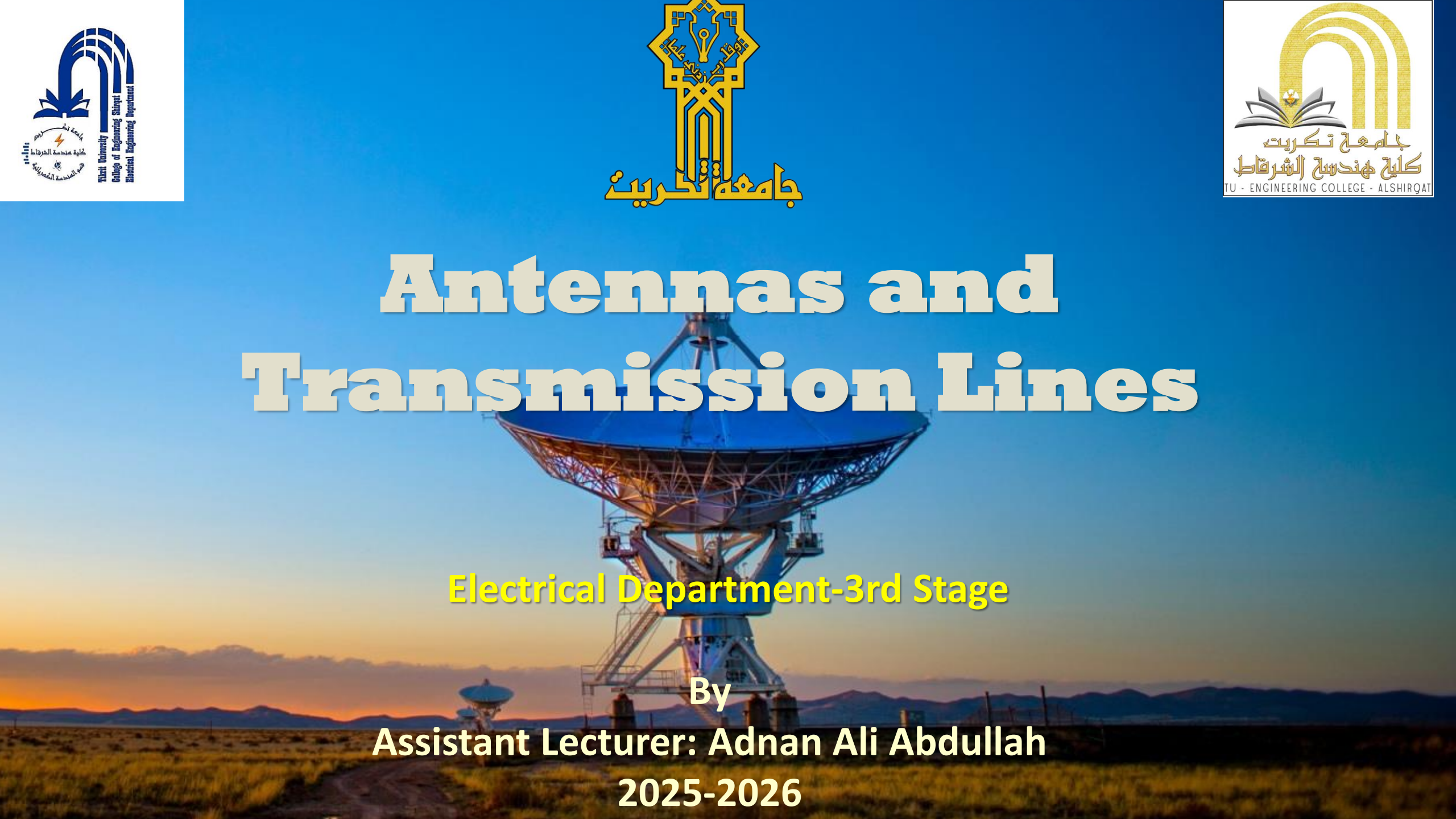


# Antennas and Transmission Lines

Electrical Department-3rd Stage

By

Assistant Lecturer: Adnan Ali Abdullah

2025-2026

## Lecture one

# Introduction

# Antennas

**In the Antennas part we will study the following topics**

- ❑Introduction
- ❑Field radiation pattern.
- ❑Radiation power Density and intensity.
- ❑ Near field-far field.
- ❑Antenna polarization.
- ❑ Pattern width.
- ❑ Half wave dipole.
- ❑ Quarter wave dipole.
- ❑ Hertz dipole
- ❑ Phase array antenna.
- ❑ Helical antenna.
- ❑ Parabolic antenna.
- ❑ Loop antenna,

# Transmission Lines

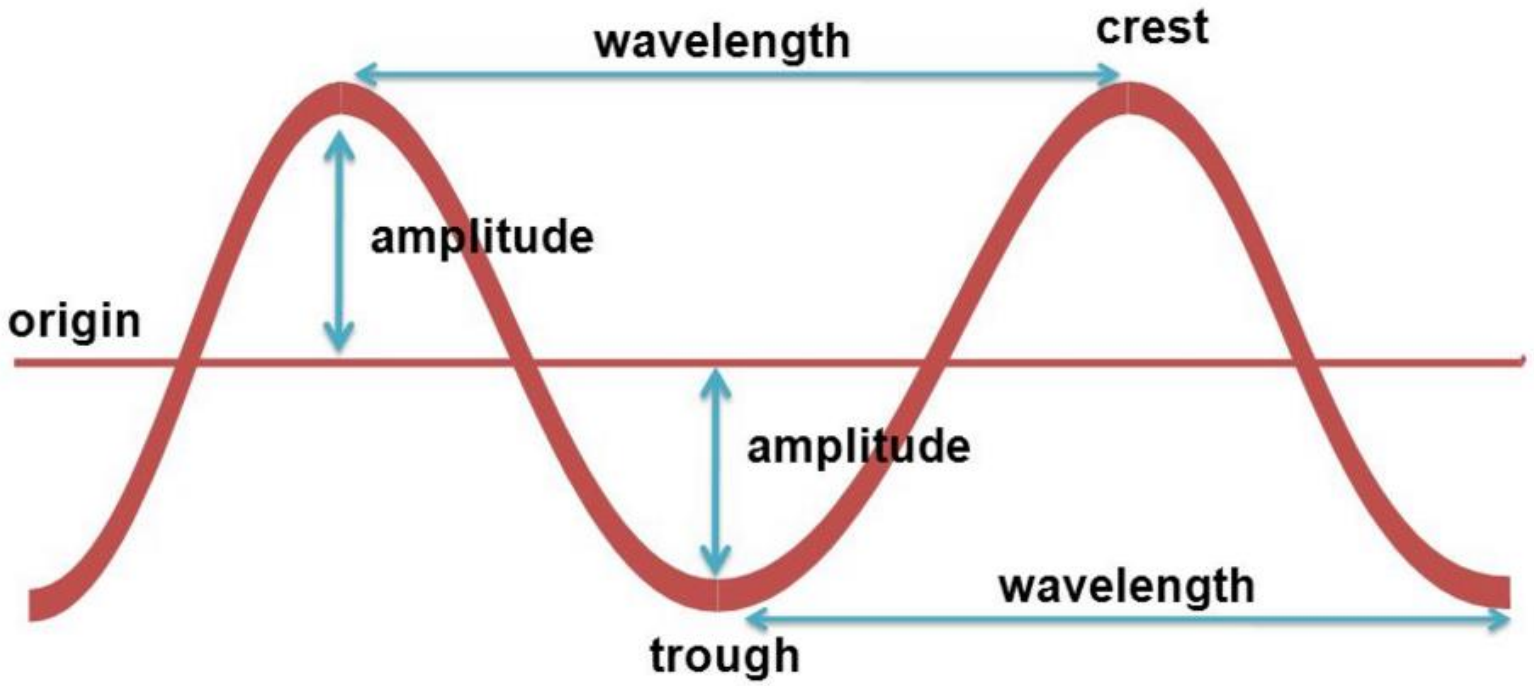
**In the Transmission lines part we will study the following topics**

- ❖Equivalent circuit.
- ❖ Characteristic impedance.
- ❖ Phase velocity.
- ❖ Reflection coefficient.
- ❖ Standing wave.
- ❖ Smith chart calculation.
- ❖Quarter-wave transformer.
- ❖Stub matching.

# Fundamentals

## Waves

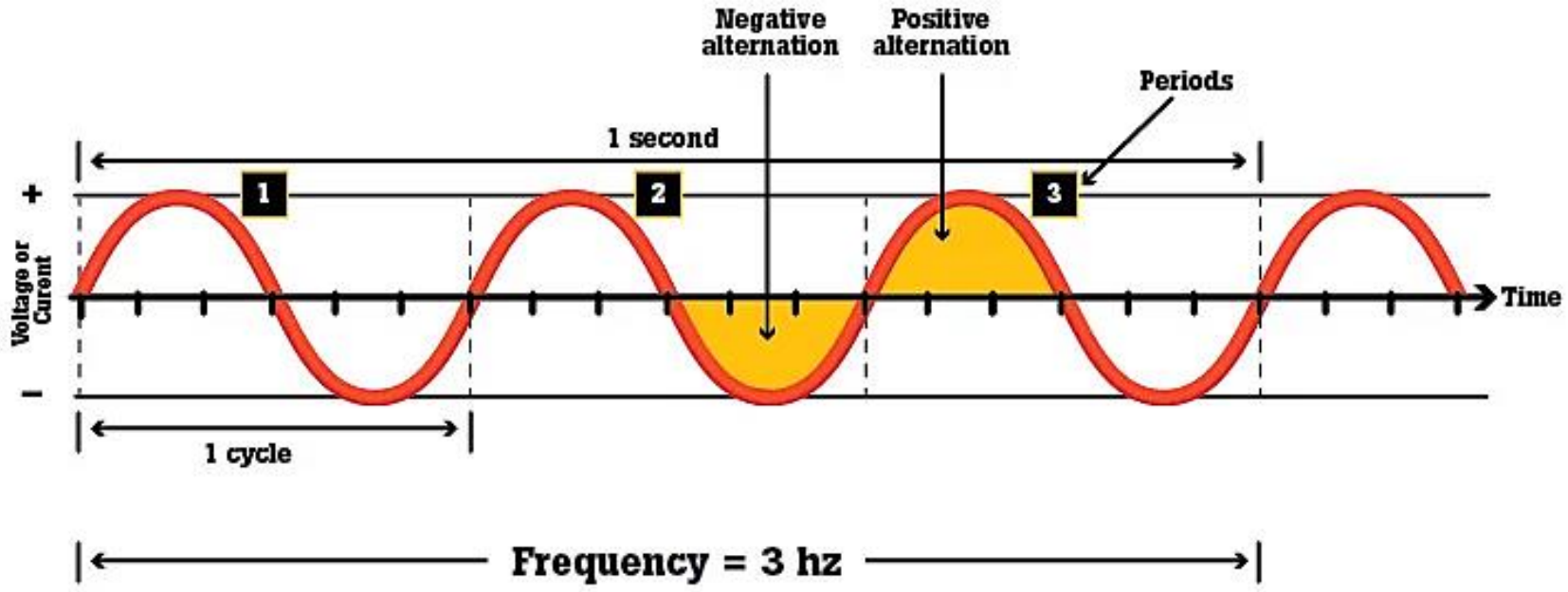
Waves are disturbances that transfer energy from one point to another without the permanent movement of matter. They can propagate through different mediums (such as air, water, or solids) or even in a vacuum (like electromagnetic waves). Waves are characterized by parameters like amplitude, wavelength, frequency, and speed.



# Frequency

frequency, in physics, the number of waves that pass a fixed point in unit time; also, the number of cycles or vibrations undergone during one unit of time by a body in periodic motion, measured in hertz,

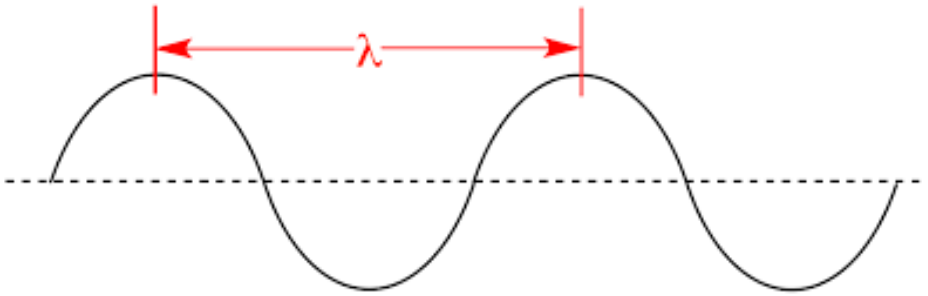
$$f = \frac{1}{T}$$

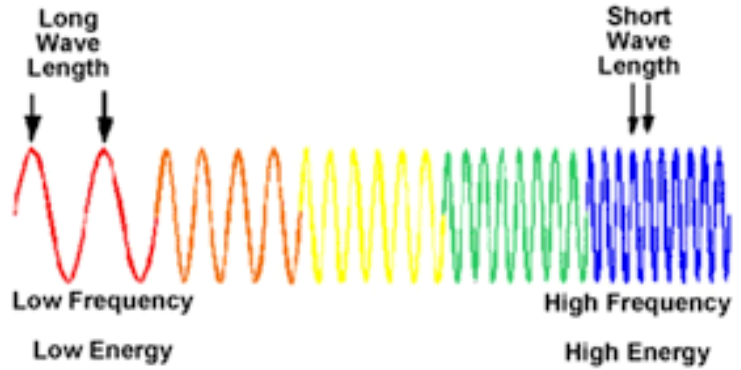


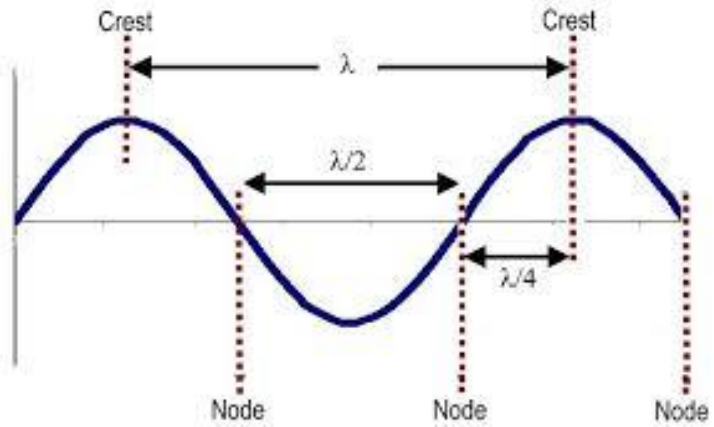
# Wavelength

The wavelength of a wave describes how long the wave is. The distance from the "crest" (top) of one wave to the crest of the next wave is the wavelength. Alternately, we can measure from the "trough" (bottom) of one wave to the trough of the next wave and get the same value for the wavelength.

$$\lambda = \frac{c}{f} = \frac{2\pi}{k}$$

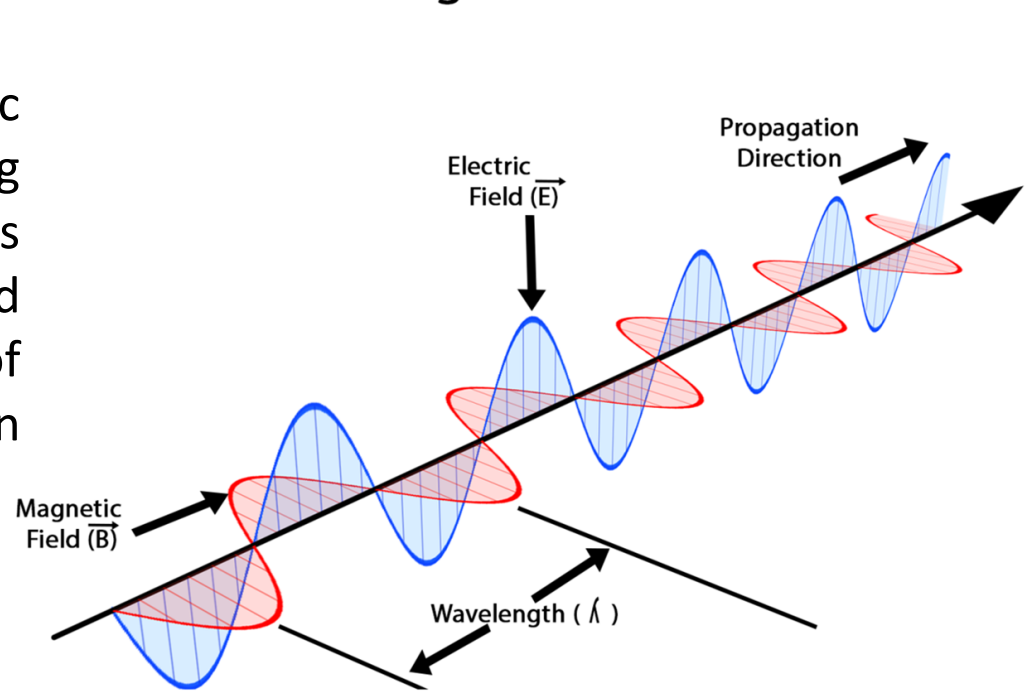


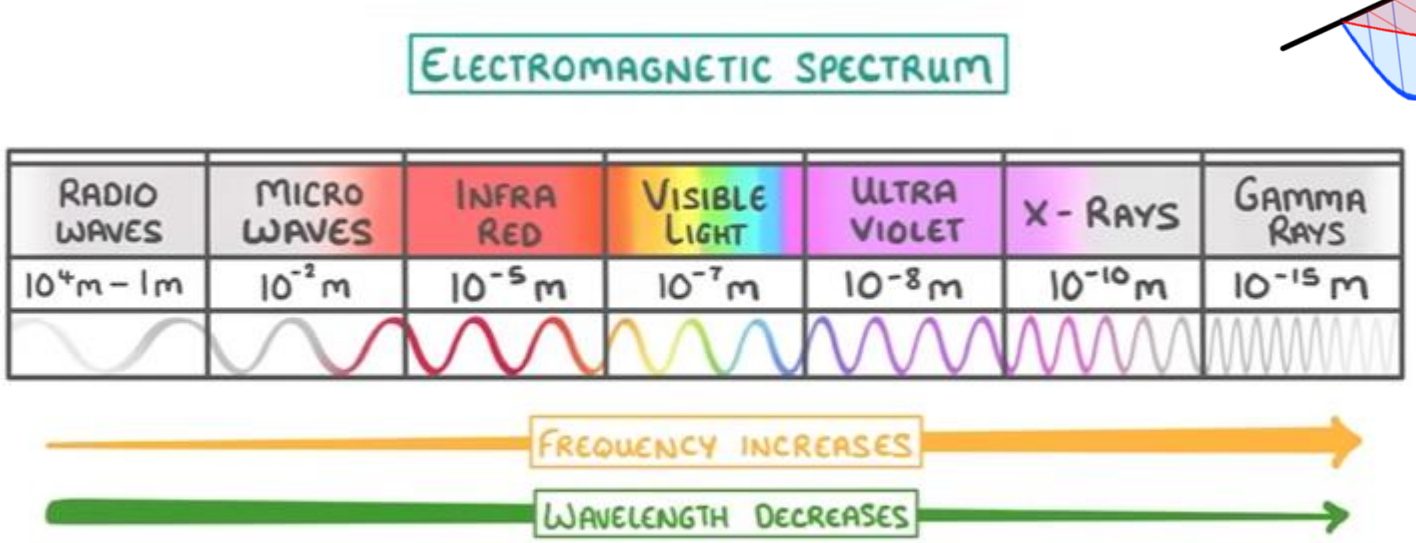



# Electromagnetic Waves

An electromagnetic wave refers to a disturbance in the electric and magnetic field that propagates through space, transferring energy from one point to another. It can be described in terms of parameters such as wavelength, amplitude, frequency, and phase. Electromagnetic waves cover a wide spectrum of frequencies and can be classified into different types based on these frequencies.



Electromagnetic (EM) waves are generated whenever electrically charged particles are accelerated. The relationship between electric charges and magnetic fields creates the foundation for generating these waves. Here's how it works:

**1- Oscillating Charges**: When an electric charge moves back and forth (oscillates), it generates a changing electric field. This change, in turn, induces a changing magnetic field.

**2- Electromagnetic Induction**: According to Maxwell's equations, a time-varying electric field generates a magnetic field, and a time-varying magnetic field generates an electric field. These two fields propagate together in space, forming an electromagnetic wave.

**3- Common Sources:**

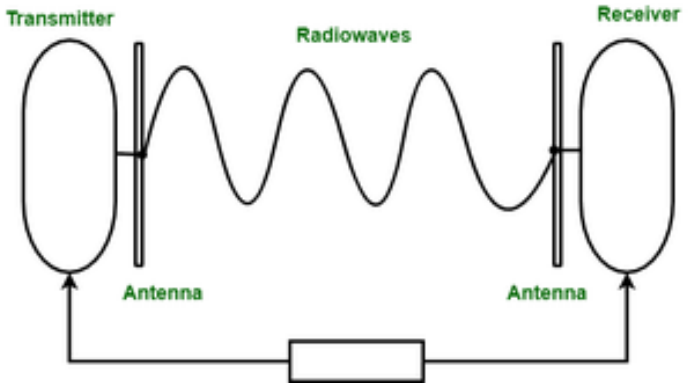
- **Antennas**: In communication systems, **EM** waves are generated using antennas. When alternating current flows through an antenna, the charges in the antenna accelerate, generating oscillating electric and magnetic fields, which then radiate as EM waves.
- **Molecular/Atomic Transitions:** On a microscopic scale, EM radiation can also be emitted when electrons in atoms move between energy levels, which generates light or other forms of EM waves.
- **Natural Sources:** Lightning strikes and the sun are natural sources of electromagnetic radiation. The sun emits a wide range of EM waves due to high-energy processes in its core.

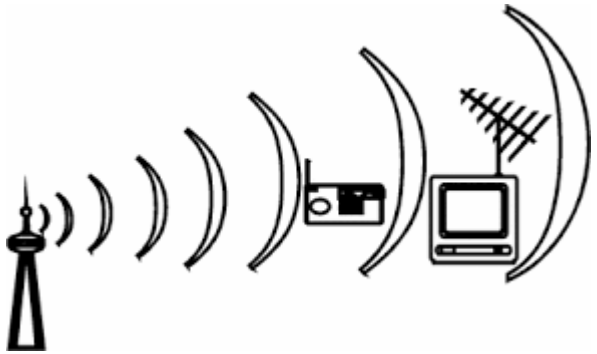
# Radio Waves

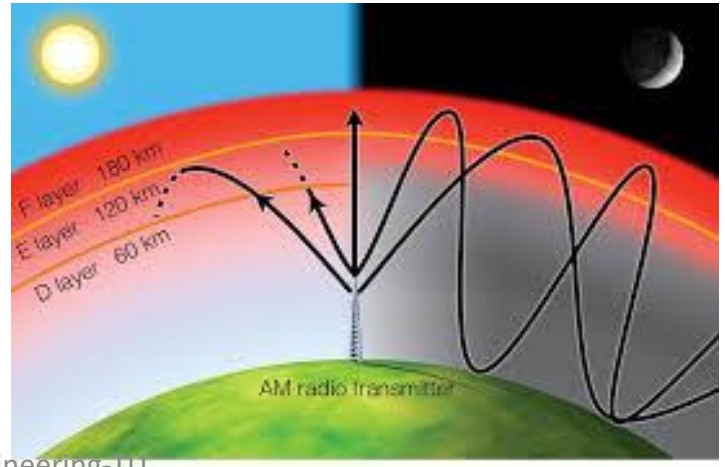
Radio waves are a type of electromagnetic radiation. A radio wave has a much longer wavelength than visible light. Humans use radio waves extensively for communications.

This radio tower has both rectangular and circular antennas to transmit and receive radio frequency energy.

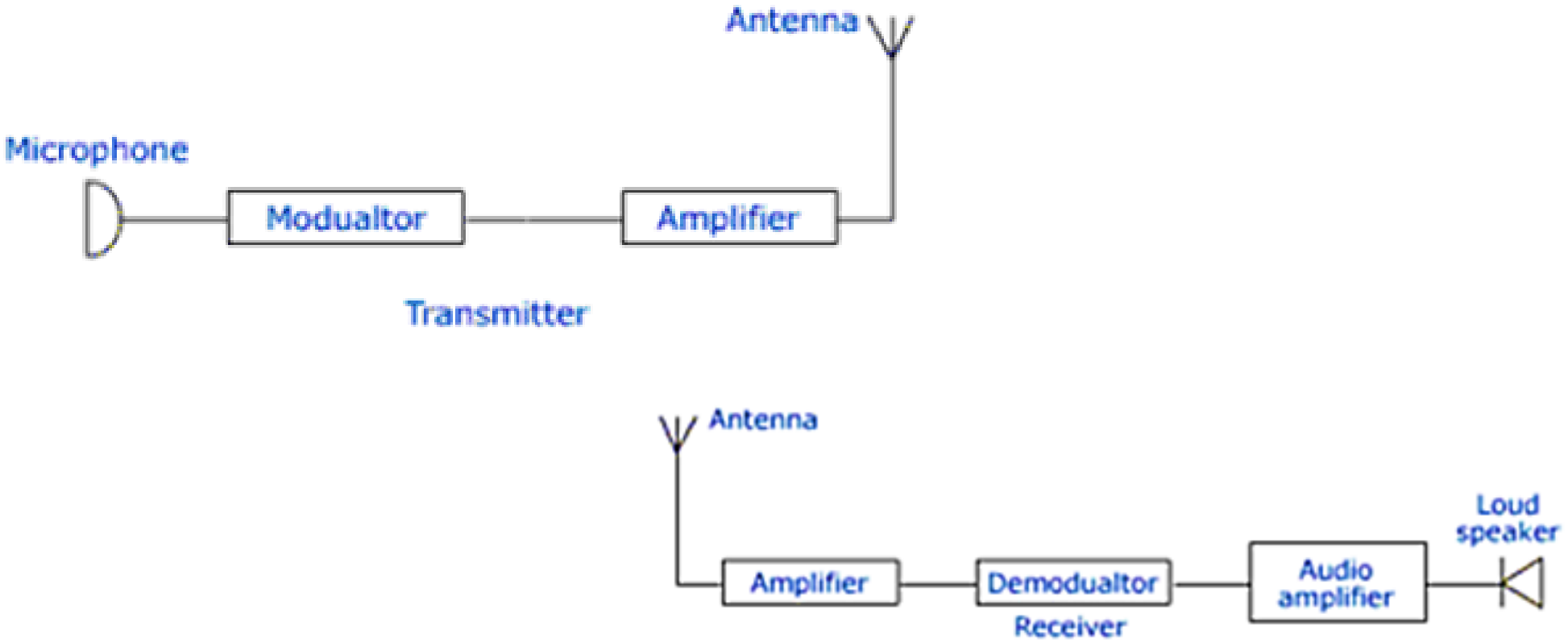
The wavelengths of radio waves range from a few millimeters (tenths of inches) to hundreds of kilometers (hundreds of miles). Visible light, for comparison, has wavelengths in the 400 to 700 nanometer range, about 5,000 times shorter than the shortest wavelength radio waves. Radio waves oscillate at frequencies between a few kilohertz (kHz or thousands of hertz) and a few terahertz (THz or 1012 hertz). "Far infrared" radiation borders radio waves along the electromagnetic spectrum and has slightly higher energy and shorter wavelengths than radio waves.





# Simple Communication System



# So, now what is the Antenna?

- An antenna is a metallic structure that captures and/or transmits radio electromagnetic waves. Antennas come in all shapes and sizes from little ones that can be found on your roof to watch TV to really big ones that capture signals from satellites millions of miles away.

- Antennas are used to transmit and receive nonionizing EM fields, which include radio waves, microwaves, infrared radiation (IR) and visible light.