***BT3 – Electronics Subject: Digital Telecommunication (II)***

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| **Digital Telecommunication II**  **(60H)** |

***Objectives***

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

1. Determine the advantages and disadvantages of PCM digital transmission.

2. Describe the bloc diagram of a PCM digital transmission system and give the role of each element.

3. Use the sampling theorem.

4. Describe the different types of sampling.

5. Identify the different types of digital modulation and demodulation systems (ASK, FSK, PSK, QPSK, and DPSK).

6. Explain the principle of frequency and time division multiplexing and state their applications

7. Designate the different microwave communication systems, describe their bloc diagrams and explain their principles (microwave link, radar and satellite).

***Teaching method***

The objective of this course is to introduce the different modern communication systems and familiarize the students with these systems. The teacher must present bloc diagrams, explain their principle of operation, and insist on applications without going into complex mathematical details.

Initially, the teacher must start with a general introduction on digital communication transmission systems, emphasizing the advantages of these systems with a respect to analog methods. Then he presents the bloc diagram of the digital system, and explains the sampling process as well as the analog to digital converter, and vice versa. Finally, he presents the digital modulation and demodulation by identifying the different types (ASK, FSK, PSK, QPSK and DPSK) and by explaining their bloc diagrams, principle of operation and utilization.

Concerning frequency and time division multiplexing systems, the teacher must present the bloc diagrams by insisting on the applications, then he explains each system separately in details.

***BT3 – Electronics Subject: Digital Telecommunication (II)***

For the microwave communication systems, the teacher must:

* Start with a general introduction specifying the frequency bands used and the different applications.
* Explain the principle of operation of microwave communication systems (Microwave link) by presenting the different phenomena associated to this system.
* Describe the satellite communication system by insisting on the orbits, transmitter, transponder and receiver
* Introduce the radar system with the aid of a bloc diagram, explain its principle of operation, present the frequency bands used and determine the main parameters.

***Teaching means***

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

***Contents***

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|  | **Hours** |
| 1. Digital transmission. | 20 |
| 2. Digital modulation and demodulation methods. | 20 |
| 3. Frequency division multiplexing | 4 |
| 4.Time division multiplexing | 4 |
| 5. Microwave link. | 4 |
| 6. Satellite communication system. | 4 |
| 7. Radar | 4 |
| **Total** | **60** |

**Part 1: *Digital transmission methods* (40h)**

Chapter 1. Digital transmission **(20h)**

Chapter 2. Digital modulation and demodulation methods **(20h)**

***BT3 – Electronics Subject: Digital Telecommunication (II)***

**Part 2 : *Multiplexing systems* (8h)**

Chapter 3. Frequency division multiplexing **(4h)**

Chapter 4. Time division multiplexing  **(4h)**

**Part 3 : *Microwave communication systems* (12h)**

Chapter 5. Microwave transmission. **(4h)**

Chapter 6. Satellite communication system. **(4h)**

Chapter 7. Radar. **(4h)**

**Part 1: Digital *transmission methods*.**

***Skills***

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

* Determine the advantages and disadvantages of digital transmissions
* Explain the principle of operation of a PCM system and determine its applications.
* State and explain the different types of sampling.
* Explain the principle of operation of Analog to digital conversion and Digital to analog conversion circuits.
* Explain the principle of operation of a delta modulation and demodulation system and determine its applications.
* State the different digital modulation and demodulation methods (ASK, PSK, FSK, QPSK, and DPSK), describe their bloc diagrams and determine their applications.

***Evaluation***

The student will be evaluated according to his aptitude to:

1. Compare the digital and analog systems by specifying the advantages and disadvantages of each system.

2. Draw the bloc diagram of a PCM digital transmission system and explain its principle of operation.

3. Calculate the sampling frequency of a PCM signal PCM (Fs=2fm).

4. Distinguish the different types of sampling.

5. Knowledge the analog to digital conversion and Digital to analog conversion circuits.

***BT3 – Electronics Subject: Digital Telecommunication (II)***

6. Draw the bloc diagram of delta modulation and demodulation system and explain its principle of operation.

7. Distinguish the different digital modulation and demodulation methods and give their fields of applications.

8. Knowledge the block diagram of themultiplexing systems and distinguish between them.

9. Draw the bloc diagram of microwave link communication system and give the role of each block.

10. Draw the block diagram of up-link and down-link of the satellite transmission system and give the role of each block.

11. Draw the block bloc diagrams of the radar system and give the role of each block.

**Chapter 1:Digital transmission. (20h)**

1.1. Introduction.

1.2. Advantages and disadvantages of PCM digital transmission.

1.3. Block diagrams of the modulator and demodulator of PCM and role of each element.

1.4. Sampling theory and the types of sampling

1.4.1. Ideal sampling.

1.4.2. Natural sampling.

1.4.3. Flat-top sampling.

1.5.Sample and hold.

1.6. Analog to digital conversion: circuit diagram and principle of its operation

1.7. Transmission channel.

1.8. Digital to analog conversion: circuit diagram and principle of its operation

1.9. Low pass filter.

1.10. Delta modulation:

1.10.1- Definition, block diagram, role, principle, analysis, generation and demodulation.

1.10.2- Applications.

**Chapter 2:Digital modulation methods**. **(20h)**

2.1. Amplitude shift keying ASK modulation:

2.1.1. Definition, block diagram, role, principle, waveforms, generation, demodulation and applications.

***BT3 – Electronics Subject: Digital Telecommunication (II)***

2.1.2. Mathematical expression of ASK signal (without analysis).

2.1.3. Utilizations.

3.2 Frequency shift keying FSK modulation:

3.2.1. Definition, block diagram, role, principle, waveforms, generation, demodulation and applications.

3.2.2. Mathematical expression of FSK signal (without analysis).

3.2.3. Utilizations.

3.3. Phase shift keying PSK modulation:

3.3.1. Definition, block diagram, role, principle, waveforms, generation and demodulation.

3.3.2. Mathematical expression of PSK signal (without analysis).

3.3.3. Coherent and noncoherent demodulation.

3.3.4. Utilizations.

3.4. Quadrature phase shift keying QPSK:

3.4.1. Definition, block diagram, role, principle, waveforms, generation and demodulation.

3.4.2. Utilizations.

3.5. Differential phase shift keying DPSK:

3.5.1. Definition, block diagram, role, principle, waveforms, generation and demodulation.

3.5.2. Utilizations.

3.6 Exercises.

**Part 2: *Multiplexing systems*  (8h)**

***Skills***

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

* Identify the bloc diagrams of the multiplexing systems (time division and frequency division) and determine the applications of each one.
* Describe the principle of formation of different groups in FDM system.
* Study the formation of frames and the synchronization procedure in TDM system.

***Evaluation***

The student will be evaluated regarding his aptitude to:

* Compare the time and frequency division multiplexing systems and determine the application of each one.

***BT3 – Electronics Subject: Digital Telecommunication (II)***

* Define the formation of different groups in FDM systems.
* Explain the hierarchy of TDM system as well as synchronization procedure.

**Chapter 3: Frequency division multiplexing. (4 h)**

3.1. Introduction.

3.2. Hierarchy of FDM system.

3.3. Bloc diagram and principle of operation.

3.4. Information source .

3.5. Formation of basic group.

3.6. Formation of super group.

3.7. Formation of master group.

3.8. Formation of radio channel.

**Chapter 4: Time division multiplexing. (4 h)**

4.1. TDM (Time Division Multiplexing).

4-2. Bloc diagram.

4.3. Principle of operation.

4.4. Utilization.

4.5. Frame and synchronization.

**Part 3: *Microwave communication systems* (12h)**

***Skills***

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

•Determine the frequency ranges used in microwave links.

•Describe the bloc diagram of microwave link communication system and calculate the link budget.

* Define the different satellite orbits.
* Distinguish the different frequency bands used in satellite systems.
* Identify the different elements of a satellite link and calculate the system gain.
* Describe the bloc diagrams of the radar system; determine its parameters as well as its applications.

***BT3 – Electronics Subject: Digital Telecommunication (II)***

***Evaluation***

* The student will be evaluated according to his aptitude to :
* Draw the bloc diagram of a microwave communication link and calculate the link budget, using the system parameters.
* Find the specified frequency band of microwave links according to their applications.

• Explain the block diagram of the up-link and down-link satellite transmission

system.

* Distinguish the constituting elements of the radar system; identify the different parameters and the domains of applications.

**Chapter 5: Microwave link. (4h)**

5.1. Frequency bands used.

5.2. Bloc diagram and role of each bloc.

5.3. Transmitter circuit.

5.4. Receiver circuit.

5.5. Diversity (frequency and space).

5.6 . System gain and attenuation.

**Chapter 6: Satellite communication system. (4h)**

6.1. Orbits classification.

6.2. Frequency allocations and antenna look angles.

6.3. Geostationary Satellite orbit.

6.4. System bloc diagram.

6.5 . Earth - satellite link (up link).

6.6. Transponder .

6.7 . Satellite-earth links (Down - Link) .

**Chapter 7: Radar. (4 h)**

7.1. Bloc diagram and fundamental principle of bloc

7.2. Frequencies and powers used.

7.3. Parameters and equations of the radar system.

7.4. Pulse radar.

7.5. Doppler effect radar.

8.6. Antennas used in radar.