |f(t)|^2 dt \ \text{... if f(t) is current}$$