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| **Part I Transmission Technology (45h)** |

**1-*Objectives*:**

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

1. Explain the propagation phenomena of the electromagnetic wave.

2. Describe the equivalent circuit of a transmission line and determine its parameters.

3. Identify the different types of transmission lines.

4. Represent an optical fiber transmission system by its operational bloc diagram.

5. Identify the different types of optical fiber cables, their characteristics and applications.

6. Determine the advantages and disadvantages of fiber optics.

7. Determine the role of an antenna and its characteristics.

8. Identify the different types of antennas and their uses.

**2-*Teaching Method:***

* This course must be taught in a simple manner without mathematical details by insisting on the principles, main parameters and applications.
* Review of the properties of electromagnetic waves.
* Explain the different phenomena of propagation in free space and in the ionosphere relative to the used frequency.
* Represent the transmission line by its equivalent circuit, by introducing the physical meaning of the main parameters (characteristic impedance, attenuation, propagation constant and velocity of propagation).
* Give some information about reflection coefficient and matching.
* Distinguish different types of lines, determine their parameters according to their geometries, and state their applications.
* Introduce the wave guides as high power transmission lines in the microwave frequency ranges; determine the cut off frequencies of the propagation modes according to the guide dimensions.
* Introduce the fiber optics as a transmission medium in the optical ranges (IR, visible and UV).
* Present the bloc diagram of an optical fiber transmission system.
* Distinguish the different types of cables and their utilizations.
* Distinguish the different sources and detectors.
* Compare the fiber optics with the coaxial lines.
* Introduce the antenna with the aid of a bloc diagram of a communication system.
* Explain the physical meaning of the antenna parameters (polarization, gain, radiation pattern, effective length and area).
* Distinguish the different types of antennas according to the used frequency and application.

**3*-Teaching Tools*:**

* 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).

**4**- ***Contents*:**

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|  | **Hours** |
| 1. **Propagation of electromagnetic waves** | **6** |
| 1. **Transmission lines** | **10** |
| 1. **Fiber optics** | **12** |
| 1. **Antenna parameters** | **7** |
| 1. **Types of Antennas** | **10** |
| **T O T A L** | **45** |

**First part: *Propagation of Electromagnetic Waves and Transmission Lines***

***Skills:***

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

* Describe the propagation phenomena in free space and the ionosphere.
* Describe the equivalent circuit of a transmission line.
* Determine the primary (R, L, G and C) and secondary (α ,β and Zc) parameters of a transmission line.
* Determine the standing wave ratio and the matching condition for a transmission line.
* Describe the different types of transmission lines.
* Determine the characteristic impedance and the propagation constant of two-parallel wire and coaxial lines.
* Identify the different propagation parameters in rectangular and circular wave guides.

***Evaluation***

The student will be evaluated according to his aptitude to:

* Determine the types of propagation of electromagnetic waves according to their used frequencies.
* Explain the physical meaning of the primary and secondary parameters of transmission lines (R, L, C, G, Ζc,α ,β ).
* Calculate the reflection coefficient at the interface between two transmission lines of different characteristic impedances.
* State the different types of lines, calculate their parameters according to their geometry and state their applications.
* Give the applications of waveguides; calculate the cut-off frequency and wavelength of the dominant mode according to the dimensions of the guide.

**Contents:**

***Chapter 1:* Propagation of electromagnetic waves (6h)**

1.1. Electrical to electromagnetic conversion.

1.2. Electromagnetic waves:

1.2.1. Wave fronts.

1.2.2. Intrinsic impedance of free space.

1.3. Propagation phenomenon:

1.3.1. Reflection.

1.3.2. Refraction.

1.3.3. Diffraction.

1.4. Ground and space wave propagation:

1.4.1. Ground wave propagation.

1.4.2. Space wave propagation.

1.4.3. Ghosting in television reception.

1.4.4. Tropospheric duting.

1.4.5. Calculation of the distance between transmitter and receiver.

1.5. Sky wave propagation:

1.5.1. Ionospheric layers.

1.5.2- Effects of the ionosphere on the sky wave:

1.5.3. Critical frequency.

1.5.4 - Critical angle.

1.5.5 - Maximum usable frequency (MUF).

1.5.6 .Suitable radiation angles.

1.5.7 . Skip zone.

1.5.8. Fading.

1.5.9. Tropospheric scatter.

1.6. Classification of electromagnetic waves according to the frequency and the propagation mode.

***Chapter 2*: Transmission lines: (10h)**

2.1. Equivalent circuit of lossy transmission line:

2.1.1. Resistance per unit length R.

2.1.2. Inductance per unit length L.

2.1.3. Conductance per unit length G.

2.1.4. Capacitance per unit length C.

2.1.5. Characteristic impedance.

2.1.6. Attenuation of the wave in the transmission line α (Without mathematical analysis).

2.1.7. Propagation constant of the wave in the transmission line γ (Without mathematical analysis).

2.1.8. Phase constant of wave β (Without mathematical analysis).

2.1.9. Exercises.

2.2. Equivalent circuit of loss-less transmission line:

2.2.1. Inductance per unit length L.

2.2.2. Capacitance per unit length C.

2.2.3. Characteristic impedance.

2.2.6. Attenuation of the wave in the transmission line α.

2.2.7. Propagation constant of the wave in the transmission line γ.

2.2.8. Phase constant of wave β.

2.2.9. Exercises.

2.3. Matching techniques:

2.3.1. Reflection coefficient.

2.3.2. Standing wave ratio.

2.3.3. Matching conditions.

*2.*4.Types of transmission lines.

2.4.1. Two-parallel wire and coaxial lines:

2.4.2. Line geometries.

2.4.3. Equivalent circuit.

2.4.4. Characteristic impedance.

2.5. Rectangular and circular wave guides:

2.5.1. Guide geometries.

2.5.2. Propagation modes.

2.5.3. Guided wavelength.

2.5.4. Cut-off frequencies.

2.5.5. Impedances.

2.5.6. Exercises.

**Second part:  *Fiber Optics*:**

***Skills:***

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

1. Describe the operational bloc diagram of an optical fiber transmission system.

2. Identify the types of optical fiber cables and their domains of utilization.

3. Determine the advantages and disadvantages of fiber optics with respect to coaxial lines.

4. Identify the different optical sources and detectors as well as their domains of utilization.

***Evaluation:***

The student will be evaluated according to his aptitude to:

* Draw the bloc diagram of a transmission system using fiber optics.
* Show the usefulness of fiber optics with respect to coaxial cables.

***Chapter 3*: Fiber optics: (12 h)**

3.1. Operational bloc diagram of a transmission system using fiber optics.

3.2. Characteristics and advantages of fiber optics.

3.3. Fiber optic transmission line (core, cladding, refractive indices, propagation using ray theory).

3.4. Types of cables (Multi-mode step index, Multi-mode graded index, single mode graded index).

3.5. Optical sources and detectors (LED source, LASER source, Photodiode and Phototransistor).

**Third part 3: *Antennas:***

***Skills:***

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

1. Determine the role of the antenna in a transmission system as well as its characteristics.

2. Identify the different types of linear antennas and their fields of utilization.

3. Determine the gain and the radiation pattern of an antenna array.

4. Identify the different types of microwave antennas and their applications.

***Evaluation:***

The student will be evaluated according to his aptitude to:

1. Determine the role of the antenna in a transmission system.

2. Select the appropriate antenna according to the used frequency band and the application.

***Chapters 4*: Antenna parameters: (7 h)**

4.1. Introduction to antennas (propagation ofelectromagnetic waves in free space, communication system using antennas.

4.2. Parameters(polarization, directivity and gain, radiation pattern, effective length and area, radiation resistance and radiation pattern).

***Chapter 5:* Types of Antennas: (10 h)**

5.1. Simple dipole, folded dipole.

5.2. Set of antennas:

5.2.1. Collinear.

5.2.2. Set of parallel antennas.

5.2.3. Set of antennas supplied in quadrature.

5.3. Rhombus antenna.

5.4. Yagi antenna (construction, parameters and applications).

6.5. Horn antenna.

6.6. Parabolic antenna.

6.7. Loop antenna.

6.8. Helical antenna.

For each antenna treat the following point: construction, parameters, principle of operation, pattern diagram and applications.

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| **Part II Telephony (45 Hours)** |

***Objectives***

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

* Describe a telephone exchange.
* Describe the telephone service.
* Examine and interpret a telephone station.
* Dimension a server.
* Explain the cellular telephone concepts.

***Teaching Methodology***

* Explain simply the general role of the telephone, and especially that of the local network system.
* Introduce the main components of the telephone system.
* Show the bloc-diagram of a telephone exchange.
* Show the control and connection units and explain their operations.
* Beginning by the local loop and continuing by the signals and signalizing, explain in details the sequence of operation of a local call then across a local telephone exchange (use an illustrations and real examples).
* With the help of illustrate a schematics and a real set, describe in details various kinds of telephone stations with their components.
* Represent on a chart, a private telephone exchange; describe the traffic and give an idea about the dimensioning of a server without entering in details.
* Introduce the cellular telephone, describe it and give an idea about the mobile system BTS (details of technology not required).

***Teaching aids***

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

***Evaluation***

The student will be evaluated according to his capacity to:

* Describe the telephone system.
* Explain the telephone transmission signals.
* Draw the bloc-diagram of a telephone exchange.
* Describe the control and connecting units.
* Describe the telephone service.
* Examine a telephone station.
* Describe a private telephone exchange.
* Describe the cellular system.

***Content***

Chapter 1 Introduction

Chapter 2 The telephone exchange

Chapter 3 The auto switch (PBX)

Chapter 4 The Traffic: dimensioning a server

Chapter 5 Transmission of telephone signals

Chapter 6 The Cellular network

**Chapter 1: Introduction (4h)**

1. Role and objective.
2. Interconnection network.

1.3. Director plans of architecture.

**Chapter 2: The telephone exchange (10h)**

2.1. General architecture.

2.2. Comparison between the transmission and reception signals in analog and digital telephony.

2.3. The block diagram of the digital telephony apparatus, role of each block.

2.4. The block diagram of the microphone-earphone, role of each block.

2.5. The block diagram of the speakerphone circuit, role of each block.

2.5. The block diagram of the alarm circuit, role of each block.

2.6. The keywords.

**Chapter 3**: **The Auto switch (PBX) (4h)**

3.1. Introduction.

3.2. Connection function.

3.3. Signaling function.

3.4. Command function.

**Chapter 4: The Traffic: dimensioning** **a server (4h)**

4.1. Definition of the traffic.

4.2. Mathematical model.

4.3. System have lost calls.

4.4. System have waiting delays.

**Chapter 5: Transmission of telephone signals (7h)**

5.1. Elaboration of the digital telephone.

5.2. The PCM with 30 channels.

5.3. Space connection.

5.4. Temporal connection.

**Chapter 6 : Cellular network (16h)**

6.1. Introduction.

6.2. Cellular concepts.

6.3. The MS terminal and SIM card.

6.4. Canonical Architecture.

6.5. Technical dimensioning of the network.

6.6. Radio resource management.

6.7. Four generations:

-Definitions of four technologies 1G, 2G, 3G and 4G.

-Characteristics and speed of transmission for each technology (Comparative table).

-Utility (High bit rate internet, video conference).

-Advantages and disadvantages of the four technologies.