Subject - Basic Electronics Engg. (104010)

FE - 2019 course

UNIT-VI: Communication Systems

Syllabus

Basic Communication System:

- Block Diagram
- Modes of Transmission
- Communication Media: Wired and Wireless
- Electromagnetic Spectrum
- Allotment of frequency band for different applications
- Block Diagram of AM and FM Transmitter and receiver,

Mobile Communication System:

- Cellular concept
- Simple block diagram of GSM system.

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UNIT-VI: Communication Systems

Q.1) Draw & explain the block diagram of Communication system.

Answer:

Communication System:

- The communication means sending, receiving and processing of information between two or more devices.
- The **communication system** basically deals with the transmission of information from one point to another using the well-defined steps which are carried out in sequential manner. The system for data transmission makes use of the information source and destination address.
- Some examples of communication system include radio broadcasting, TV broadcasting, mobile communication, computer communication etc.

Block diagram of Communication System:

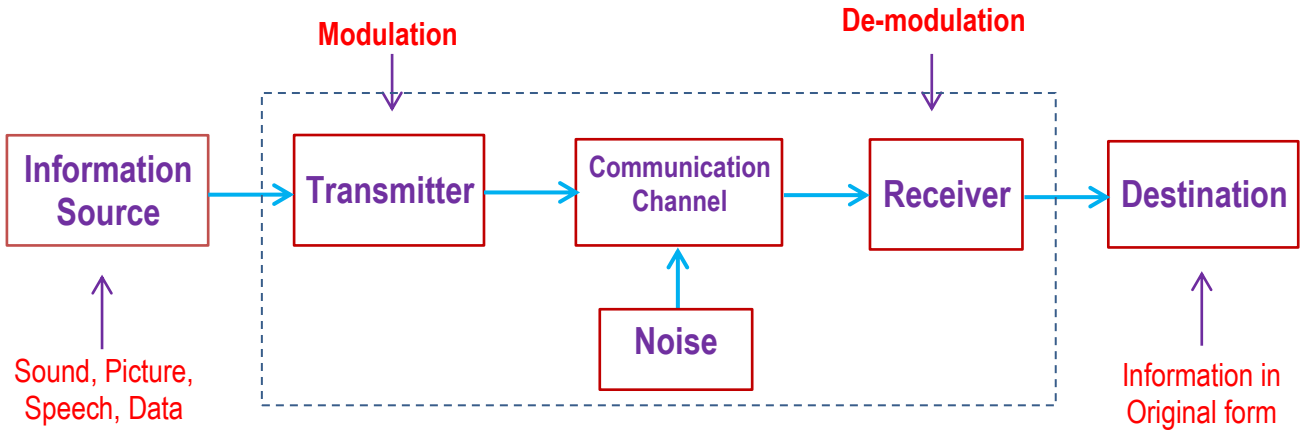


Fig. Block diagram of Basic Communication System

Block diagram of Communication System is shown in figure.

It consists of,

1. Information source
2. Transmitter
3. Communication channel
4. Receiver
5. Destination

1. Information source:

- The communication system establishes the communication bridge between the transmitter and receiver. To establish this communication bridge between the transmitter and receiver, we need information to send. This information originates in the information source.
- The information generated by the source may be in the form of sound, picture, speech.
- **Example:** In telephone/Mobile communication - information in the form of sound.

2. Transmitter: (Modulation)

- The transmitter is a device which converts the signal produced by the source into a form that is suitable for transmission over a given channel or medium.
- Transmitters use a technique called modulation to convert the electrical signal into a form that is suitable for transmission over a given channel or medium. Modulation is the main function of a transmitter.

3. Communication channel:

- The communication channel is a medium through which the signal travels. or
- The communication channel is a wired or wireless medium through which the signal (information) travels from source (transmitter) to destination (receiver).
- Communication channels are divided into two categories: wired and wireless.
- **Examples** of wired channels - co-axial cables, fiber optic cables & twisted pair telephone lines.
- **Examples** of wireless channels - air, water & vacuum.

4. Noise:

- Noise is an unwanted signal that enters the communication system via the communication channel and interferes with the transmitted signal.
- The noise signal degrades the transmitted signal.

5. Receiver: (Demodulation)

- The receiver is a device that receives the signal (electrical signal) from the channel and converts the signal (electrical signal) back to its original form (light and sound) which is understandable by humans at the destination.
- **Example:** TV set receives the signals sent by the TV transmitting stations and converts the signal into a form which is easily understandable by the humans who are watching TV.

6. Destination:

- The destination is the final stage in the communication system. Generally, humans at some place are considered as the destination. A destination is a place where humans consume the information.
- **Example**: if you are watching TV, you are considered as the destination.

Q.2) Give the classification of different modes of transmission & explain it.

Answer:

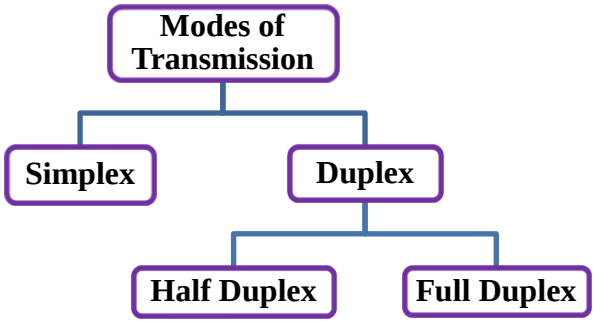
Modes of Transmission:

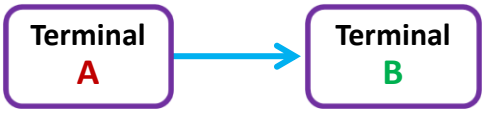
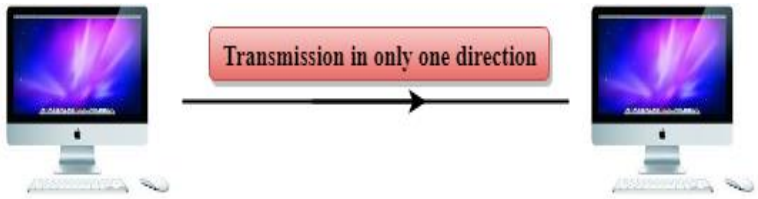
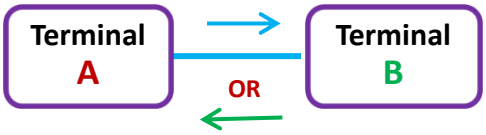
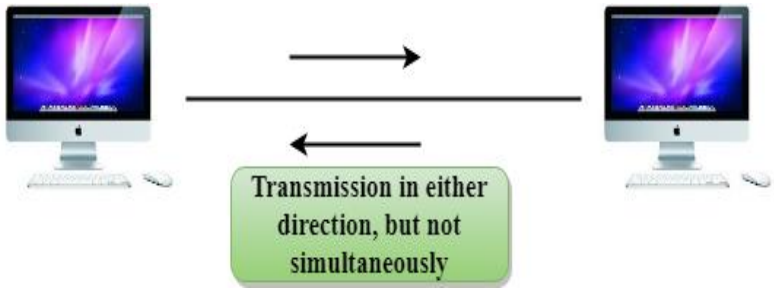
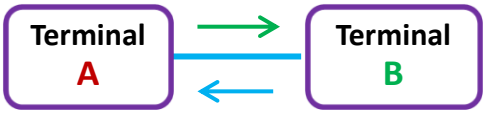
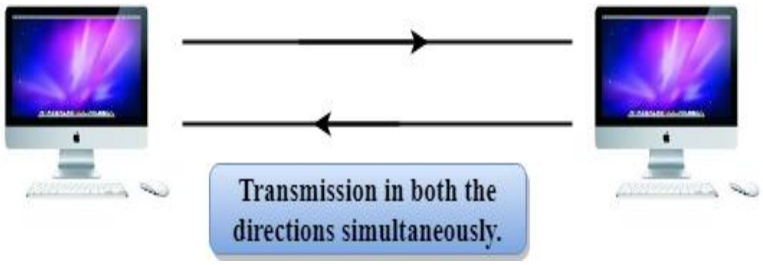
- The way in which data is transmitted from one device to another device is known as **transmission mode**.
- The transmission mode is also known as the communication mode.
- Each communication channel has a direction associated with it, and transmission media provide the direction. Therefore, the transmission mode is also known as a directional mode.
- The transmission mode is defined in the physical layer.

The **modes of transmission** are as follows,

1. Simplex
2. Duplex: Half duplex and full duplex.

   The **transmission mode** defines the direction of signal flow between **two** connected devices.



1. Simplex Mode: Transmission in only one direction. 	
2. Half Duplex Mode: Transmission in either direction, but not simultaneously. 	
3. Full Duplex Mode: Transmission in both directions simultaneously. 	

1. Simplex Mode:

- In Simplex mode, the communication is unidirectional, i.e., the data flow in one direction.
- A device can only send the data but cannot receive it or it can receive the data but cannot send the data.
- This transmission mode is not very popular as mainly communications require the two-way exchange of data. The simplex mode is used in the business field as in sales that do not require any corresponding reply.
- **Example:** Keyboard and Monitor are the examples of the simplex mode as a keyboard can only accept the data from the user and monitor can only be used to display the data on the screen.

Advantages:

- In simplex mode, the station can utilize the entire bandwidth of the communication channel, so that more data can be transmitted at a time.

Disadvantages:

- Communication is unidirectional, so it has no inter-communication between devices.

2. Half-Duplex Mode:

- In half-duplex mode, each station can both transmit and receive, but not at the same time.
- When one device is sending, the other can only receive, and vice versa.
- The half-duplex mode is used in cases where there is no need for communication in both directions at the same time. The entire capacity of the channel can be utilized for each direction.
- **Example:** Walkie- talkie in which message is sent one at a time and messages are sent in both the directions.

Advantages:

- In half-duplex mode, both the devices can send and receive the data and also can utilize the entire bandwidth of the communication channel during the transmission of data.

Disadvantages:

- In half-duplex mode, when one device is sending the data, then another has to wait, this causes the delay in sending the data at the right time.

3. Full-Duplex Mode:

- In full-duplex mode, both stations can transmit and receive simultaneously.
- In full duplex mode, signals going in one direction share the capacity of the link with signals going in other direction, this sharing can occur in two ways:
- Either the link must contain two physically separate transmission paths, one for sending and other for receiving. The capacity is divided between signals travelling in both directions.
- Full-duplex mode is used when communication in both directions is required all the time. The capacity of the channel however must be divided between the two directions.
- **Example:** Telephone Network in which there is communication between two persons by a telephone line, through which both can talk and listen at the same time.

Advantages:

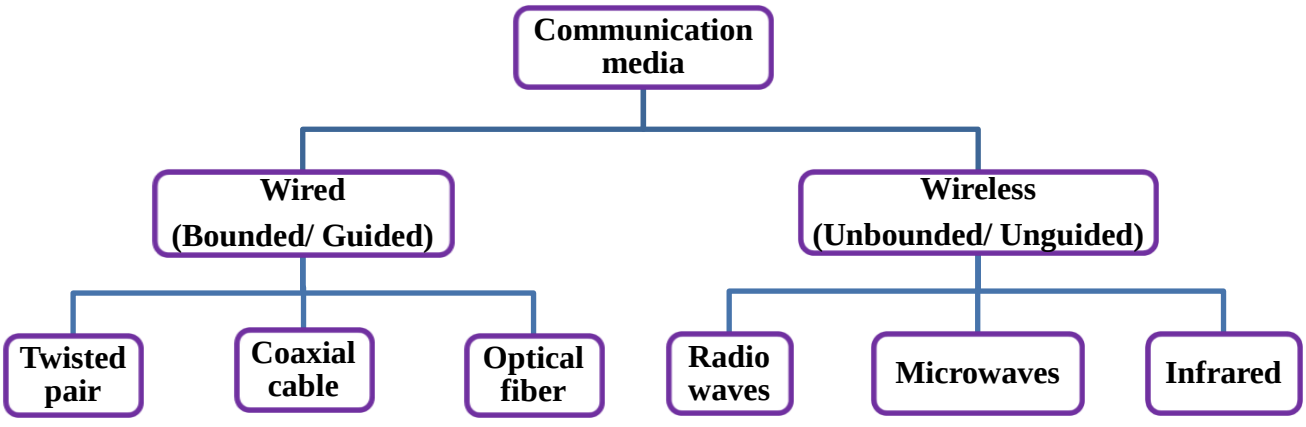
- Both the stations can send and receive the data at the same time.

Disadvantages:

- In full-duplex mode, there is no dedicated path exists between the devices, and then the capacity of the communication channel is divided into two parts.

Q.3) Explain different types of communication media/Transmission media used in electronic communication OR Explain different types of cables used in electronic communication.

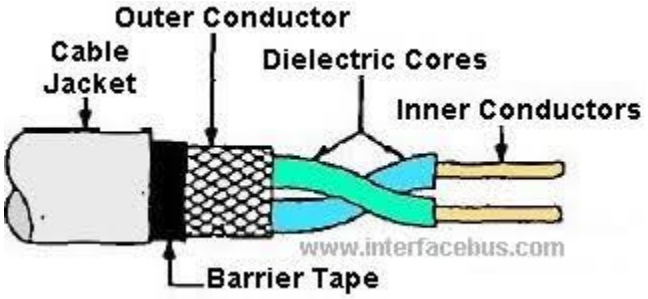
Answer:



A. Wired Media (Bounded/Guided media) :

- In this communication, devices are connected to each other by cables.
- It is also known as bounded/guided media.
- **Example:** Copper wire, Fiber optic cables etc.
- Wired media are further categories as Twisted pair, Coaxial cable and Optical fiber.

1. Twisted Pair:



- It consists of a pair of copper wires twisted around each other; the wires are around 1 to 2 mm thick and they are twisted to reduce the interference from the surrounding wires.
- Remember that a current carrying wire has a magnetic field around it that can interfere with that of another wire when in close proximity.
- Twisted Pair is of two types:

(i) Unshielded Twisted Pair (UTP):

This type of cable has the ability to block interference and does not depend on a physical shield for this purpose.

It is used for telephonic applications.

Advantages:

- Least expensive
- Easy to install
- High speed capacity

Disadvantages:

- Susceptible to external interference
- Lower capacity
- Short distance transmission due to attenuation

(ii) Shielded Twisted Pair (STP):

This type of cable consists of a special jacket to block external interference.

It is used in fast-data-rate Ethernet and in voice and data channels of telephone lines.

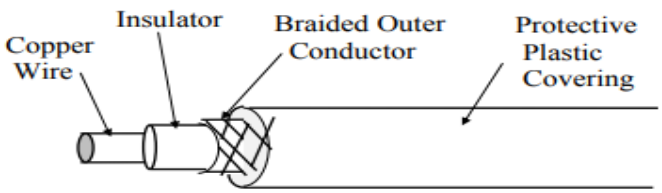
Advantages:

- Better performance
- Eliminates crosstalk
- Comparatively faster

Disadvantages:

- Comparatively difficult to install and manufacture
- More expensive
- Bulky

2. Coaxial Cable:



- Offering better data rates and less signal attenuation, a coaxial cable consist of a central copper conductor that is surrounded by a foil shield. The foil is covered by yet another shield known as a braided shield. Unlike twisted pairs, coaxial cables only have a single copper conductor. The conductor and the foil shield are separated by a dielectric.
- Cable TVs and analog television networks widely use Coaxial cables.

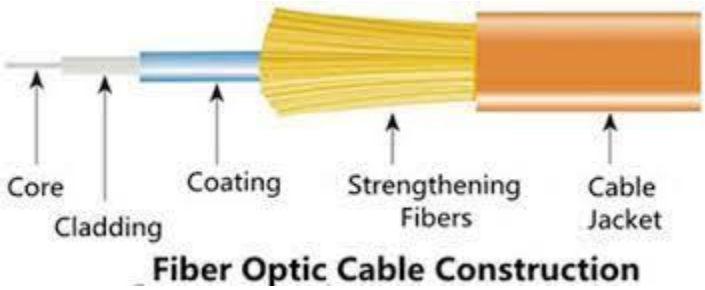
Advantages:

- High Bandwidth
- Better noise Immunity
- Easy to install and expand
- Inexpensive

Disadvantages:

- Single cable failure can disrupt the entire network

3. Fiber Optic:



Fiber Optic Cable Construction

- It is the most expensive of wired mediums and offers the highest rates of data transmission. They are often used in long distance communications and are never affected by any electromagnetic fields. This is because it involves light.
- A fiber optic cable is a thin, flexible, transparent medium made of very fine glass or plastic fibers. It utilizes the principle of total internal reflection. Unlike twisted pairs or coaxial cables, a fiber optic uses light pulses generated by laser or an injection diode to transmit data. Each pulse of light represents a single bit of data.
- It is used for transmission of large volumes of data.

Advantages:

- Increased capacity and bandwidth
- Light weight
- Less signal attenuation

Disadvantages:

- Difficult to install and maintain
- High cost
- Unidirectional

B. Wireless media (Unbounded/Unguided media):

- A wireless network uses radio waves as the sole medium for transmitting and receiving data. There are no wires involved. An example is the wireless router in your home. Radio waves are electromagnetic waves which are transverse in nature and they have the longest wavelength on the electromagnetic spectrum.
- They travel at the speed of light and have frequencies ranging from 3 kHz to 3 GHz. Radio waves can easily be absorbed by most materials and can bend around objects as well. However, they are susceptible to nearby electromagnetic fields which can cause losses in the data rate.

Advantages:

- Signal is broadcasted through air
- Used for larger distances

Disadvantages:

- Less Secure

There are 3 major types of Unguided Media:

1. **Radiowaves:**
   These are easy to generate and can penetrate through buildings. The sending and receiving antennas need not be aligned. Frequency Range:3KHz – 1GHz. AM and FM radios for transmission.
2. **Microwaves:**
   It is a line of sight transmission i.e. the sending and receiving antennas need to be properly aligned with each other. The distance covered by the signal is directly proportional to the height of the antenna. Frequency Range: 1GHz – 300GHz.
   These are majorly used for mobile phone communication and television distribution.
3. **Infrared:**
   Infrared waves are used for very short distance communication. They cannot penetrate through obstacles. This prevents interference between systems. Frequency Range: 300GHz – 400THz. It is used in TV remotes, wireless mouse, keyboard, printer, etc.

Additional Information (Note: If comparison is asked write following points.)

Specifications	Wired network	Wireless network
Speed of operation	Higher	Lower
System Bandwidth	High	Low
Cost	Less expensive	More expensive
Installation time	Wired network installation is requires more time	Wireless network installation requires less time

Mobility	Limited	Not limited
Transmission medium	Twisted pair, Coaxial cable and Optical fiber.	Radio waves, Microwaves or infrared
Applications	LAN (Ethernet), MAN	WLAN, WPAN, Infrared, Cellular (GSM,CDMA, LTE)
QoS (Quality of Service)	Better	Poor due to high value of jitter and delay in connection setup

Q.4) Explain the IEEE electromagnetic frequency spectrum.

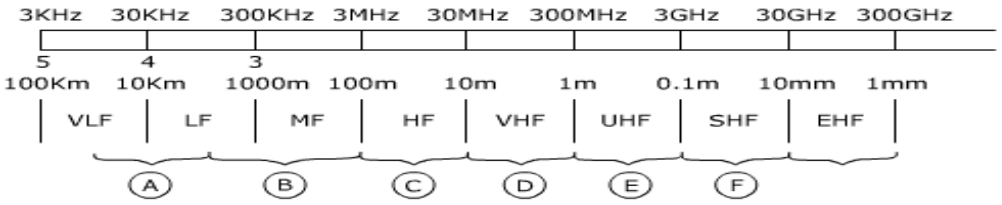
Answer:

Electromagnetic Spectrum: It is a signal made up of oscillating electric and magnetic fields.

- The entire range of frequencies that the EM wave can produce oscillations is termed as *Electromagnetic Spectrum.*
- For the classification purpose, the EM spectrum is divided into small segments and each segment is given a nomenclature.

Each range is identified by end frequencies or wavelengths that differ by a factor of 10.

Frequency (f) range	Wavelength (λ) range	EM spectrum nomenclature
3 – 30 KHz	100 – 10 Km	VLF – Very Low Frequency
30 – 300 KHz	10 – 1 Km	LF – Low Frequency
0.3 – 3 MHz	1000 – 100 m	MF – Medium Frequency
3 – 30 MHz	100 – 10 m	HF – High Frequency
30 – 300 MHz	10 – 1m	VHF – Very High Frequency
0.3 – 3 GHz	1000 – 100 mm	UHF – Ultra High Frequency
3 – 30 GHz	100 – 10 mm	SHF – Super High Frequency
30 – 300 GHz	10 – 1 mm	EHF – Extremely High Frequency



Pictorial Representation of R.F. Bands

Q.5) What is modulation? Explain need of modulation. What are the different techniques of modulation?

Answer:

Terminologies in Communication Systems:

- **Time (t):** Time is a fundamental quantity with reference to which all communications happen. It is measured in seconds (sec).
- **Frequency (f):** Frequency is fundamental quantity with reference to which all signals in a communication system are more commonly distinguished. Frequency is defined as the number of oscillations per second. It is measured in hertz (Hz).
- **Wavelength (λ):** Wavelength is defined as the distance travelled by an EM wave during the time of one cycle.
- **Spectrum:** The frequency domain representation of the given signal.
- **Bandwidth (B.W.):** It is that portion of the EM spectrum occupied by a signal. More specifically it is the range of frequencies over which the information is present in the original signal and hence it may also be termed as signal bandwidth.
- **Channel Bandwidth:** The range of frequencies required for the transmission of modulated signal.
- **Baseband Signal:** Message signal in its original frequency range.
- **Modulation:** Modulation is a process in which any of the characteristics of carrier signal such as amplitude, frequency or phase is varied according to the instantaneous value of modulating signal.

Need of modulation: (Why modulation is required?)

1) To reduce the height of antenna
2) Avoids mixing of signal
3) Allows multiplexing of signal
4) Allows long distance communication
5) Improves quality of reception

Different techniques of modulation:

1. **Amplitude modulation (AM):** (Amplitude "A" is variable)

   If amplitude of carrier signal is varied according to instantaneous amplitude of modulating signal, then process is called as amplitude modulation.

2. **Frequency modulation (FM):** (Frequency "f" is variable)

   If frequency of carrier signal is varied according to instantaneous amplitude of modulating signal, then process is called as frequency modulation.

3. **Phase modulation (PM):** (Phase "φ" is variable)

   If phase of carrier signal is varied according to instantaneous amplitude of modulating signal, then process is called as phase modulation.

Q.6) Differentiate between Amplitude modulation (AM) & Frequency modulation (FM)

Answer:

#Comparison between Amplitude Modulation (AM) & Frequency Modulation (FM)

Amplitude Modulation (AM)	Frequency Modulation (FM)

Amplitude of AM will change with the modulating voltage.	Amplitude of FM remains constant.
Transmitted power is dependent on the modulation index.	Transmitted power remains constant. It is independent on the modulation index.
Carrier power and one sideband power are useless.	All transmitted power is useful
FM receivers are not immune to noise.	FM receivers are immune to noise.
Bandwidth $= 2f_m$. Bandwidth is interdependent on modulation index.	Bandwidth $= 2(\delta + f_m)$. Bandwidth depends on modulation index.
Bandwidth is less than FM.	Bandwidth is large hence large channel is required.
AM equipments are more complex	FM equipments are more complex
Not possible to operate several channels on same frequency	Possible to operate several transmitters on same frequency

Q.7) Draw Block Diagram of AM Transmitter and explain

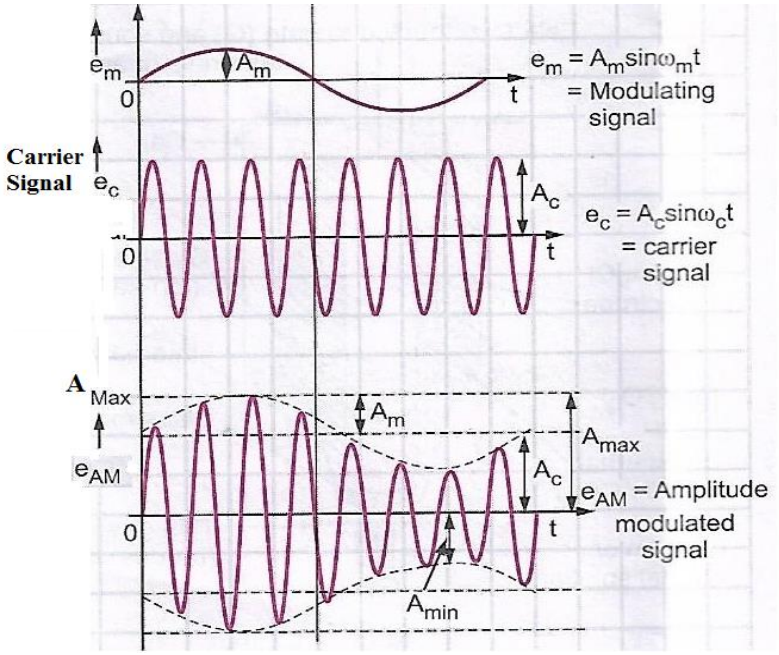
Answer:

Modulation:

Modulation is the process by which some characteristics of a high frequency wave called the carrier, is changed according to the instantaneous value of a low frequency wave called the modulating wave. The resultant wave is called the modulated wave.

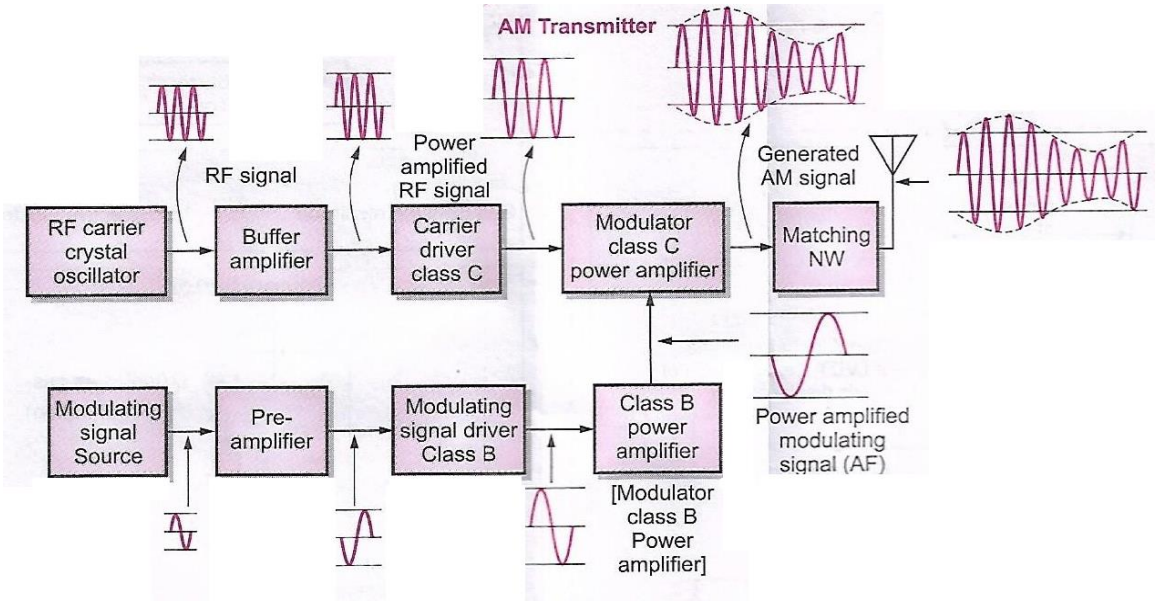
Amplitude Modulation:

Amplitude modulation is obtained by varying the amplitude of the carrier by the modulating signal, the change in amplitude from the unmodulated value being proportional to the instantaneous value of the modulating signal independent of its frequency.



Block Diagram of AM Transmitter:

High Level AM Transmitter



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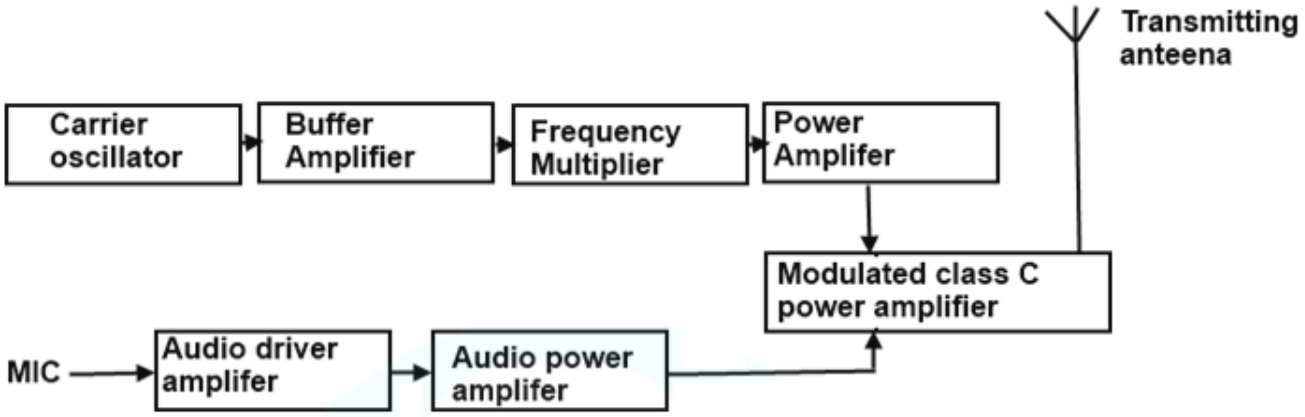


figure. Block Diagram of AM Transmitter

Block Diagram of AM Transmitter consists of,

1. Carrier Oscillator
2. Buffer Amplifier
3. Frequency Multiplier
4. Power Amplifier
5. Audio Amplifier
6. Modulator

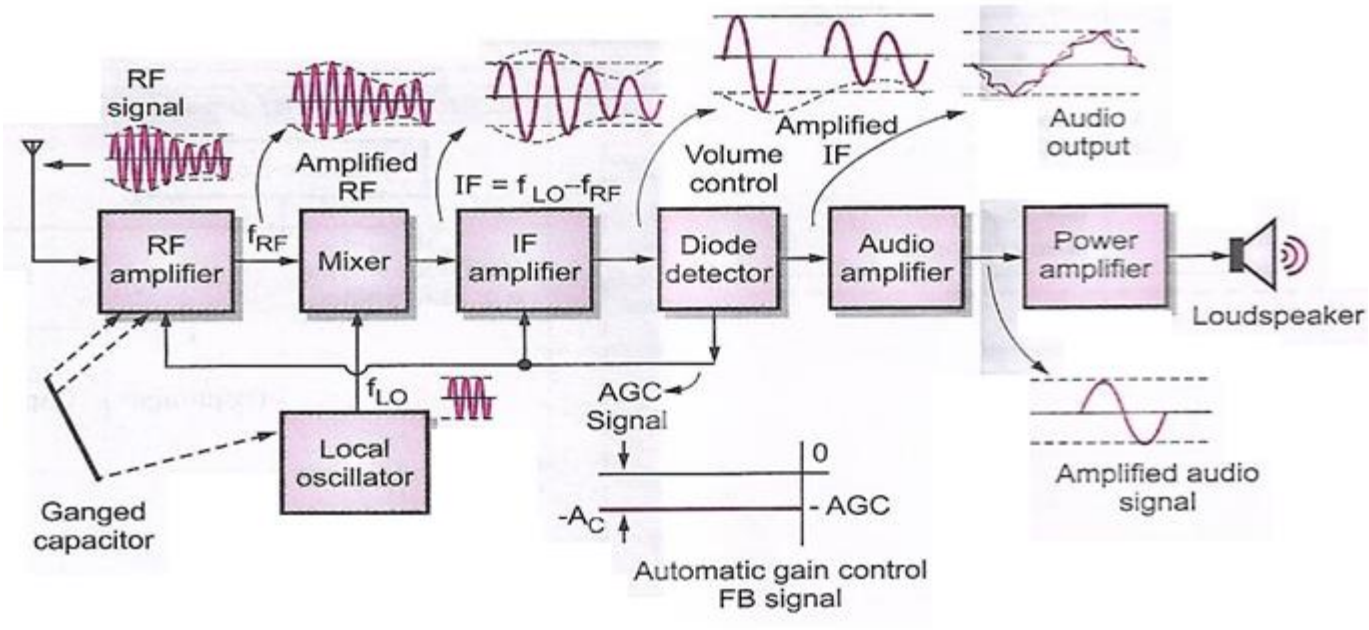
Explanation of each block,

1. **Carrier Oscillator:**
   An oscillator is used to operate the transmitted at a desirable fixed radio frequency (RF).The power output of the oscillator, being not sufficiently large, is amplified in several stage to the desirable.
2. **Buffer Amplifier:**
   This amplifier isolates the oscillate from the succeeding stage, so that the variation of coupling and antenna loading do not influence the oscillator frequency.
3. **Frequency Multiplier:**
   Oscillator cannot generate very high carrier frequencies. To obtain such frequencies, the frequency multiplier is used to multiply the frequency of oscillator output signal to the required value.
4. **Power Amplifier:**
   The modulated carrier is fed to this stage for final amplification before being carried to the antenna.
5. **Audio Amplifier:**
   This amplifier is used to amplify the audio signal output of the microphone that converts the speech or music to be transmitted into equivalent electrical signal.
6. **Modulator:**
   The function of the modulator is to amplitude modulate the RF carrier in accordance with the amplified audio signal.

Q.8) Draw Block Diagram of AM Receiver and explain OR Draw block diagram of Super Heterodyne AM radio receiver and explain its operation

Answer:

Block Diagram of AM Receiver OR Superhetrodyne AM Radio Receiver:



Block Diagram of AM Receiver consists of,

1. Antenna
2. RF Amplifier
3. Local Oscillator
4. Mixer
5. IF amplifier
6. Detector
7. Audio and Power amplifiers

Explanation of each block,

1. **Antenna:**

   The antenna picks up all radiated signals and feeds them into the RF amplifier. These signals are very small (usually only a few microvolts).

2. **RF Amplifier:**

   This circuit can be adjusted (tuned) to select and amplify any carrier frequency within the AM broadcast band. Only the selected frequency and its two side bands pass through the amplifier. (Some AM receivers don't have a separate RF amplifier stage.)

3. **Local Oscillator:**

   This circuit generates a steady sine wave at a frequency 455 KHz above the selected RF frequency.

4. **Mixer:**

   This circuit accepts two inputs, the amplitude modulated RF signal from the output of the RF amplifier (or the antenna when there is no RF amplifier) and the sinusoidal output of the local oscillator (LO). These two signals are then "mixed" by a nonlinear process called *heterodyning* to produce sum and difference

frequencies. For example, if the RF carrier has a frequency of 1000 KHz, the LO frequency is 1455 KHz and the sum and difference frequencies out of the mixer are 2455 KHz and 455 KHz, respectively. The difference frequency is always 455 KHz no matter what the RF carrier frequency.

5. **IF amplifier:**

   The input to the If amplifier is the 455 KHz AM signal, a replica of the original AM carrier signal except that the frequency has been lowered to 455 KHz, The IF amplifier significantly increases the level of this signal.

6. **Detector:**

   This circuit recovers the modulating signal (audio signal) from the 455 KHz IF. At this point the IF is no longer needed, so the output of the detector consists of only the audio signal.

7. **Audio and Power amplifiers:**

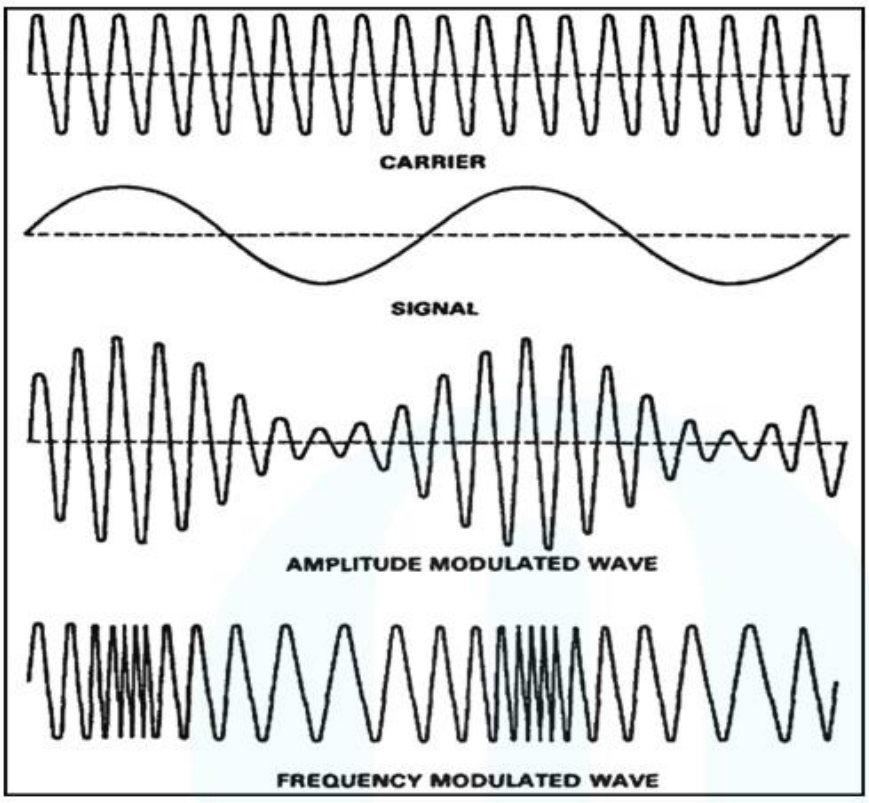
   This circuit amplifies the detected audio signal and drives the speaker to produce sound.

FM Modulation:

Mathematically, a frequency modulated (FM) waveform can be described using the equation,

$$s(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_0^t m(\tau)\, d\tau\right]$$

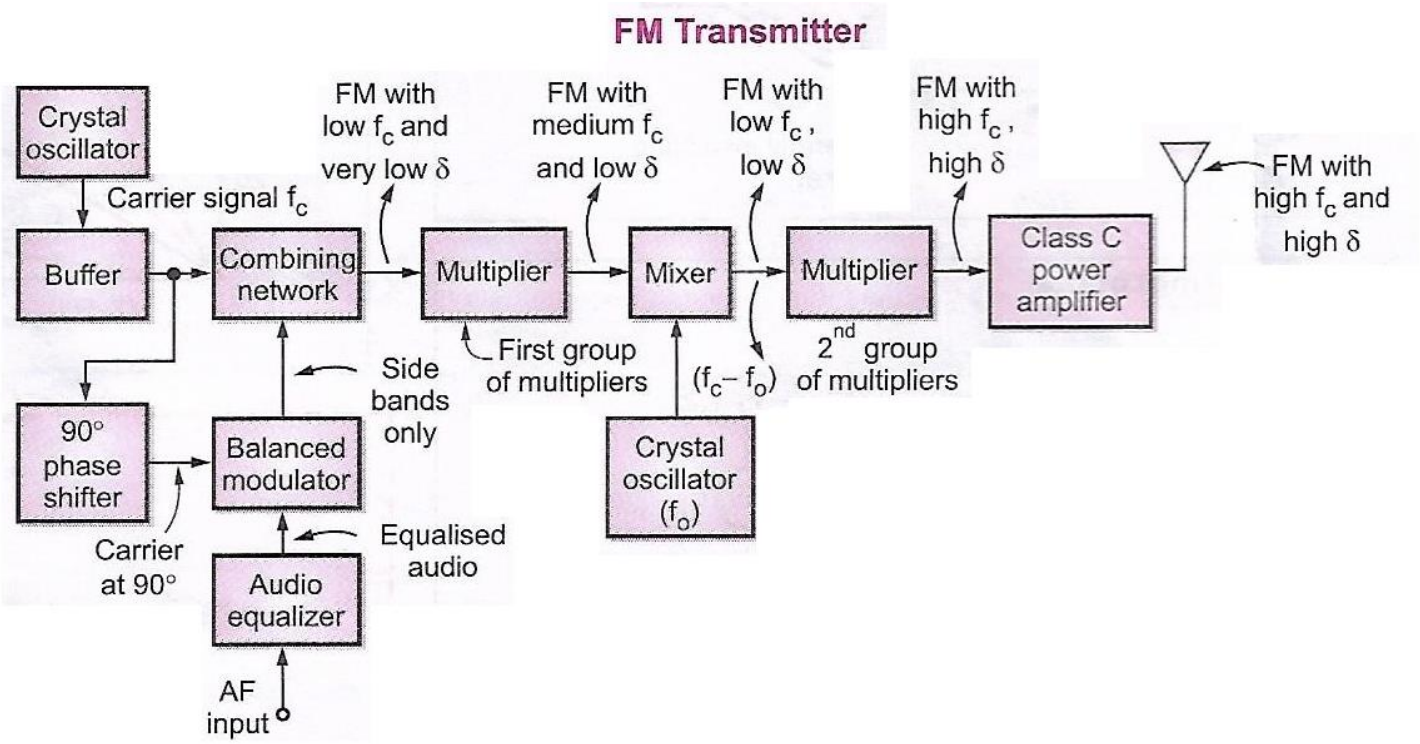
Where **s(t)** is the FM wave, $\mathbf{A_c \cos 2\pi f_c t}$ is the high frequency sinusoidal carrier and m(t) is the baseband message signal (the voice signal). The parameter k_f is the frequency sensitivity of the FM modulator.



Q.9) Draw Block Diagram of FM Transmitter and explain

Answer:

Simple diode detector with AGC



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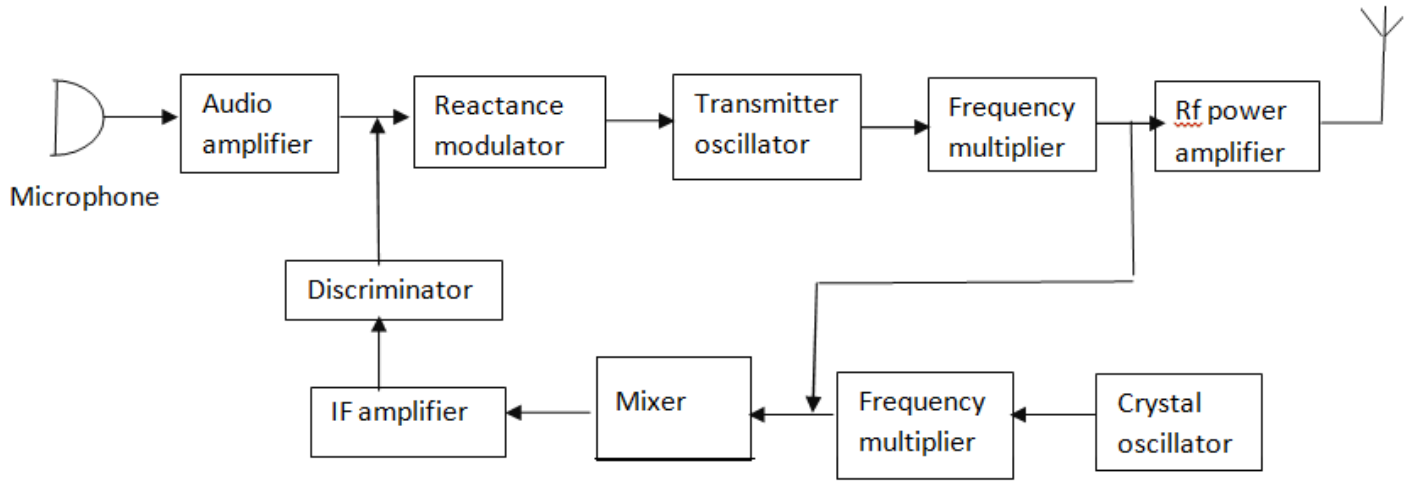


Block Diagram of FM Transmitter consists of,

1. Audio Amplifier:
2. Reactance Modulator:
3. Transmitter Oscillator:
4. Frequency Multiplier:
5. Mixer:
6. IF Amplifier:
7. Discriminator:

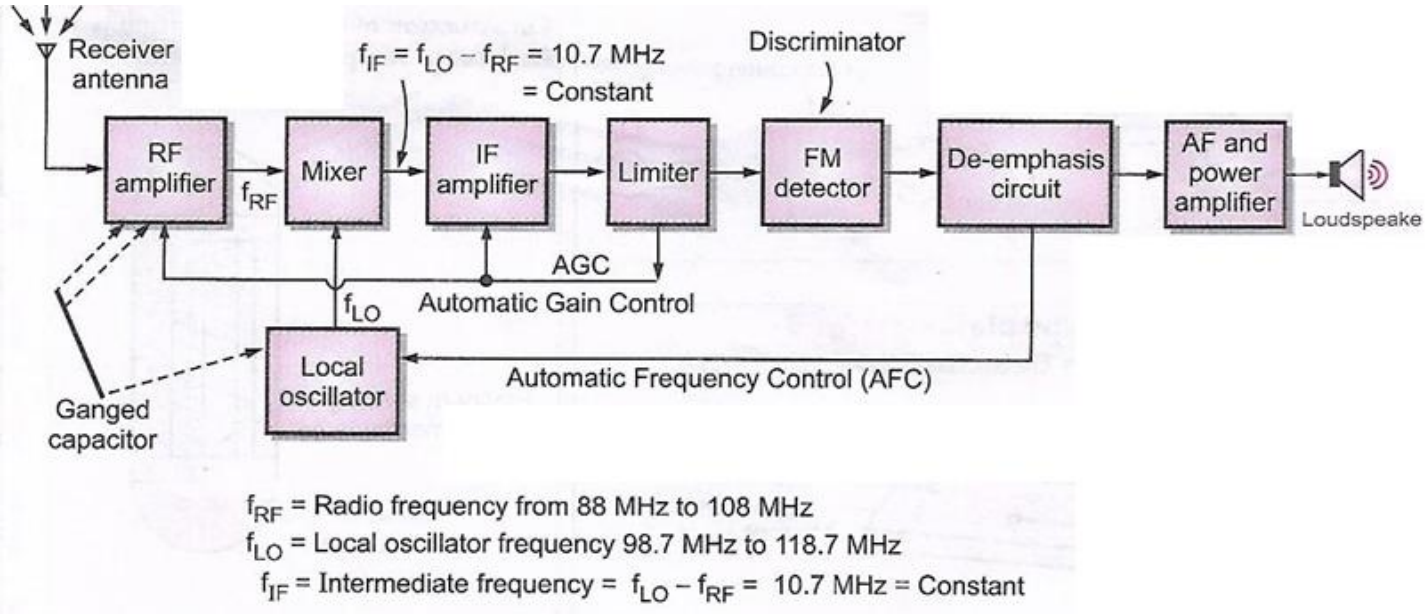
Explanation of each block,

1. **Audio Amplifier:**
   It amplifies the audio signal from the microphone which converts the sound into equivalent electrical signal.
2. **Reactance Modulator:**
   This transforms the audio amplitude changes into frequency changes of the transmitter oscillator.
3. **Transmitter Oscillator:**
   An RF oscillator is used here to generate the desirable oscillations.
4. **Frequency Multiplier:**
   A number of frequency multipliers are used in this stage to raise the frequency to the required value.
5. **Mixer:**
   A part of the output of block of frequency f_c and that of frequency f_o .The frequency multiplier block beat together in the mixer stage to produce a f_c-f_o Signal.
6. **IF Amplifier:**
   The IF amplifier significantly increases amplitude of f_c-f_o frequency component signal.
7. **Discriminator:**
   The output of the IF amplifier is applied to a phase discriminator which gives a zero DC output voltage if the frequency of its input signal to which it is tuned remains constant.

Q.10) Draw Block Diagram of FM Receiver and explain

Answer:

FM Receiver



Block Diagram of AM Receiver consists of,

1. Antenna
2. RF Amplifier
3. Local Oscillator
4. Mixer
5. IF amplifier
6. Limiter

7. FM Detector (Discriminator)
8. De-emphasis circuit
9. Audio and Power amplifiers

Explanation of each block,

1. **Antenna:**
   The antenna picks up all radiated signals and feeds them into the RF amplifier.
2. **RF Amplifier:**
   The RF amplifier amplifies the received signal intercepted by the antenna. The amplified signal is then applied to the mixer stage.
3. **Local Oscillator:**
   The second input of the mixer comes from the local oscillator.
4. **Mixer:**
   The two input frequencies of the mixer generate an IF signal of 10.7 MHz.
5. **IF amplifier:**
   An IF signal of 10.7 MHz is then amplified by the IF amplifier.
6. **Limiter:**
   The output of the IF amplifier is applied to the limiter circuit. The limiter removes the noise in the received signal and gives a constant amplitude signal. This circuit is required when a phase discriminator is used to demodulate an FM signal.
7. **FM Detector (Discriminator):**
   The output of the limiter is now applied to the FM discriminator, which recovers the modulating signal. However, this signal is still not the original modulating signal.
8. **De-emphasis circuit:**
   Before applying it to the audio amplifier stages, it is de-emphasized. De-emphasizing attenuates the higher frequencies to bring them back to their original amplitudes as these are boosted or emphasized before transmission.
9. **Audio and Power amplifiers:**
   The output of the de-emphasized stage is the audio signal, which is then applied to the audio stages and finally to the speaker. It should be noted that a limiter circuit is required with the FM discriminators. If the demodulator stage uses a ratio detector instead of the discriminator, then a limiter is not required. This is because the ratio detector limits the amplitude of the received signal.

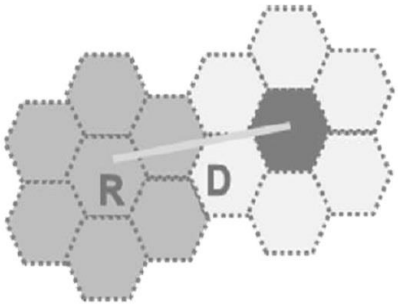
Q.11) Explain the cellular concept. Draw and explain block diagram of GSM system

Answer:

#Mobile communication system: Cellular concept

- The immense potential of conventional telephone cannot be exploited to its maximum due to the limitation imposed by the connecting wires. But this restriction has been removed with the advent of the cellular radio.
- If we use dedicated RF loop for every subscriber, we need larger bandwidth to serve even a limited number of subscriber in a single city.
- To overcome this B.W. problem, subscribers have to share the RF channels on need basis, instead of dedicated RF loops. This can be achieved by using multiple access methods FDMA, TDMA, or CDMA. Even then the number of RF channels required to serve the subscribers, works out to be impracticable.

- With limited frequency resource, cellular principle can serve thousands of subscribers at an affordable cost. In a cellular network, total area is subdivided into smaller areas called "cells". Each cell can cover a limited number of mobile subscribers within its boundaries. Each cell can have a base station with a number of RF channels.
- Frequencies used in a given cell area will be simultaneously reused at a different cell which is geographically separated.



For example,

- A typical seven-cell pattern can be considered.
- Total available frequency resources are divided into seven parts, each part consisting of a number of radio channels and allocated to a cell site.

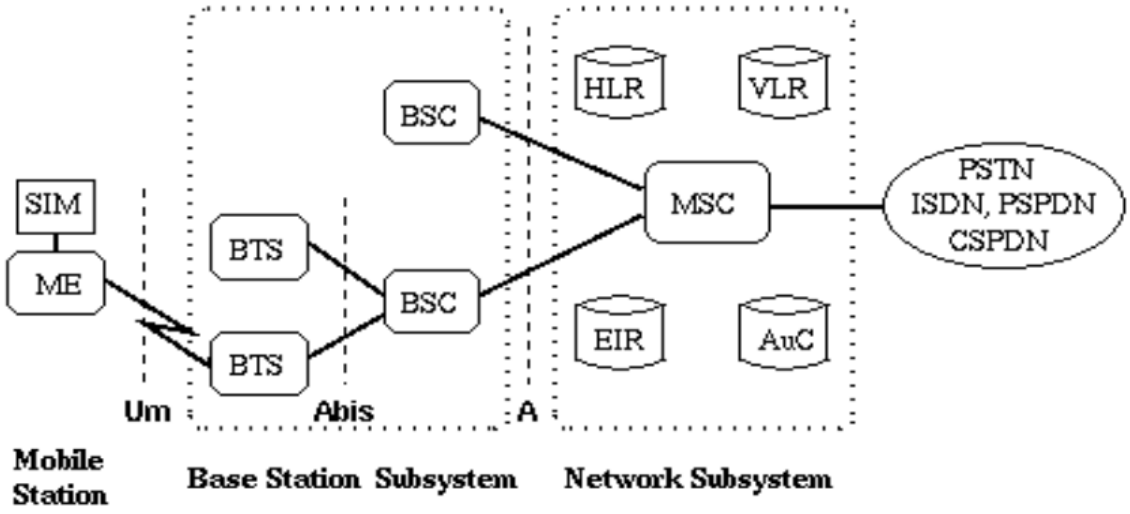
Shape of Cells:

- For analytical purposes a "Hexagon" cell is preferred to other shapes on due to the following reasons.
- A hexagon layout requires fewer cells to cover a given area. Hence, it envisages fewer base stations and minimum capital investment.
- Other geometrical shapes cannot effectively do this. For example, if circular shaped cells are there, then there will be overlapping of cells.
- Also for a given area, among square, triangle and hexagon, radius of a hexagon will be the maximum which is needed for weaker mobiles.

#Global System for Mobile (GSM):

Block diagram of GSM:

GSM is a second generation cellular standard developed to cater voice services and data delivery using digital modulation.



SIM Subscriber Identity Module	BSC Base Station Controller	MSC Mobile services Switching Center
ME Mobile Equipment	HLR Home Location Register	EIR Equipment Identity Register
BTS Base Transceiver Station	VLR Visitor Location Register	AuC Authentication Center

- The GSM network architecture consists of three major subsystems:

  i) Mobile Station (MS)

  ii) Base Station Subsystem (BSS)

  iii) Network Switching Subsystem (NSS)

- The wireless link interface between the MS and the Base Transceiver Station (BTS), which is a part of BSS. Many BTSs are controlled by a Base Station Controller (BSC). BSC is connected to the Mobile Switching Center (MSC), which is a part of NSS. Figure shows the key functional elements in the GSM network architecture.

1. Mobile Station (MS):

A mobile station communicates across the air interface with a base station transceiver in the same cell in which the mobile subscriber unit is located. The MS communicates the information with the user and modifies it to the transmission protocols if the air-interface to communicate with the BSS. The user's voice information is interfaced with the MS through a microphone and speaker for the speech, keypad, and display for short messaging, and the cable connection for other data terminals. The MS has two elements. The Mobile Equipment (ME) refers to the physical device, which comprises of transceiver, digital signal processors, and the antenna. The second element of the MS is the GSM is the Subscriber Identity Module (SIM). The SIM card is unique to the GSM system. It has a memory of 32 KB.

2. Base Station Subsystem (BSS):

A base station subsystem consists of a base station controller and one or more base transceiver station. Each Base Transceiver Station defines a single cell. A cell can have a radius of between 100m to 35km, depending on the environment. A Base Station Controller may be connected with a BTS. It may control multiple BTS units and hence multiple cells. There are two main architectural elements in the BSS – the Base Transceiver Subsystem (BTS) and the Base Station Controller (BSC). The interface that connects a BTS to a BSC is called the A-bis interface. The interface between the BSC and the MSC is called the A interface, which is standardised within GSM.

3. Network Switching Subsystem (NSS):

The NSS is responsible for the network operation. It provides the link between the cellular network and the Public switched telecommunicates Networks.