Unit 5
Chapter 1

5-1. Define the terms *communications* and *telecommunications.*

Answer:-

Communications is the process of conveying information from one place to another. Communications requires a source of information, a transmitter, a receiver, a destination, and some form of transmission medium (connecting path) between the transmitter and the receiver.

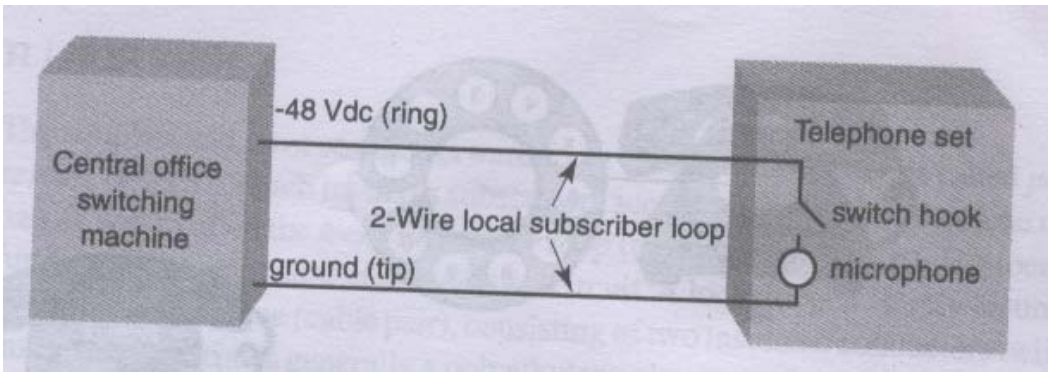
Telecommunications is long-distance communications (from the Greek word *tele* meaning "distant" or "afar"). Although the word "long" is an arbitrary term, it generally indicates that communications is taking place between a transmitter and a receiver that are too far apart to communicate effectively using only sound waves.

Although telephone systems were originally developed for conveying human speech information (voice), they are now also used extensively to transport data.

5-2. Describe *a local subscriber loop.*

Answer:-

The simplest and most straight forward form of telephone service is called *plain old telephone services(*POTS), which involves subscribers accessing the public telephone network through pair of wires called the *local subscriber loop* (or simply *local loop). A* local loop is simply an unshielded twisted - pair transmission line (cable pair), consisting of two insulated conductors twisted together.



The subscriber loop provides the means to connect a telephone set at a subscriber location to the closest telephone office, which is commonly called an *end office, locale change office,* or *central office.* Once in the central office, the subscriber loop is connected to an *electronic switching system (ESS),* which enables the subscriber to access the telephone network.

5-3. Briefly describe the basic functions of a standard telephone set.

Answer:-

Functions of the Telephone Set :-

The basic functions of a telephone set are as follows:

1. Notify the subscriber when there is an incoming call with an audible signal, such as a bell, or with a visible signal, such as a flashing light. This signal is analogous to an interrupt signal on a microprocessor, as its intent is to interrupt what you are doing. These signals are purposely made annoying enough to make people want to answer the telephone as soon as possible.

2. Provide a signal to the telephone network verifying when the incoming call has been acknowledged and answered (i.e., the receiver is lifted off hook).

3. Convert speech (acoustical) energy to electrical energy in the transmitter and vice versa in the receiver. Actually, the microphone converts the acoustical energy to mechanical energy, which is then converted to electrical energy. The speaker performs the opposite conversions.

4. Incorporate some method of inputting and sending destination telephone numbers (either mechanically or electrically) from the telephone set to the central office switch over the local loop. This is accomplished using either rotary dialers (pulses) or Touch-Tone pads (frequency tones).

5. Regulate the amplitude of the speech signal the calling person outputs onto the telephone Line. This prevents speakers from producing signals high enough in amplitude to interfere with other people's conversations taking place on nearby cable pairs (crosstalk).

6. Incorporate some means of notifying the telephone office when a subscriber wishes to place an outgoing call (i.e., handset lifted off hook). Subscribers cannot dial out until they receive a dial tone from the switching machine.

7. Ensure that a small amount of the transmit signal is fed back to the speaker. enabling talkers to hear themselves speaking. This feedback signal is sometimes called *side tone* or *talkback.* Side tone helps prevent the speaker from talking too loudly.

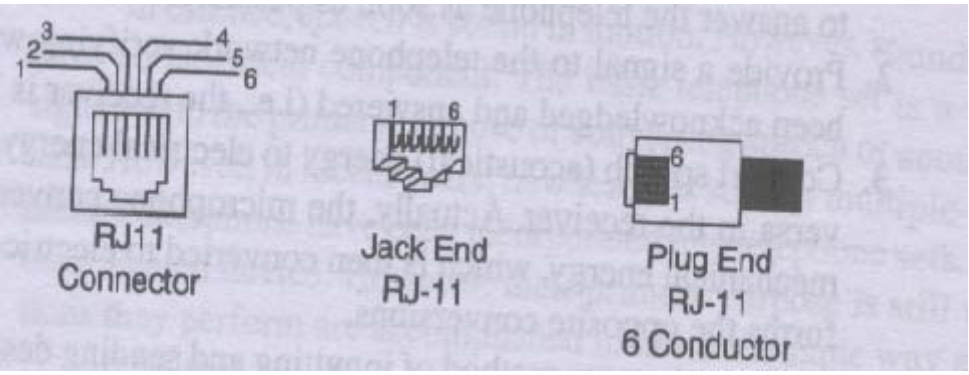
8. Provide an open circuit (idle condition) to the local loop when the telephone is not in use (i.e., on hook) and a closed circuit (busy condition) to the local loop when the telephone is in use (off hook).

9. Provide a means of transmitting and receiving call progress signals between the central office switch and the subscriber, such as on and off hook, busy, ringing, dial pulses. Touch-Tone signals, and dial tone.

5-4. What is the purpose of the *RJ-11 connector?*

Answer:-

Since the 1960s, phone plugs and jacks have gradually been replaced in the home with miniaturized plastic plug known as RJ-11 and a matching plastic receptacle shown in figure. *RJ* stands for *registered jacks* and is sometimes described as RJ-XX. RJ is a series of telephone connection interfaces (receptacle and plug) that are registered with the U.S. Federal Communications Commission (FCC). The term *jack* sometimes describes



both the receptacle and the plug and sometimes specifies only the receptacle. RJ-11 is the most common telephone jack in use today and can have up to six conductors. Although an RJ-11 plug is capable of holding six wires in a 3/16 inch-by-3/16-inch body, only two wires (one pair) are necessary for a standard telephone circuit to operate. The other four wires can be used for a second telephone line and/or for some other special function.

5-5. List and briefly describe the essential components of a standard telephone set.

Answer:-The essential components of a telephone set are the ringer circuit, on/off hook circuit, equalizer circuit, hybrid circuit, speaker, microphone, and a dialing circuit. Ringer circuit:- The telephone *ringer* has been around since August 1, 1878, when Thomas Watson filed for the first ringer patent. The *ringer circuit,* which was originally an electromagnetic bell, is placed directly across the tip and ring of the local loop. The purpose of the ringer is to alert the destination party of incoming calls. The audible tone from the ringer must be loud enough to be heard from a reasonable distance and offensive enough to make a person want to answer the telephone as soon as possible. In modern telephones, the bell has been replaced with an electronic oscillator connected to the speaker. Today, ringing signals can be any imaginable sound, including buzzing, beeping, chiming, or your favorite melody.

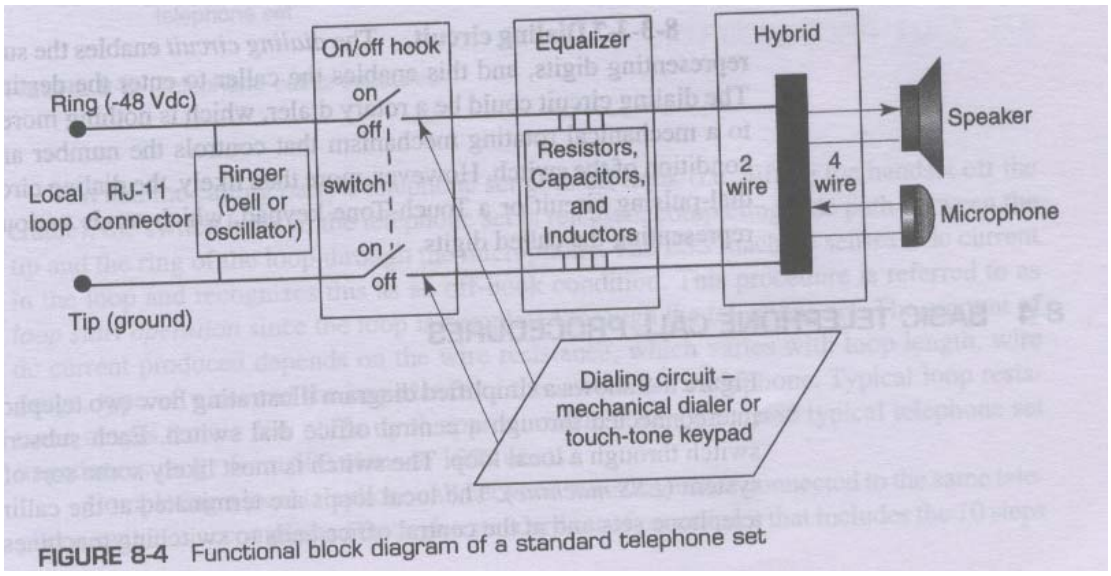


FIGURE 8-4 Functional block diagram of a standard telephone set

On/off hook circuit:- The *on/off hook circuit* (sometimes called a *switch hook)* is nothing more than a simple single-throw. double-pole (STDP) switch placed across the tip and ring. The switch is

mechanically connected to the telephone handset so that when the telephone is idle (on hook), the switch is open. When the telephone is in use (off hook), the switch is closed, completing an electrical path through the microphone between the tip and ring of the local loop.

Equalizer circuit:- *Equalizers* are combinations of passive components (resistors, capacitors, and so on) that are used to regulate the amplitude and frequency res ponse of the voice signals. The equalizer helps solve an important transmission problem in telephone set design, namely, the interdependence of the transmitting and receiving efficiencies and the wide range of transmitter currents caused by a variety of local loop cables with different dc resistances.

Speaker:- In essence, the *speaker* is the receiver for the telephone. The speaker converts electrical signals received from the local loop to acoustical signals (sound waves) that can be heard and understood *by a* human being. The speaker is connected to the local loop through the hybrid network. The speaker is typically enclosed in the *handset* of the telephone along with the microphone.

Microphone:- For all practical purposes, the *microphone* is the transmitter for the telephone. The microphone converts acoustical signals in the form of sound pressure waves from the caller to electrical signals that are transmitted into the telephone network through the local subscriber loop. The microphone is also connected to the local loop through the hybrid network. Both the microphone and the speaker are transducers, as they convert one form of energy into another form of energy. A microphone converts acoustical F energy first to mechanical energy and then to electrical energy, while the speaker performs the exact opposite sequence of conversions.

Hybrid network:- The *hybrid network* (sometimes called a *hybrid coil* or *duplex coil)* in a telephone set is a special balanced transformer used to convert a two-wire circuit (the local loop) into a four-wire circuit (the telephone set) and vice versa, thus enabling full-duplex operation over a two-wire circuit. In essence, the hybrid network separates the transmitted signals from the received signals. Outgoing voice signals are typically in the 1 –V to 2-V range, while incoming voice signals are typically half that value. Another function of the hybrid network is to allow a small portion of the transmit signal to be returned to the receiver in the form of a *sidetone.* Insufficient sidetone causes the speaker to raise his voice, making the telephone conversation seem unnatural. Too much sidetone causes the speaker to talk too softly, thereby reducing the volume that the listener receives.

Dialing circuit:- The *dialing circuit* enables the subscriber to output signals representing digits, and this enables the caller to enter the destination telephone number. The dialing circuit could be a rotary dialer, which is nothing more than a switch connected to a mechanical rotating mechanism that controls the number and duration of the on/off condition of the switch. However, more than likely, the dialing circuit is either an electronic dial-pulsing circuit or a Touch-Tone keypad, which sends various combinations of tones representing the called digits.

5-6. Briefly describe the steps involved in completing a local telephone call.

Answer:-

Step 1:- Calling station goes off hook.

Step 2:- After detecting a dc current flow on the loop, the switching machine retw an audible dial tone to the calling station, acknowledging that the caller h access to the switching machine.

Step 3:- The caller dials the destination telephone number using one of two metbo mechanical dial pulsing or, more likely, electronic dual-tone multifrequencj (Touch-Tone) signals.

Step 4:-When the switching machine detects the first dialed number, it removes ii. dial tone from the loop.

Step 5:-The switch interprets the telephone number and then locates the local Ic for the destination telephone number.

Step 6:- Before ringing the destination telephone, the switching machine tests destination loop for dc current to see if it is idle (on hook) or in use (- hook). At the same time, the switching machine locates a signal path through the switch between the two local loops.

Step 7a:- if the destination telephone is off book, the switching machine sends a station busy signal back to the calling station.

Step7b:- If the destination telephone is on hook, the switching machine sends a, ing signal to the destination telephone on the local loop and at the same ii sends a ring-back signal to the calling station to give the caller some asslK.1 ance that something is happening.

Step 8:- When the destination answers the telephone, it completes the loop, causin dc current to flow.

Step 9:- The switch recognizes the dc current as the station answering the telephone. At this time, the switch removes the ringing and ring-back signals and cornI pletes the path through the switch, allowing the calling and called parties begin their conversation.

Step 10:- When either end goes on hook, the switching machine detects an open circuit on that loop and then drops the connections through the switch.

5-7. Explain the basic purpose of *call progress tones* and *signals.*

Call progress tones and *call progress signals* are acknowledgment and status signals that ensure the processes necessary to set up and terminate a telephone call are completed in an orderly and timely manner. Call progress tones and signals can be sent from machines to machines, machines to people, and people to machines. The people are the subscribers (i.e., the calling and the called party), and the machines are the electronic switching systems in the telephone offices and the telephone sets themselves.

5-8. List and describe the two primary categories of *signaling and signaling messages.*

Signaling can be broadly divided into two major categories: *stat ion signaling* and *interoffice signaling.* Station signaling is the exchange of signaling messages over local loops between stations (telephones) and telephone company switching machines. On the other hand, interoffice signaling is the exchange of signaling messages between switching machines. Signaling messages can be subdivided further into one of four categories: *alerting, supervising, controlling,* and *addressing.* Alerting signals indicate a request for service, such as going off hook or ringing the destination telephone. Supervising signals provide call status information, such as busy or ring-back signals. Controlling signals provide information in the form of announcements, such as number changed to

another number, a number no longer in service, and so on. Addressing signals provide the routing information, such as calling and called numbers.

Table 8-1 Call Progress Tone Summary

Tone or Signal	Frequency	Duration/Range
Dial tone	350 Hz plus 440 Hz	Continuous
DTMF	697 Hz, 770 Hz, 852 Hz, 941 Hz, 1209 Hz, 1336 Hz, 1477 Hz, 1633 Hz	Two of eight tones On, 50-ms minimum Off, 45-ms minimum, 3-s maximum
MF	700 Hz, 900 Hz, 1100 Hz, 1300 Hz, 1500 Hz, 1700 Hz	Two of six tones On, 90-ms minimum, 120-ms maximum
Dial pulses	Open/closed switch	On, 39 ms Off, 61 ms
Station busy	480 Hz plus 620 Hz	On, 0.5 s Off, 0.5 s
Equipment busy	480 Hz plus 620 Hz	On, 0.2 s Off, 0.3 s
Ringing	20 Hz, 90 vrms (nominal)	On, 2 s Off, 4 s
Ring-back	440 Hz plus 480 Hz	On, 2 s Off, 4 s
Receiver on hook	Open loop	Indefinite
Receiver off hook	dc current	20-mA minimum, 80-mA maximum,
Receiver-left-off-hook alert	1440 Hz, 2060 Hz, 2450 Hz, 2600 Hz	On, 0.1 s Off, 0.1 s

Table 8-2 Call Progress Tone Direction of Propagation

Tone or Signal	Direction
Dial tone	Telephone office to calling station
DTMF	Calling station to telephone office
MF	Telephone office to telephone office
Dial pulses	Calling station to telephone office
Station busy	Telephone office to calling subscriber
Equipment busy	Telephone office to calling subscriber
Ringing	Telephone office to called subscriber
Ring-back	Telephone office to calling subscriber
Receiver on hook	Calling subscriber to telephone office
Receiver off hook	Calling subscriber to telephone office
Receiver-left-off-hook alert	Telephone office to calling subscriber

5-9. Briefly describe *dual-tone multi frequency* and *multi frequency* signaling and tell where they are used.

DTMF was originally called *Touch-Tone.* DTMF is a more efficient means than dial pulsing for transferring telephone numbers from a subscriber's location to the central office switching machine.

DTMF is a simple two-of-eight encoding scheme where each digit IS represented by the linear addition of two frequencies. DTMF is strictly for signaling between a Subscriber's location and the nearest telephone office or message switching center. DTMF is sometimes confused with another two-tone Signaling system called *multi frequency signaling* (MF), which is a two-of-six code designed to be used only to convey information between two electronic switching machines.

Figure shows the keypad matrix used with a DTMF keypad. As the figure shows, the keypad is comprised of 16 keys and eight frequencies.

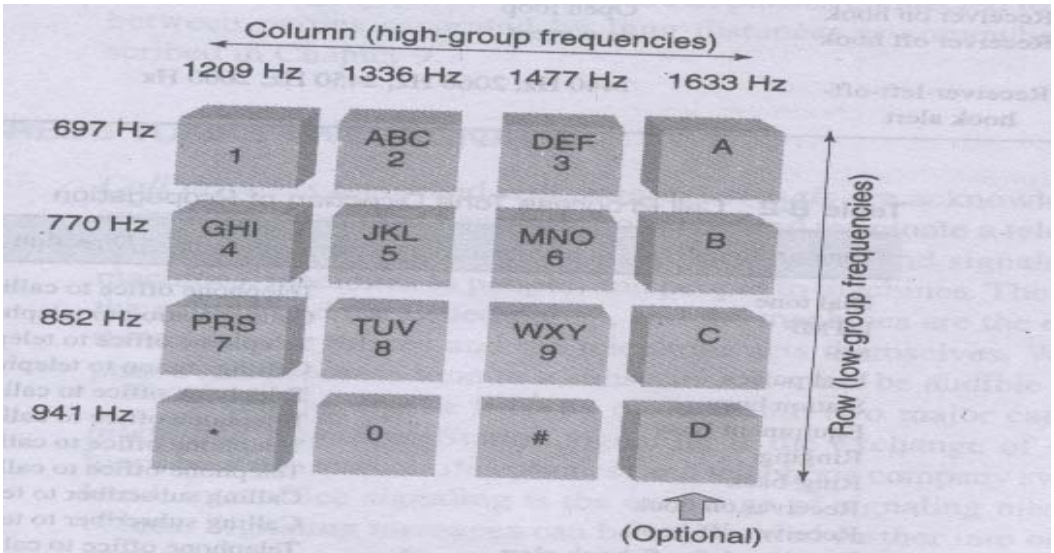


FIGURE 8-6 DTMF keypad layout and frequency allocation

Muitifrequency:-

Muitifrequency (MF) *tones* (codes) are similar to DTMF signals in that they involve the Simultaneous transmission of two tones. MF tones are used to transfer digits and control signals between switching machines, whereas DTMF signals are used to transfer digits and control signals between telephone sets and local switching machines. MF tones are combinations of two frequencies that fall within the normal speech bandwidth so that they can be propagated over the same circuits as voice.

Table 8-4 Multifrequency Codes

Frequencies (Hz)	Digit or Control
700 + 900	1
700 + 1100	2
700 + 1300	4
700 + 1500	7
900 + 1100	3
900 + 1300	5
900 + 1500	8
1100 + 1300	6
1100 + 1500	9
1100 + 1700	Key pulse (KP)
1300 + 1500	0
1500 + 1700	Start (ST)
2600 Hz	IDLE

5-10. Describe *dial pulsing.*

Dial Pulses:-

Dial pulsing (sometimes called *rotary dial Pulsing)* is the method originally used to transfer digits from a telephone set to the local switch. Pulsing digits from a rotary switch began soon after the invention of the automatic switching machine. The concept of dial pulsing is quite simple and is depicted in Figure.

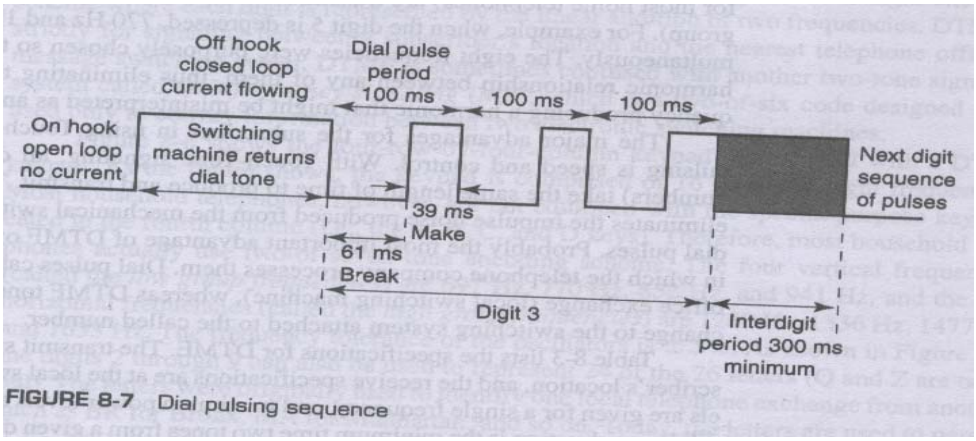


FIGURE 8-7 Dial pulsing sequence

The process begins when the telephone set is lifted off hook, completing a path for current through the local loop. When the switching machine detects the 0ff-hook Condition, it responds with dial tone. After hearing the dial tone, the subscriber begins dial pulsing digits by rotating a mechanical dialing mechanism and then letting it return to its rest position. As the rotary switch returns to its rest position, it outputs a series of dial pulses corresponding to the digit dialed. When a digit is dialed, the loop circuit alternately opens (breaks) and closes (makes) a prescribed number of times. The number of switch make/break sequences corresponds to the digit dialed (i.e., the digit 3 produces three switch openings and three switch closures). Dial pulses occur at 10 make/break cycles per second (i.e., a period of 100 ms per pulse cycle).

5-11. What is the difference between a *station-busy* signal and an *equipment-busy* signal?

Station Busy signal:-

In telephone terminology, a *station* is a telephone set. A *station-busy signal* is sent from the switching machine back to the calling station whenever the called telephone number is off hook (i.e., the station is in use). The station-busy signal is a two-tone signal comprised of 480 Hz and 620 Hz. The two tones are on for *0.5* seconds, then off for 0.5 seconds. Thus, a busy signal repeats at a 60-pulse-per-minute (ppm) rate.

Equipment Busy signal :-

The *equipment-busy signal* is sometimes called a *congestion tone* or a *no-circuits-available tone.* The equipment-busy signal is sent from the switching machine back to the calling station whenever the system cannot complete the call because of equipment unavailability. The equipment-busy signal uses the same two frequencies as the station-busy signal, signal except the equipment-busy signal is on for 0.2 seconds and off for 0.3 seconds (120 ppm).