Audio-Visual systems

**(60 hours)**

### General objectives

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

* Determine the characteristics of the image: light, characteristics of vision, colors, analysis and synthesis of image.
* Explain the function, the constitution and the regulation of the video camera.
* Explain the function, the constitution and the regulation of the LCD screens.
* Identify the digital compression for fixed and animated pictures.
* Determine the MPEG multiplex organization, channel coding and the digital signal modulation.
* Present the digital TV operation.

# Chapter 1: Image (8h)

1. Colors: The light, Nature of light, Newton’s experiment

2 Eye and vision: Eye constitution, Characteristics of the human eye (Sensitivity, curve,

Persistence of vision, Visual acuity)

3 The colors: Additive mixing, Subtractive mixing, Characteristics of color

(Luminance or brightness, Tint or hue, Saturation)

4 Maxwell’s triangle

5 Optical filters

# Chapter 2: Analysis and synthesis of pictures (6h)

1 Picture elements

2 The television picture

3 Horizontal and vertical scanning (progressive)

4 Interlaced scanning: Motion pictures, Flicker, Odd and even lines, Scanning frequencies

# Chapter 3: The video camera and LCD (8h)

1 Principle of the conversion of the picture to electrical current: The photoemission, the photoconductivity

2 The optical separator for Red, Green and Blue

3 Dichroic mirrors

4 The CCD (coupled charge device)

* + Principle of operation of the cell
  + Transfer of charges
  + Structure of interline transfer (IT)
  + Structure of frame transfer (FT)
  + Structure of frame interline transfer (FIT)

5 The electronic shutter

6 Aliasing defect

7 Video processing in CCD camera: Sampling, Gamma correction

8 LCD: Constitution, Principle of operation

9 The calculation of the bandwidth of the video signal for CCIR systems

# Chapter 4: Analog TV (8h)

1 Bloc diagrams of a TV transmitter and receiver

2 Principle and Bloc diagram of the analog systems (NTSC, PAL and SECAM)

3 Video composite signal of a color TV

# Chapter 5: Video signal (8h)

1 Compatibility: Forward, Reverse

2 The R, G, B signals

3 Calculation of luminance signal (Y)

4 Matrix circuit to produce the luminance: principle of operation

5 The difference Signals (R-Y) and (B-Y)

6 Color-bar signal

7 Digital video signals:

Image size

Sampling design choice

Digital frame constitution

Detection and control error principle

8 Parallel and serial interfaces

9 Signal serialization principles (4:2:2)

# Chapter 6: Digital compression (14h)

1 Compression necessity

2 Image redundancy, Spatial redundancy, Temporal redundancy

3 Necessity of normalization of compression techniques

4 JPEG: Fixed images compression

Discrete cosines transform (DCT)

The six functions keys of JPEG algorithm:

Blocks splitting

Discrete cosines transform

DCT quantization coefficient

Zigzag scan

Length variable coding

Entropy coding (Huffman)

JPEG compression treatment diagram

5 MPEG1: Multimedia animated picture compression

MPEG1 typical sequence (images I, P, B)

Movement estimate

Movement compensation

Interpolation

Flow control

Encoder

Decoder

6 MPEG2: compression in professional quality

MPEG2 profiles and levels

Macro-blocks structures

Prediction types

7 Sound compression (MPEG audio)

Frequently masking

Temporary masking

Block diagram of MPEG audio coder and decoder, role and principle of operation of each block

Standard MUSICAM

Structure of MPEG audio frame layer II (it is used in television)

# Chapter 7: Digital television (8h)

1 Block diagram of MPEG audio coder and decoder, role and principle of operation of each block

Standard MUSICAM

2 Multiplexing of signals: multiplex organization MPEG2, Program stream, Transfer stream, MPEG2 constitution

3 Scrambling and access control: DVB standard scrambling principle, Access control mechanism

4 Coding and error correction

5 Digital signals modulation: Time quadrate modulation, European emission retained features

(DVB= Digital video broadcasting)

6 Emission and reception process: Block diagram, Role of each block