EE206 Communication Principles

Part A (Weeks 1-8)

Analog Communications

Part B (Weeks 9-16)

Digital Communications

Spring 2022

Key Contacts

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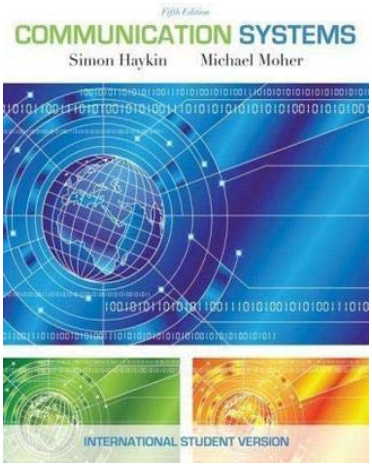
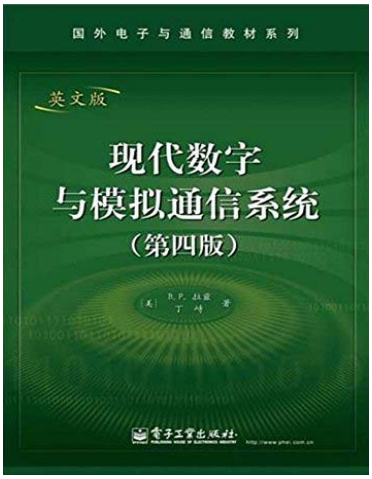
Reference Books

- Textbook
  - Simon Haykin and Michael Moher, *Communication Systems (International Student Version)*, 5th Edition, John Wiley & Sons, 2010
- Reference Book
  - B. P. Lathi and Zhi Ding, *Modern Digital and Analog Communication Systems*, 4th Edition, Oxford University Press, 2009





Course Assessment

- Continuous Assessment (Homework, Lab)
- Mid-term Exam (Closed-book, 1 hour)
- Final Exam

☐Course materials can be downloaded at http://bb.sustech.edu.cn.

Part A

Analog Communications

Outline

① Introduction
② Amplitude Modulation
③ Angle Modulation

What is Communication?

- In this course, *communication* refers to the transmission of information-bearing message from one point to another.
- Goal: reproduce at the destination an acceptable replica of the source message.

Analog vs. Digital Messages

- Message – Physical manifestation of information as produced by the source.

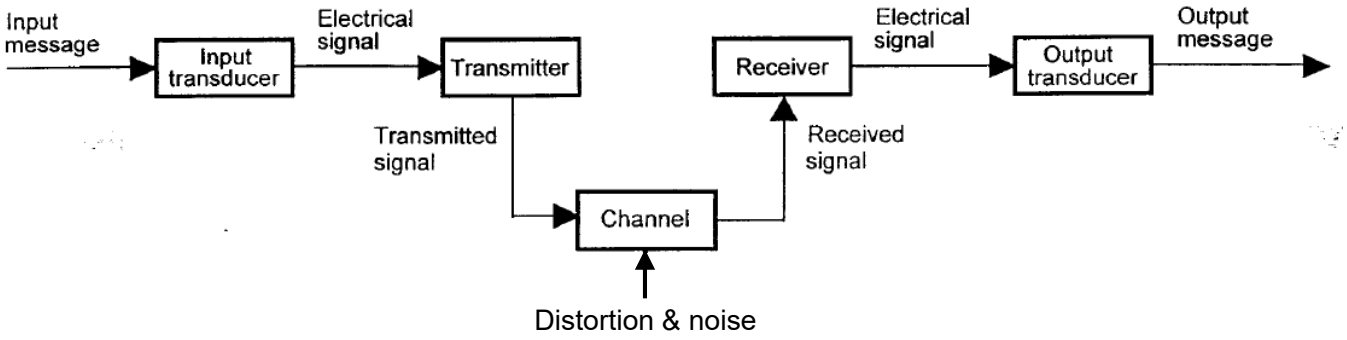
- An analog message can be described as a time-varying waveform, usually smooth and continuous.

✓ For analog communication, we need to keep fidelity.

- A digital message is a sequence of discrete symbols.

✓ For digital communication, we need to keep accuracy, usually in a specified amount of time.

Elements of a Communication System (1)



- Input/Output Message
  - Voice, plain text, image, video, etc
- Transducer
  - Convert the message into an electrical signal and vice-versa
  - *Example*: microphone converts acoustic voice signal into an electrical signal

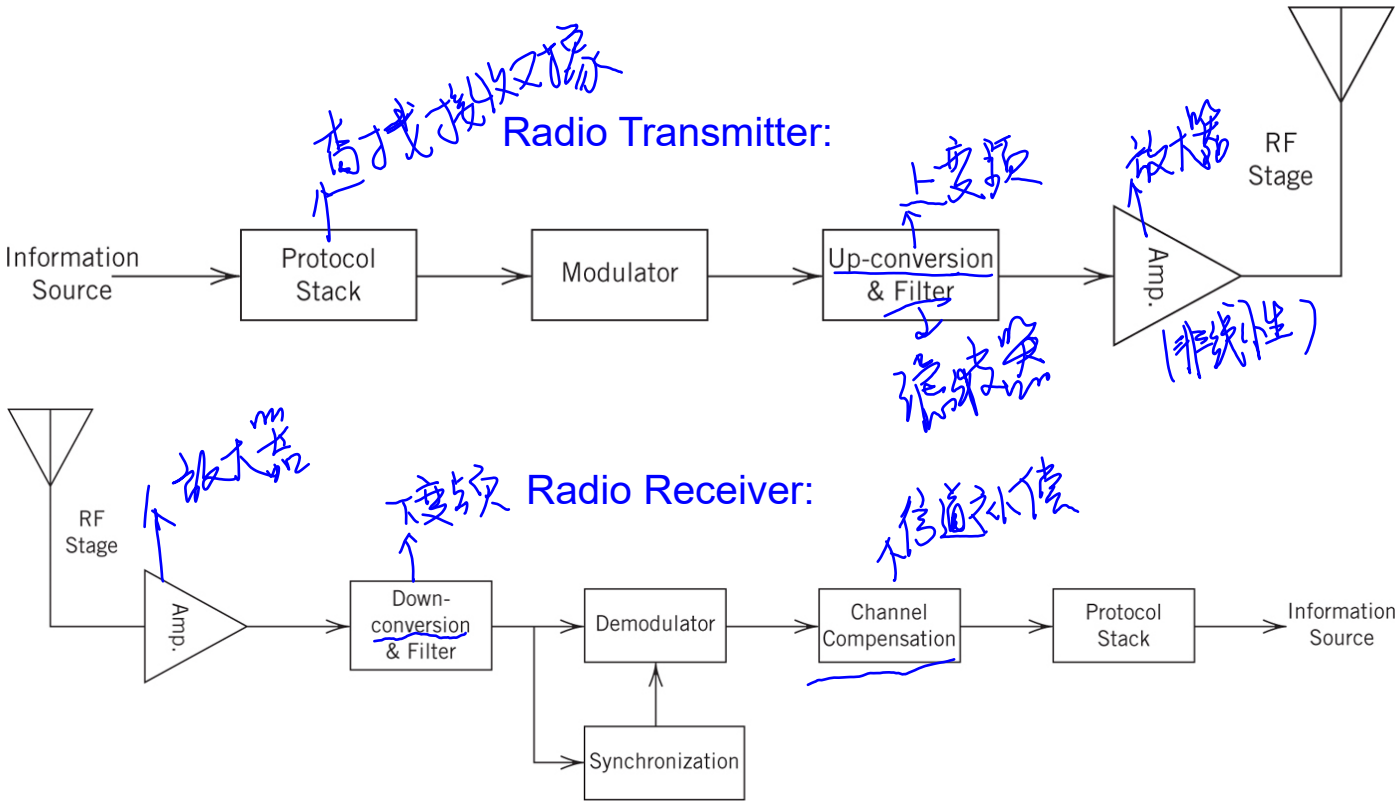
Elements of a Communication System (2)

- Transmitter
  - Converts the electrical signal into a form that is suitable for transmission through the physical channel
  - *Example*: electrical signal → radio signal, light wave, infra-red, laser, etc
  - The process matching the message/electrical signal to the channel is called modulation (needs to be reversible).
- Channel
  - The physical medium that is used to send the signal from transmitter to receiver.
  - *Example*: wire cables, optical fiber cables, atmosphere

Elements of a Communication System (3)

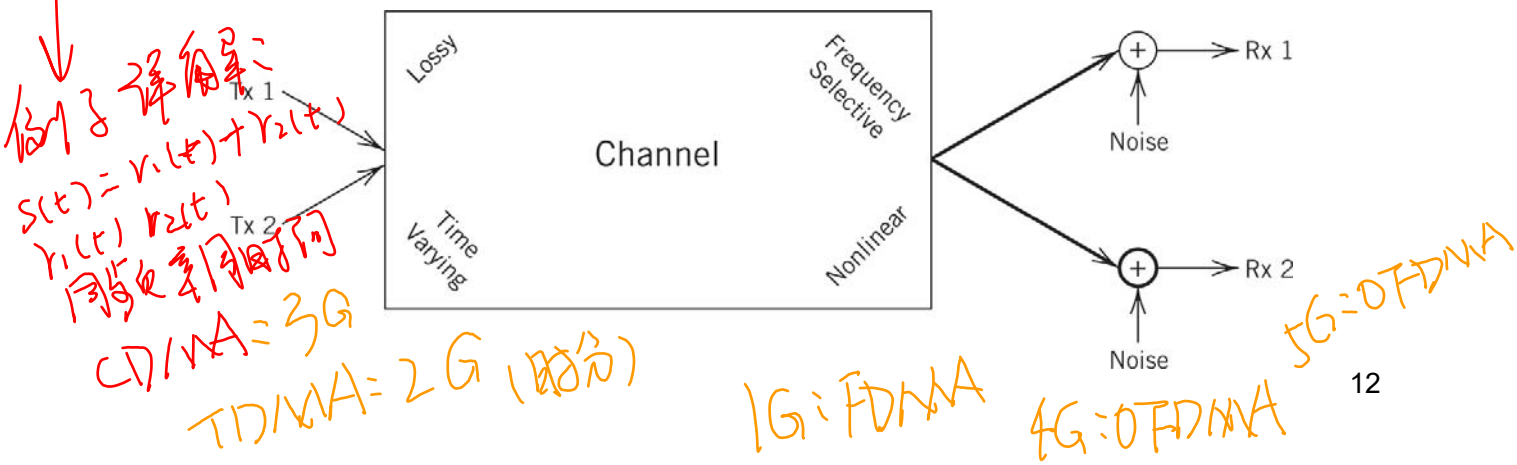
- Distortion & Noise
  - *Additive noise*: thermal noise (receiver's components), manmade noise (automobile ignition noise), atmospheric noise (lightning), and interference from other users
  - *Fading (non-additive distortions)*: multipath propagation
- Receiver
  - To recover the message from the received signal. The reverse counterpart of transmitter
  - Process called demodulation

Example – Wireless Communications



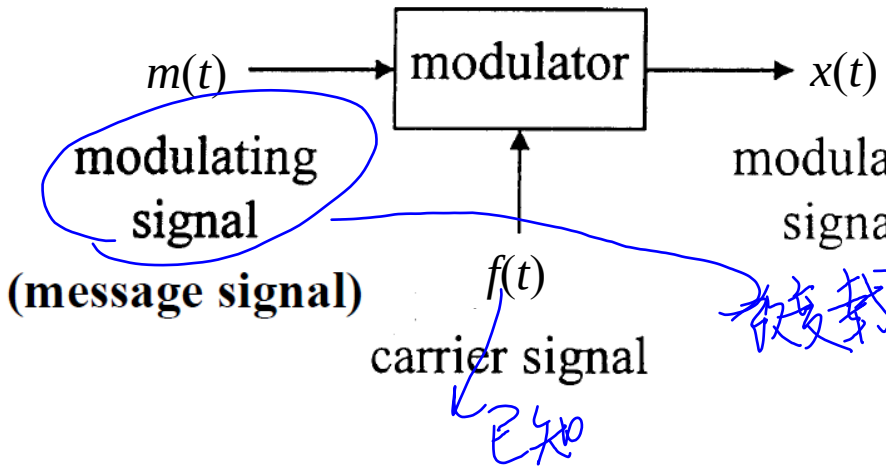
Channel Impairments

- Propagation loss – Signal gets weaker
- Frequency selectivity – channel gain varies over frequency
- Time-varying channel – Shadowing, fading
- Nonlinearity – due to nonlinear elements in the channel
- Interference – due to shared usage of a common resource
- Noise – random motion of electrons



Definition of Modulation

- Modulation is a process in which the modulator systematically alters a **carrier signal** in accordance with a **modulating signal** which represents the message.
- The resulting modulated signal thereby **carries** the message information.



Main Purposes of Modulation

- Enable the communication signal to travel further
- Reduce the size of RF (radio frequency) antennas by transmitting at higher frequency (antenna size is proportional to wavelength)
- Transmit multiple signals on one communication medium (multiplexing)
- Conform to RF spectrum regulations

Types of Modulations (1)

- We consider a sinusoidal carrier signal

$$f(t) = A_c \cos[2\pi f_c t + \phi(t)] = A_c \cos\theta(t)$$

where A_c is the carrier amplitude

f_c is the carrier frequency (i.e., frequency of unmodulated carrier)

$\phi(t)$ is the instantaneous phase of carrier

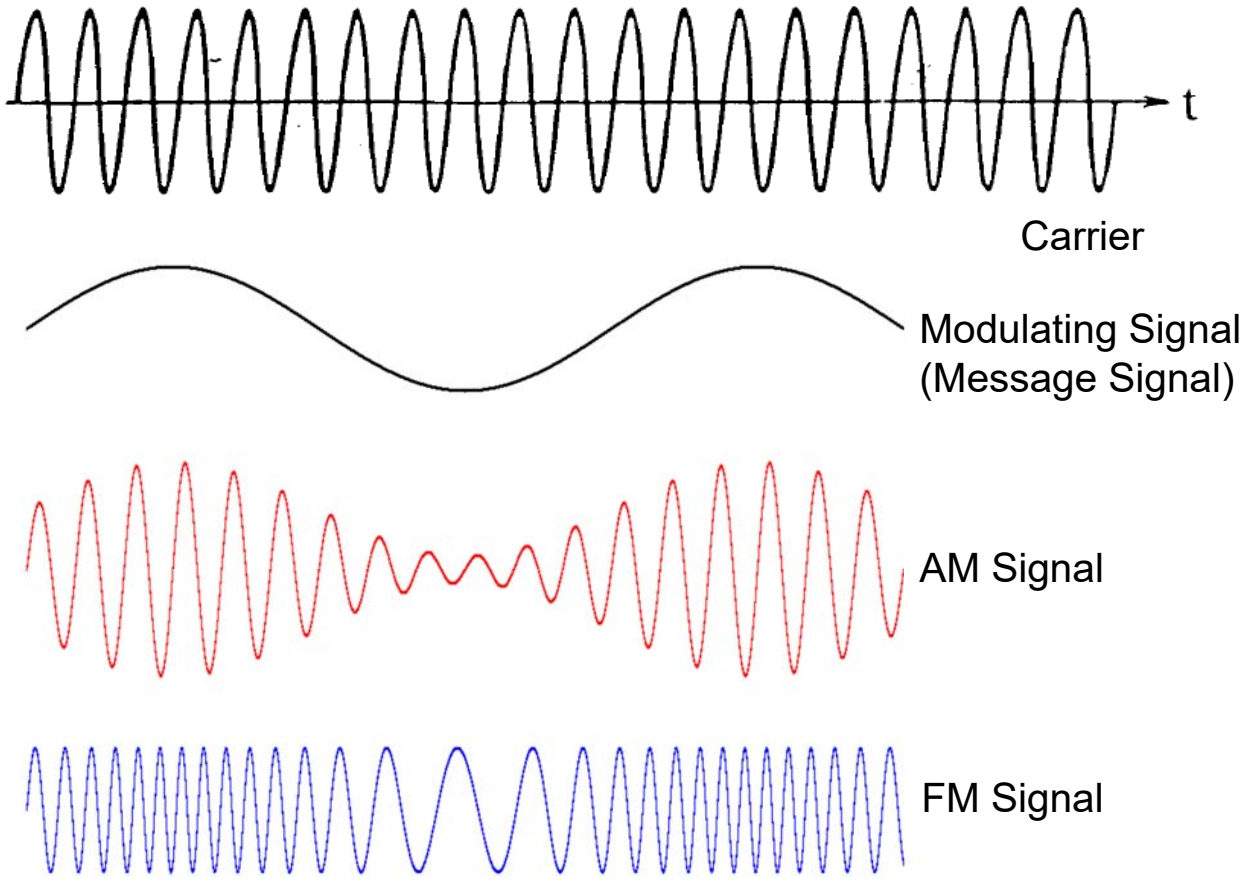
$\theta(t)$ is the instantaneous angle of carrier

Types of Modulations (2)

The carrier can be altered in three of its parameters:

1. Amplitude: $A_c(t) = g\,[m(t)]$
   This is called Amplitude Modulation (AM).
2. Frequency: $f_c(t) = g\,[m(t)]$
   This is called Frequency Modulation (FM).
3. Phase: $\phi(t) = g\,[m(t)]$
   This is called Phase Modulation (PM).

FM and PM are two forms of Angle Modulation ($\theta(t) = g\,[m(t)]$)



How to plot PM waveform?