**Analog communications I (60h)**

***1-Objectives***

At the end of this course, the student will be able to:

1. Describe the functional bloc diagram of a transmitter.

2. Explain the signal transmission techniques and the different types of modulation.

3. Describe the frequency band as defined by the CCIR.

4. Describe the functional block diagram of AM, SSB, DSB, FM transmitters and receivers.

5. Explain the principle of operation of each block circuit in AM transmitter and receiver.

6. Explain the principle of operation of each block circuit in FM transmitter and receiver.

7. Describe the properties of pulse modulation and its field of application.

8. Describe the functional block diagram of PAM, PPM, PWM transmitters and receivers.

9. Describe the functional bloc diagram of a stereo FM transmitter and receiver and their fields of use.

***2-Teaching method***

* The teacher starts with a general description of a transmission system by identifying its different parts (transmitter, transmission channel and receiver).
* For transmission techniques: the teacher will first identify the different frequency bands used in radio-frequency systems according to the CCIR. After that, he insists on the necessity of modulation by introducing the different types of analog and digital modulations as well as the information sources.
* For the analog modulation part, the teacher must:

1-start with a general introduction of AM and FM modulations,

2-determine the main parameters of the AM and FM signals (carrier, modulation index, bandwidth, power),

3-give the different AM and FM modulation circuits (AM SSB, AM DSB, WBFM, NBFM),

4-present the bloc diagram of an AM and a FM transmitters with details and analysis of each bloc,

5-present the bloc diagram of an AM and a FM receivers then analyze each part.

• For the analog demodulation part, the teacher must:

1-determine the signal characteristic at the input and the output of the AM and FM demodulation circuits,

2-present and analyze the circuits used in AM receiver (Antenna, RF amplifier, mixer, IF amplifier, AGC, envelope detector, audio amplifier and loudspeaker),

3-present and analyze the circuits used in FM receiver (Antenna, RF amplifier, mixer, IF amplifier, AGC, demodulator, audio amplifier and loudspeaker),

4-give the usefulness and explain the necessity of using the limiters, the pre-emphasis and the de-emphasis circuits in FM systems.

• In the pulse modulation part, the teacher must start with a general introduction on the pulse modulation with the aid of Shannon’s theory and its applications. Then he describes the different block diagrams of pulse modulation (PAM, PPM and PWM) transmitters and receivers and the advantages and disadvantages of each type.

• For the FM stereo transmitter and receiver, the teacher introduces the system in a simple manner and emphasizes the system by insisting on the applications.

**3-Teaching aids**

* Overhead projector or power point on white board or active board with accessories.
* A notebook.
* A technical manual.
* A multi-media computer (if possible).
* Technical information documentaries (movies).
* Library access (guided if possible).

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**Part 1: *Introduction to communication systems***

***Skills***

At the end of this part, the student will be able to:

1- Present the functional bloc diagram of a transmission system.

2- Describe the role of each element.

***Evaluation***

The student will be evaluated according to his aptitude to:

1-Draw and identify the functional bloc diagram of a general communication system.

2-Calculate the wavelength from the frequency and the velocity of propagation of an electromagnetic wave.

**Chapter 1 Introduction to communication systems** (**4h)**

1-1.Properties of the electromagnetic wave (wavelength, frequency and velocity of propagation).

1-2.Functional bloc diagram of a transmission system.

1-3.Transmitter (source of information, modulator, tuned amplifier).

1-4.Transmission channel.

1-5.Receiver (demodulator, filter, destination).

**Part 2: *Transmission techniques***

***Skills***

At the end of this part, the student will be able to:

1. Describe the transmission techniques and the transmitted signal characteristics.
2. Describe the propagation phenomena of electromagnetic waves.
3. Identify the frequency bands as defined by the CCIR.
4. Identify the different types of modulation and their properties.
5. Describe the different techniques of modulation.

***Evaluation***

The student will be evaluated according to his aptitude to:

1. Explain the transmission techniques, using a general bloc diagram.
2. Explain the propagation principle of electromagnetic waves.
3. Identify the different frequency bands according to the CCIR.
4. Explain the need of the modulation and distinguish the different types.

**Chapter 2: Transmission techniques** (**6h)**

2-1. Frequency ranges of a transmission system as determined by the CCIR.

2-2. Types of information sources .

2-3. Frequency spectrum of different information sources.

2-4. Necessity of modulation.

2-5. Different types of modulations and their properties:

Define:

2-5-1. Analog modulations (AM, FM, PM).

2-5-2. Pulse modulations (PAM, PPM, PWM).

2-5-3. Digital modulations (PCM - ASK - FSK - PSK).

**Part 3: *Analog modulations***

***Skills***

At the end of this part, the student will be able to:

1. Determine the principles of AM and FM modulations and identify their properties.
2. Explain the principle of operation of different AM and FM modulation circuits.
3. Describe the functional bloc diagrams of AM and FM transmitters.
4. Describe the functional bloc diagrams of AM and FM receivers.
5. Identify the different types of antennas used in AM and FM reception systems.
6. Explain the principle of operation of the radio-frequency conversion used in AM and FM systems.
7. Identify the components of the IF amplifier and determine their roles in the AM and FM modulations.
8. Describe the functional bloc diagram and the principle of operation of the AGC circuit in AM and FM.
9. Study the principle of AM demodulation using envelope detector.
10. Explain the principle of operation and the usefulness of limiter in FM receiver.
11. Explain the principle of operation and the usefulness of AFC in FM receiver.
12. Describe the principle of operation of FM demodulators.
13. Explain the principle of operation and the usefulness of pre-emphasis and de-emphasis circuits in FM system.

***Evaluation***

The student will be evaluated according to his aptitude to:

1. Calculate the AM and FM wave parameters (modulation index, bandwidth, frequency deviation and power).
2. Distinguish the different AM and FM modulation circuits.
3. Compare the performances of AM and FM modulations.
4. Draw the bloc diagrams of AM and FM transmitters and explain the operations and roles of the different stages.
5. Select the convenient type of antenna according to the AM or FM reception mode.
6. Give the usefulness of the frequency conversion in AM and FM systems.
7. Draw the bloc diagram of an AM receiver, determine the operation and role of each bloc and present the input and output signals (antenna, RF amplifier, mixer, IF amplifier, AGC, demodulator, audio amplifier and loudspeaker).
8. Draw the bloc diagram of a FM receiver, determine the operation and role of each bloc and present the input and output signals (antenna, RF amplifier, mixer, IF amplifier, AGC, demodulator, audio amplifier and loudspeaker).
9. Give the usefulness and explain the principle of operation of AGC circuits in AM and FM systems.
10. Give the usefulness and explain the necessity of using limiters, pre-emphasis and de-emphasis circuits and AFC in FM systems.

**Chapter 3: Amplitude modulation** (**6h)**

3-1- Properties of the amplitude modulation:

3-1-1. Principle of AM modulation.

3-1-2. Spectrum of AM waves.

3-1-3.Frequency ranges.

3-1-4. Modulation index.

3-1-5. Domains of utilization.

3-1-6. Power.

3-2- Modulation circuit: Principle of operation of each type of the following circuits:

3-2-1- Double side band (DSB).

3-2-1- Double side band suppressed carrier (DSBSC).

3-2-1- Single side band (SSB).

**Chapter 4: AM Transmitter (6h)**

4-1. Bloc diagram of AM transmitter.

4-2. Role and principle of operation of each bloc.

4-3. Wave forms at different test points.

4-4. Oscillator and frequency multiplier.

4-5. SSB and DSB modulators.

4-6. Amplifier stage.

4-7. Coupling and matching of different stages.

**Chapter 5: AM Receiver (8h)**

5-1. Functional bloc diagram of AM receiver.

5-2. Signal characteristics at the input and output of each bloc.

5-3. Antenna of AM receiver:

5-3-1. Types of antennas and their parameters.

5-3-2. Tuned circuit (Band pass filter).

5-3-3. RF amplifier.

5-3-4- Frequency conversion:

5-3-4-1. Principle and usefulness.

5-3-4-2. Oscillators and different types of mixers.

5-3-4-3. Frequency conversion modes.

5-3-4-4. Frequency addition and frequency multiplication.

5-3-5.Tuned amplifier (Intermediate frequency):

5-3-5-1. Principle of operation.

5-3-5-2. Circuits.

5-3-5-3- Advantages and disadvantages.

5-3-6. AGC (Automatic gain control):

5-3-6-1. Objective.

5-3-6-2. Principle of operation.

5-3-7- AM demodulation (envelope detector):

5-3-7-1. Principle of detection.

5-3-7-2. Rectification of input signal.

5-3-7-3. Envelope detector (Rectifier and filter).

5-3-7-4. Wave forms at the demodulator's input and output.

5-3-7-5. Different types of demodulators.

5-4. Audio amplifier and loudspeaker.

**Chapter 6: FM modulation (6h)**

6-1.Properties of frequency modulation:

6-1-1. Definition and principle.

6-1-2. Modulation index.

6-1-3. Spectrum of a FM signal.

6-1-4. Power and bandwidth of a FM signal.

a) Narrow band NBFM.

b) Wide band WBFM.

6-2. FM modulation circuits.

**Chapter** **7: FM transmitter (6h)**

7-1. Functional bloc diagram of FM transmitter.

7-2. Information source (micro ....) of the input signal.

7-3- Pre-emphasis circuit (role and principle of operation) .

7-4. Voltage controlled oscillator VCO .

7-5. Frequency multiplier.

7-6. Power amplifier.

7-7. Antenna.

**Chapter 8: FM Receiver (8h)**

8-1. Different types of receivers: direct, heterodyne and super heterodyne.

8-1-1- Role, Principle of operation, circuits and domains of utilization.

8-2. Functional bloc diagram of FM receiver.

8-2-1. Signal characteristics at the input and output of each bloc.

8-3. Antenna reception of input signals.

8-4. HF frequency tuned amplifier.

8-5. Frequency conversion (mixer, local oscillator).

8-6.Intermediate amplifier.

8-7. Limiter (role, principle of operation, types and circuits).

8-8.Automatic frequency control (AFC).

8-9. Demodulator:

8-9-1. FM detector (principle, circuit, input and output signals)

8-9-2. Discriminator (role, principle of operation, vectors diagram)

8-9-3. Ratio detector (role, principle of operation) .

8-9-4. De-emphasis circuit (role and principle of operation)

8-10.Automatic gain control AGC (role, principle of operation and circuit).

8-10-1. Audio amplifier.

8-10-2. Loudspeaker.

**Part 4: *Pulse Modulations***

***Skills:***

At the end of this part, the student will be able to:

1-Determine the principle of pulse modulations and identify their different properties.

2-Identify different types of pulse modulations and determine their applications.

3-Present the block diagrams of (PAM, PPM, PWM) transmitters and receivers with details and analysis of each bloc.

***Evaluation***

The student will be evaluated according to his aptitude to:

1-Distinguish the different types of pulse modulations.

2-Calculate the sampling frequency according to Shannon’s theory.

3-Determine the parameters of different types of pulse modulations and their applications.

4-Understand the principle of operation of each block of (PAM, PPM and PWM) transmitters and receivers.

5-Knowlege the input and output signals at each block in (PAM, PPM and PWM) transmitters and receivers.

**Chapter 9: Pulse modulation** (**6h)**

9.1. Introduction.

9.2. Shannon’s theorem.

9.3. Types of pulse modulation (PAM, PPM, and PWM).

9.4. Advantages and disadvantages of each type.

9.5. Block diagram of the modulator and demodulator for each type, role of each block, waveforms at the input and the output of each block.

9.6. Applications.

**Part 5: *FM Stereo system (transmitter and receiver*)**

***Skills***

At the end of this part, the student will be able to:

1-Describe the functional bloc diagram of a FM stereo transmitter.

2- Study the different signal processing stages of a FM stereo transmitter.

3-Describe the functional bloc diagram of a FM stereo receiver.

4- Study the different signal processing stages of a FM stereo receiver.

***Evaluation***

The student will be evaluated according to his aptitude to:

1-Draw the functional bloc diagram of a FM stereo transmitter.

2-Draw the functional bloc diagram of a FM stereo receiver.

3-Explain the operations and determine the applications of the above block diagrams.

**Chapter 10*:******FM Stereo system*** (**4 h)**

10-1.FMStereo transmitter:

10-1-1. Functional bloc diagram and role of each element.

10-1-2 Principle of operation.

10-1-3 Applications.

10-2-FMStereo receiver:

10-2-1. Functional bloc diagram and role of each element.

10-2-2. Principle of operation.

10-2-3. Applications.