



# Chapter Nine: Telecommunication

**Telecommunication:** is concerned with sending and receiving information over a distance. In the broadest sense, information can be in the form

- ✓ written
- ✓ spoken words,
- ✓ numbers,
- ✓ diagrams,
- ✓ pictures,
- ✓ music
- ✓ computer data.

## Early history

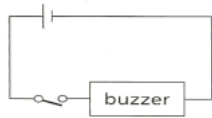
| Scientist                                                                               | Invention                                             | Functions                                                                                                                                                                                                   | Figure                                                                                                                                   |
|-----------------------------------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Wheatstone</b><br>(mid-19th century)                                                 | Electric Telegraph                                    | ✓ Which messages were sent in Morse code as currents in cables.                                                                                                                                             | <br><small>Telegraph transmitting key c.1890</small> |
| <b>Bell</b>                                                                             | The Telephone                                         | <ul style="list-style-type: none"> <li>✓ Making it possible to transmit speech electronically.</li> <li>✓ The use of electrical signals</li> </ul>                                                          | <br><small>Early telephone c.1890</small>           |
| In 1895, after <b>Hertz</b> has using mathematically by <b>Maxwell</b> , <b>Marconi</b> | Wireless Telegraphy(1901)                             | <ul style="list-style-type: none"> <li>✓ Sent and received across the Atlantic.</li> <li>✓ radio telephony became possible and</li> <li>✓ the 'wireless', transformed home life.</li> </ul>                 | <br><small>Radio set 1946</small>                   |
| <b>Baird</b> 1930s                                                                      | Television                                            | ✓ Picture transmission                                                                                                                                                                                      | <br><small>Early television 1948</small>            |
| Since the 1990s                                                                         | Telephone communication<br>Cell phone<br>Fiber optics | <ul style="list-style-type: none"> <li>✓ transmit information at an even greater rate along optical fibers.</li> <li>✓ Rapid communication</li> <li>✓ worldwide via fax, e-mail and the Internet</li> </ul> |                                                                                                                                          |

## Representing Information Digital or Analogue

Information can be represented electrically in two ways.

### a) Digital Method

- ✓ **simple circuit:** In this method electricity is switched on and off and the information is in the form of electrical pulses



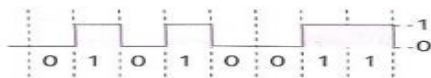
a Simple digital circuit

- ✓ **Morse code:** data can be sent by the 'dots' and 'dashes' of Morse code by closing the switch for a short or a longer time. (· -)



b A in Morse code

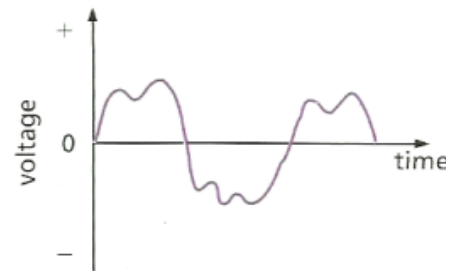
- ✓ **Binary Code:** Computers use the simpler binary code with 1 and 0 represented by 'high' or 'low' voltages respectively.



c S in binary code

### b) Analogue

- ✓ In this case the information is changed to a voltage or current that *varies continuously* and smoothly over a range of values.
- ✓ The waveform of the voltage or current, i.e. its variation with time, represents the information and is an analogue of it,
- ✓ **For example,**
  - the loudness and frequency (pitch)



## Basic communication System

**Electrical signals** representing 'information' from a microphone, a television camera, a computer, etc., can be sent from a place to place using either cables or radio waves. While some signals can be sent directly through cables, in general, and certainly in radio and television, as we will see later, a 'carrier' wave is required to transport them as shown in Figure 3.4.

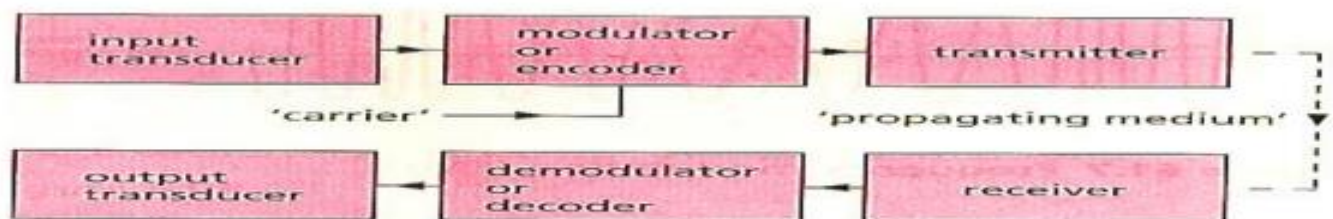


Figure: 3. 4 Communication system

Signals from the input transducer are added to the carrier in the modulator or encoder by the **process of modulation**. This involves impressing one wave system (the signal) upon another, higher frequency, system (the carrier). The modulated signal is then sent by the transmitter into the propagating **medium** (i.e. cable or radio wave).

At the receiving end, **the receiver** may have to select and perhaps amplify the modulated signal before the demodulator or decoder extracts from it the information signal for delivery to the **output transducer**. Some form of storage by a tape or disc may also be required.

## Radio waves

**Radio waves:** are members of the family of electromagnetic radiation.

They are energy carriers which travel at the speed of light  $c$ , their frequency  $f$  and wavelength  $\lambda$  by the **equation  $v = f\lambda$** . Where  $v = c = 3.0 \times 10^8$  m/s in a vacuum (or air).

Radio waves can be classified either by their frequency or their wavelength. The table 3.1 below shows how they are grouped into different frequency bands.

**Table: 3.1 Classification of radio waves**

| Frequency band                    | Typical wavelength   | Some uses                                                |
|-----------------------------------|----------------------|----------------------------------------------------------|
| Low (LF)<br>30 kHz–300 kHz        | Long<br>1500 m       | Long-wave radio and communication over large distances   |
| Medium (MF)<br>300 kHz–3 MHz      | Medium<br>300 m      | Medium-wave local and distant radio                      |
| High (HF)<br>3 MHz–30 MHz         | Short<br>30 m        | Short-wave radio and communication, amateur and CB radio |
| Very high (VHF)<br>30 MHz–300 MHz | Very short<br>3 m    | FM radio, police, emergency services                     |
| Ultra high (UHF)<br>300 MHz–3 GHz | Ultra short<br>30 cm | TV (bands 4, 5)                                          |
| Super high (SHF)<br>above 3 GHz   | Microwaves<br>3 cm   | Radar, communication satellites, telephone and TV links  |

(1 GHz = 1000 MHz)

Radio waves can travel from a transmitting aerial in one or more *of three different ways*.

### a) Surface or ground waves

- ✓ These follow the earth's surface
- ✓ Have a limited range,
- ✓ Being greatest (1500 km) for long waves
- ✓ Much less for VHF.

### b) Space waves

- ✓ These give straight-line transmission over 100 km
- ✓ the way VHF, UHF and microwaves travel.
- ✓ They can also penetrate the ionosphere
- ✓ satellite communication uses this type of transmission

### C) Sky waves

- ✓ These travel skywards and if they are below a certain critical frequency (typically 30 MHz) are returned to Earth by bouncing off the ionosphere.
- ✓ This consists of layers of air molecules (the D, E and F layers),
- ✓ stretching from about 80 km above the Earth to 500 km,
- ✓ Sky waves of low, medium and high frequencies can travel thousands of kilometers.

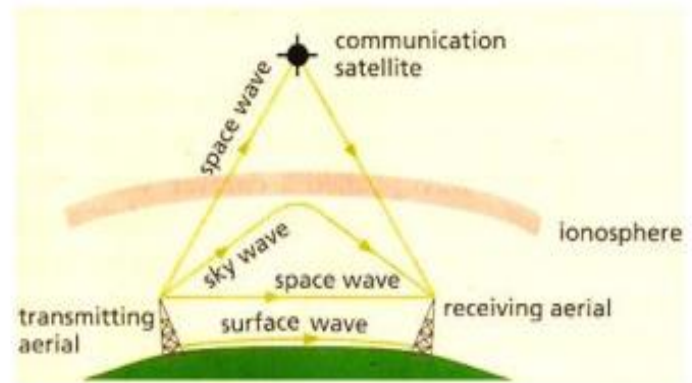


Figure: 3.5 Transmission of radio waves

## Radio system

**Radio waves** are emitted by aerials when a.c. flows in them

**Audio Frequency (a.f.) currents** : Alternating currents with frequencies below about 20 kHz.

**Radio Frequency (r.f.) currents**: Those with frequencies greater than 20 kHz.

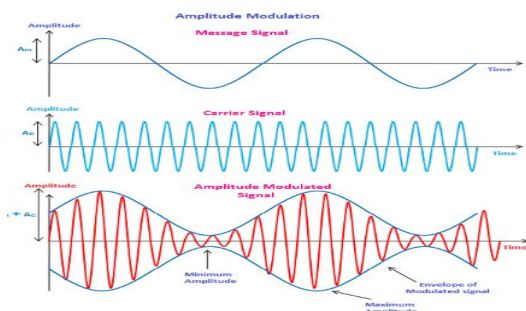
However, speech and music generate a.f. currents and so some way of combining a.f. with r.f. is required if they are to be sent over a distance.

#### a) Transmitter

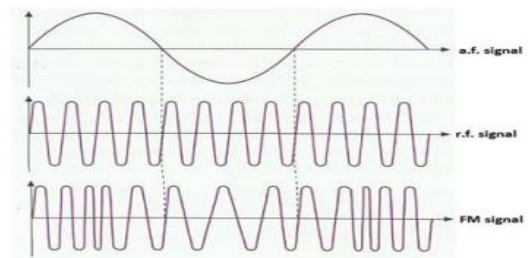
**Oscillator**: produces an r.f. current which would cause an aerial connected to it to send out an electromagnetic wave,

**carrier wave**: is the continuous electromagnetic radiation, of constant amplitude and frequency, that is given out by a transmitter. The r.f. signal has to be modified or modulated so that it 'carries' the a.f. This is done in various ways.

- **In amplitude modulation (AM)**: the amplitude of the r.f. is varied so that This type of transmitter is used for medium and long-wave broadcasting in Britain.



- **In frequency modulation (FM)**: which is used in VHF broadcast, the frequency of the carrier is altered at a rate equal to the frequency of the a.f. but the amplitude remains constant.

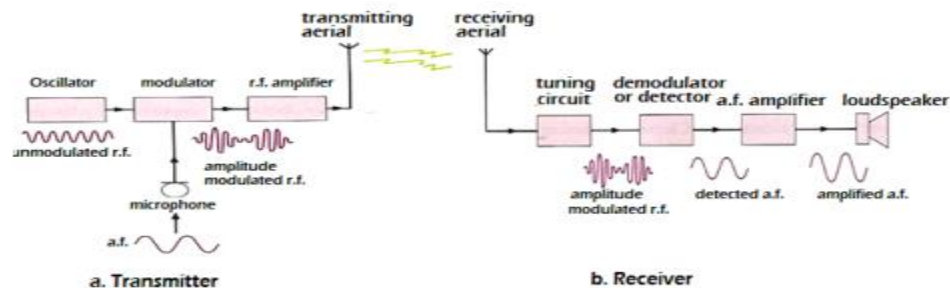


## B) Receiver

**Tuning circuit:** selects the wanted signal from the aerial.

**The detector (or demodulator):** separates the a.f. (speech or music) from the r.f. carrier. **The**

**amplifier:** then boosts the a.f. which produces sound in the loudspeaker.



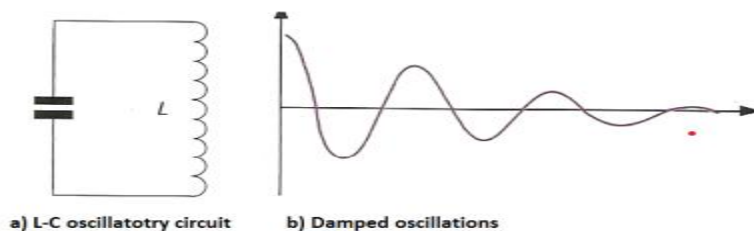
## Electrical oscillations

The production of r.f. currents is impossible with mechanical generators but is readily achieved electrically by using an **oscillatory circuit**.

oscillatory circuit contains a

- capacitor  $C$
- coil  $L$

If  $C$  is charged and discharges through  $L$ , currents flows backwards and forwards round the circuit, alternately discharging and charging  $C$ , first one way then the other. The frequency of the a.c. produced depends on  $C$  and  $L$ ; Due to *the resistance of the coil*, the current eventually stops and a *decaying or damped oscillation* is obtained,



## Tuning circuit

A **tuning circuit**: is the heart of selecting a specific radio station in a receiver. Each induces a signal in the aerial of a radio receiver but if the aerial is connected to an **L-C circuit**.

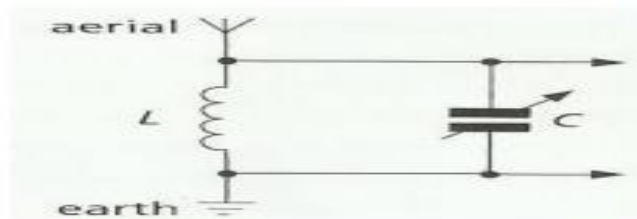


Figure: 3. 10 Turning circuit

## Detection or demodulation

In detection or demodulation, the a.f. which was 'added' to the r.f. in the transmitter is recovered in the **receiver**. The diode produces rectified pulses of **r.f.** current  $I_r$ . These charge up  $C$  during the positive half-cycles as well as flowing through the earphone. During the negative half-cycles when the diode is non-conducting,  $C$  partly discharges through the earphone. The **p.d.**  $V_c$  across  $C$  (and the earphone) varies as in Figure 3.11c if  $C$  and  $R$  have the correct values. The voltage has been smoothed and apart from the slight **r.f.** ripple  $V_c$  has the same frequency and shape as the modulating **a.f.** and reproduces the original sound in the earphone. Germanium diodes are used as detectors. If a loudspeaker is to be operated, the detector is followed by several stages of **a.f.** amplifications. A suitable resistor then replaces the earphone

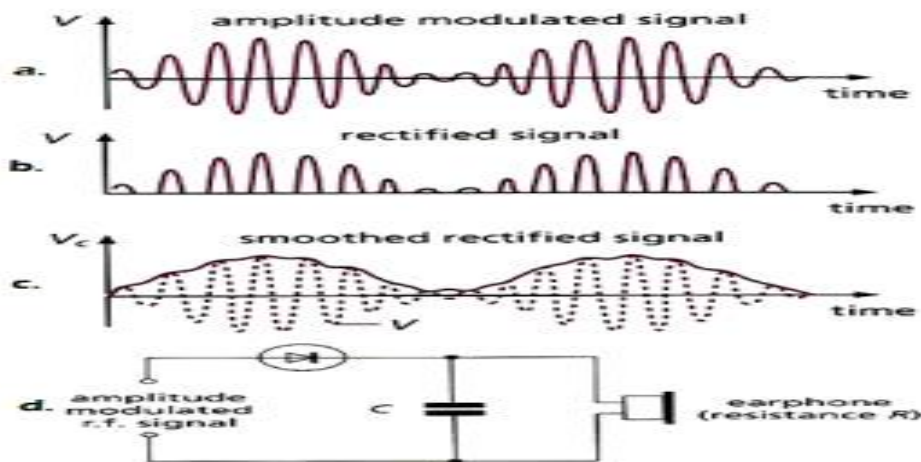


Figure: 3. 11 Detection of an AM signals

## Simple Radio Receiver

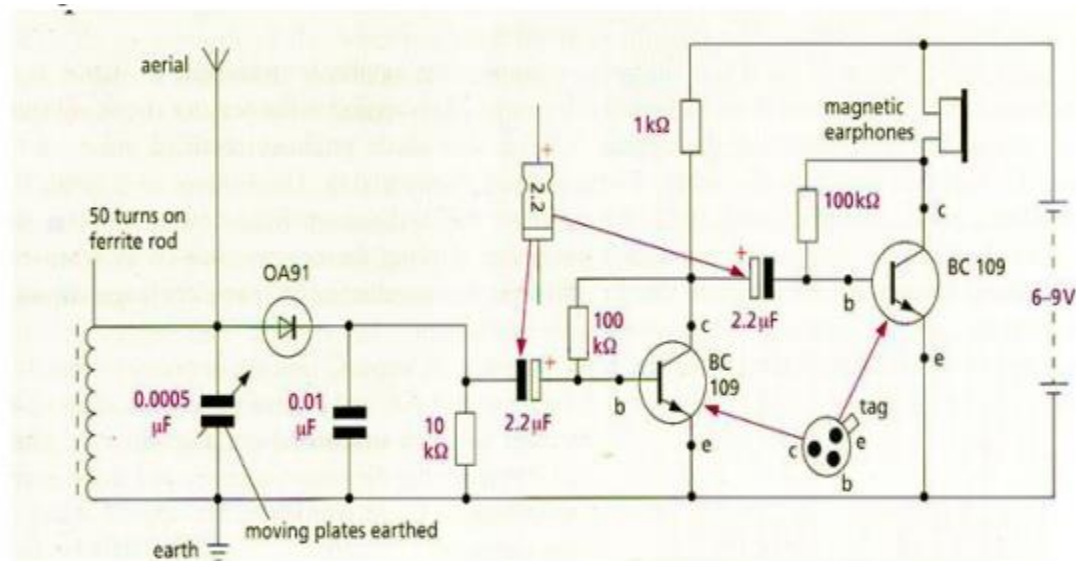


Figure: 3. 12 Simple radio receiving circuit

## Television

### a) Black and white

A television receiver is basically a CRO with two-time bases. The horizontal or line time base acts as in the CRO. The vertical or frame time base operates at the same time and draws the spot at a much slower rate down to the bottom of the screen. The spot thus draws a series of parallel lines of light (625) which covers the screen, Figure 3.15, and is called a **raster**.

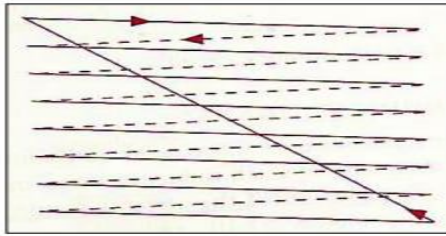


Figure: 3. 15 Pattern of lines (raster) on a TV screen

### b) Color

One type of color television has three electron guns and the screen is coated with about a million tiny light emitting dots arranged in triangles. One 'dot' in each triangle emits red light when hit by electrons, another green light and the third blue light.

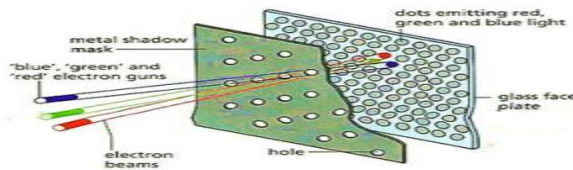


Figure: 3. 16 Colour TV screen

### c) Energy transfers

If this  $V$  and an electron has charge  $e$  and a mass  $m$ , then an amount of electrical energy  $eV$  (from  $W = QV$ ) is transferred to kinetic energy of the electron. Therefore

$$k.e = \frac{1}{2}mv^2 = eV$$

Where  $V$  is the final velocity of the electron. This k.e. is transferred to heat and light when the electron hits the screen, We can calculate the k.e. if we take  $e = 1.6 \times 10^{-19} \text{ C}$ ,  $V = 25 \text{ kV}$  Then  $k.e$ .

$$e = eV = 1.6 \times 10^{-19} \text{ C} \times 25 \times 10^3 = 4.0 \times 10^{-15} \text{ J}$$

## Question and Answers

### 1. What is the Telecommunication?

- ✓ Telecommunications is concerned with sending and receiving information over a distance.

### 2. What is the Telegraph?

- ✓ Telegraph messages were sent in Morse code as currents in cables.

### 3. list two ways of Representing information?

- ✓ Information can be represented electrically in two ways
  - **Digital method** :- electricity is switched on and off and the information is in the form of electrical pulses.
  - **Analogue method** :- in this the information is changed to a voltage or current that varies continuously and smoothly over a range of values

### 4. What is basic building blocks of any communication system?

- ✓ The basic building blocks of any communication system the are shown in figure.

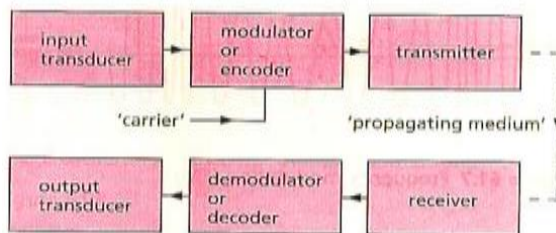


Figure: 3.4 Communication system

### 5. What is the Radio waves?

- ✓ Radio waves are member of the family of electromagnetic radiation.

### 6. What are three different ways for transmitting radio waves?

- ✓ Radio waves can travel from a transmitting aerial in one or more *of three different ways*.
  - Surface Or Ground Waves
  - Sky Waves
  - Space Waves

### 7. Explain surface or ground waves?

- These follow the earth's surface have a limited range. Being greatest (1500 km ) for long waves but much less for VHF.

### 8. Explain sky waves?

- These travel skywards and if they are below a certain critical frequency (typically 30 MHz ) are returned to earth by bouncing off the ionosphere.

### 9. Explain the space waves?

- These gives straight-line transmission over 100 km or so on Earth in the absence of intervening obstacles such as hills and building, and the way VHF,UHF and microwave travel.

### 11. What are types of Radio system?

- ❖ Transmitter
- ❖ Receiver

### 12. Discuss transmitter and receiver?

#### a) Transmitter

**Oscillator:** produces an r.f. current which would cause an aerial connected to it to send out an electromagnetic wave.

**carrier wave:** is the continuous electromagnetic radiation, of constant amplitude and frequency, that is given out by a transmitter.

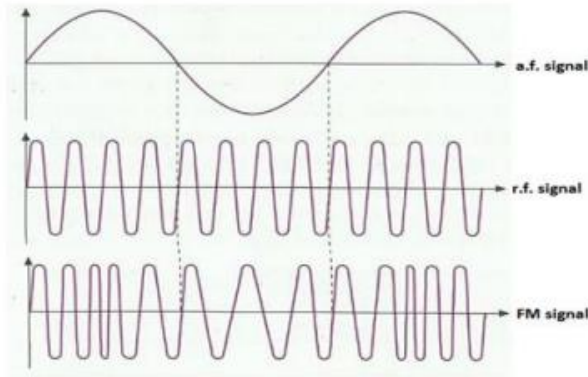
#### b) Receiver

**tuning circuit:** selects the wanted signal from the aerial.

**The detector (or demodulator):** separates the a.f. (speech or music) from the r.f. carrier. **The amplifier:** then boosts the a.f. which produces sound in the loudspeaker.

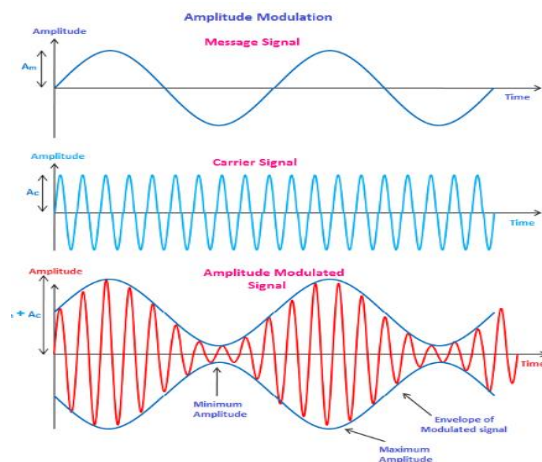
### 13. What is frequency modulation (FM)?

- **In frequency modulation (FM):** which is used in VHF broadcast, the frequency of the carrier is altered at a rate equal to the frequency of the a.f. but the amplitude remains constant.



#### 14. What is amplitude modulation (AM)?

- **In amplitude modulation (AM):** the amplitude of the r.f. is varied so that it depends on the a.f. current from the microphone, the process occurring in a modulator. This type of transmitter is used for medium and long-wave broadcasting in Britain; shown below is a block diagram for one.



#### 15. Explain electrical oscillation?

- Production of r.f. current is impossible with mechanical generators but is readily achieved electrically by using an oscillatory circuit.

#### 16. What is the turning Circuit?

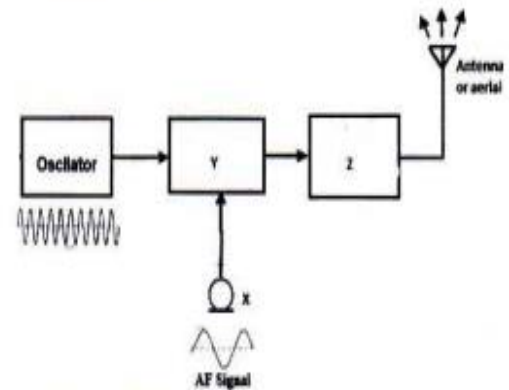
- **tuning circuit:** selects the wanted signal from the aerial.
- Different transmitting stations send out radio waves of different frequencies.

#### 17. What is the detection or demodulation?

- Detection or demodulation the r.f. which was added to the r.f. in the transmitter is recovered in the receiver.

#### EXAM 2024

5. The diagram below shows a system of radio Telecommunication. Look at it carefully and then answer the following questions



- a) The system represents. (1 mark)

Radio transmitter   
Radio receiver

- b) Name the parts of the diagram labeled. (3 marks)

X   
Y   
Z

- c) What is the function of the oscillator in the system? (2 marks)

#### EXAM 2019

7. The a system of radio transmitter.

then answer the following questions

a) Products audio frequency (a.f) signals ?

.....

b) Produces carrier frequency (r.f) signals?

.....

c) Sends out radio waves?

.....

d) Mixes a.f signals in to r.f carrier ?,

.....

e) Increases the energy of modulated wave?.

.....