4.3 Modern electronic devices

Integrated circuits (ICs) are densely packed electronic circuits which are much smaller, much cheaper to make and much less likely to fail than circuits built from discrete (separate) components. They may contain thousands of transistors, diodes, resistors and small capacitors.

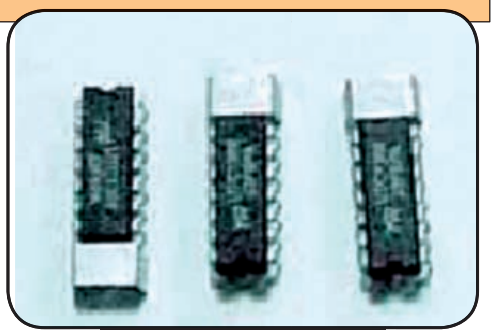


Fig 4.30 Simple Integrated Circuits

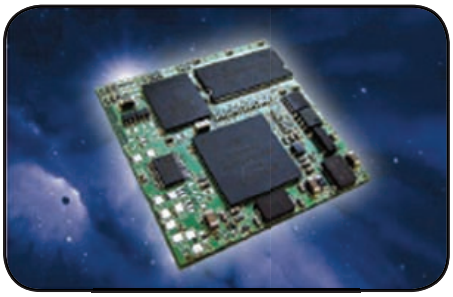


Fig 4.31 circuit with ICs

All these are included in a tiny chip of silicon,no more than 5mm square and 0.5mmthick and connected together by thin aluminium strips. These are mostly used in TV s and computers. It is very difficult to think of an electronic instrument which does not contain ICs.

In 1960,ICs contained components only up to about 100.They were known as SSI.Present ICs contain.components from 1000-100000

SSI	-	**Small** scale 1 Cs
MSI	-	Medium scale 1 Cs
LSI	-	Large scale 1 Cs
VLSI	-	Very large scale 1 Cs

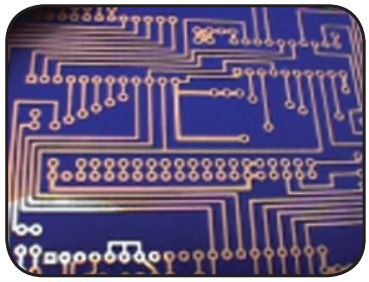


Fig 4.32 Complex Integrated circuits

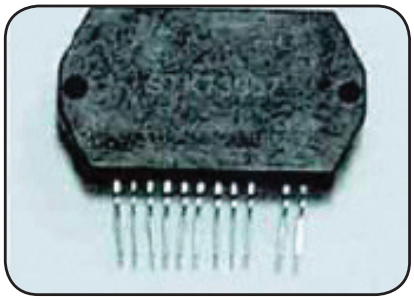


Fig 4.33 Single line **IC**

Identification of ICs

ICs can be classified according to the terminals. They are 1.Single line **packages.**
2.Dual line **packages.**

Terminals of single line packages are arranged in one line.

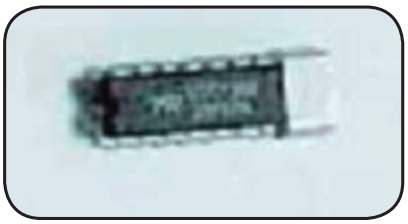


Fig 4.34 Dual line **packages**

There is a notch and a small dot near by to identify the terminal - 1. The other terminals are named accordingly in the anti clockwise direction.

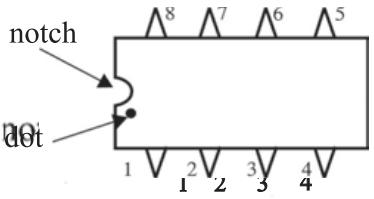


Fig 4.35
Numbering the terminals

Types of ICs

Integrated circuits can be divided into two groups.

1. Digital ICs
2. Analogue ICs

Digital ICs operate with digital signals whereas analogue ICs operates with analogue signals.

Analogue ICs

Operational Amplifiers

This is a very popular IC type used in many electronic circuits. These include amplifier type circuits of many kinds for both audio and radio frequencies. They handle voltages that vary smoothy and continously over a range of values.

Fig 4.36-Analogue IC$_s$

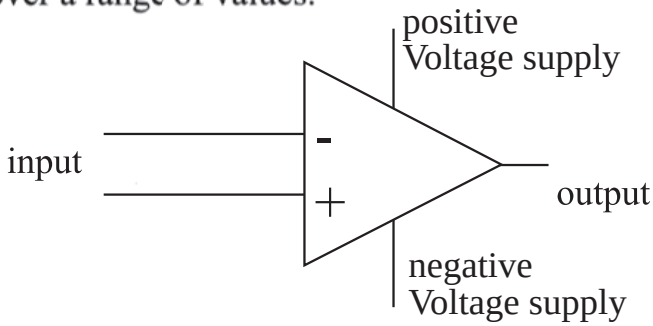


Fig 4.37-Symbol of an operational amplifier

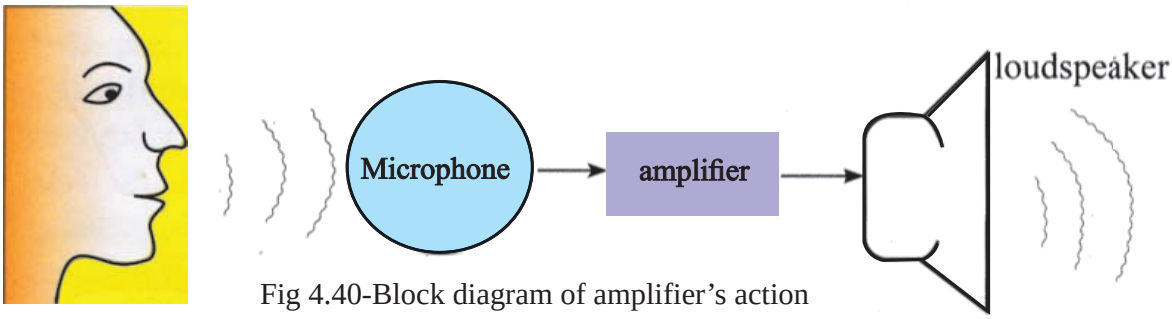


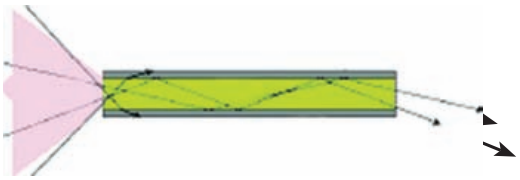
Fig 4.40-Block diagram of amplifier's action

Many circuits can be formed from these (ICs.) The IC-741 shown in Figure 4.36 is of the group OP-AMP. About 150 different circuits could be made using linear ICs. AMP = Operational Amplifier.

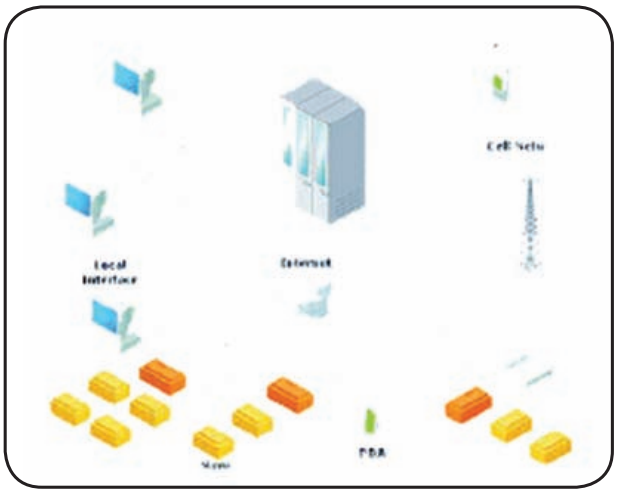
Digital electronic devices

These contain switching-type circuits handling voltage pulses which have only one of two voltage levels, 0 and 1.

These are used in calculators, computers, communication devices etc. Digital electronic technology is extensively used to send signals through optical fibres.



Sending signals through optical fibres



One distinguishing characteristc of this type of IC is that their inputs and outputs are either 'high' (e.g. near the supply voltage, which is often 5V or low. (e.g.near OV). They include logic gates, memories, microprocessors and many other kinds of chips.

Logic Gates

Logic gate is a simple electronic circuit. When one or more signals (inputs) are given to the gate, a result (output) is given out. There are three basic logic gates. They are AND gate, OR gate and NOT gate. The circuit diagram, tabulation of inputs and output and symbol of each gate are given below in fig 4.41. For inputs, 1 denotes "ON" and O denotes "OFF". For output I denotes "glowing" and O denotes "not glowing" of the bulb.

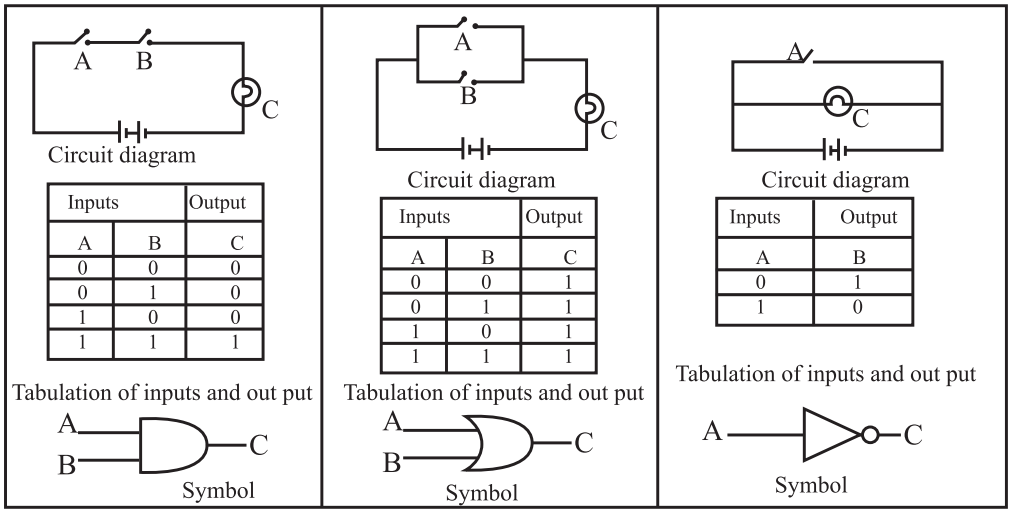


Fig 4.41(a) AND gate Fig 4.41(b) OR gate Fig 4.41(c) NOT gate

Several of the above gates could be combined to produce more complex logic gates.

4.4 Rectification

Converting alternating current into direct current

We use cells, batteries and dynamos to generate electricity in our day to day life. Direct current (DC) is obtained from cells and batteries where as an aleternating current (AC) is obtained from most of the dynamos. Domestic electric supply is also AC of 230V. But direct current is necessary to operate elecronic equipment. Therefore converting AC into DC is more important.

This process of converting alternating current into direct current is called "RECTIFICATION"

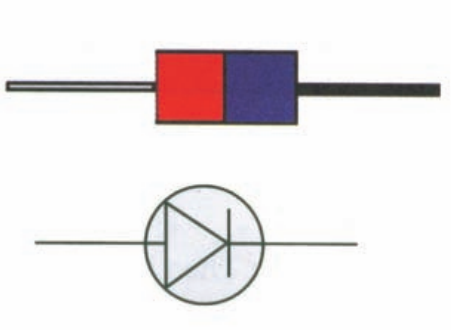


Fig 4.42-Some rectifier diodes

Half (cycle) wave rectification

This is done by using a single diode rectifier circuit.

The positive half cycles of the AC input forward bias the diode which conducts,producing positive half cycles of current.

The negative half cycles of the input reverse bias the diode and no current passes.

The output across the load is a varying but direct (one way) voltage,that is DC, consisting of only the positive half cycles of the AC input.

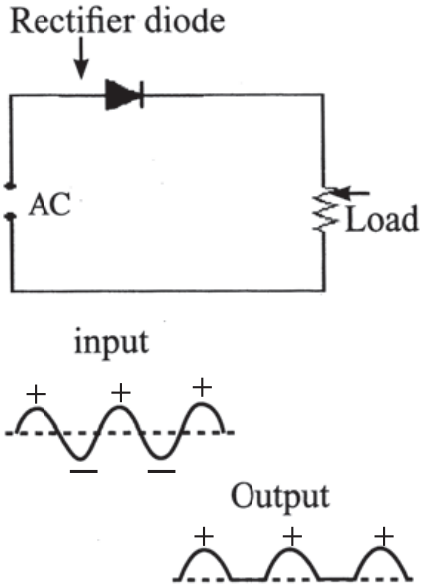


Fig. 4.43
Half cycle rectification circuit

Half cycle rectification of 12V AC voltage obtained from a bicycle dynamo is shown in the Figure 4.43

Activity 4.4

I N 4001 diode

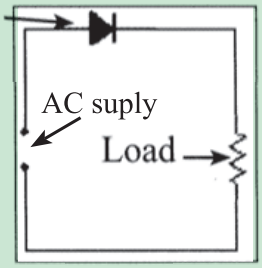


Fig 4.44

Generate an AC voltage from a bicycle dynamo, measure the volatage and the current. Try to identify its terminals.

Now connect an I N 4001 diode to the circuit and again measure the voltage and the current. Identify the terminals.

Try to **operate** a radio with this outpt current.

This current is passed through the rectifier diode. Then a D.C voltage consisting of only the positive half cycles is produced.

When using domestic high voltage electricity, first the voltage has to be reduced. This can be done by using a step down transformer. (Fig 4.45) This current is passed through the rectifier diode. Then a DC voltage consisting of only the positive half cycles is produced.

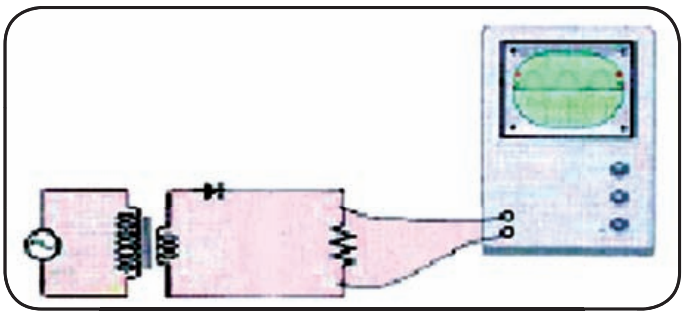


Fig 4.46 - Half cycle rectification when observed through an oscillescipe.

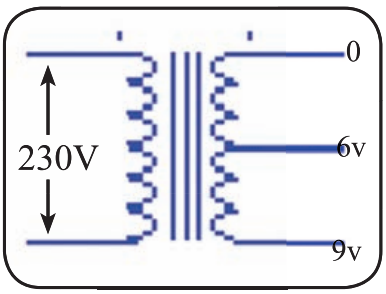


Fig 4.45 Transformer

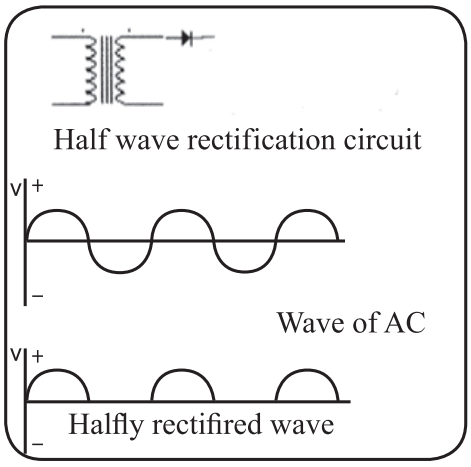


Fig 4.47

Half wave rectification

Full wave rectification

This is done by using four rectifier diodes. This circuit is known as the 'rectifier bridge'. This is shown in the figure 4.48.

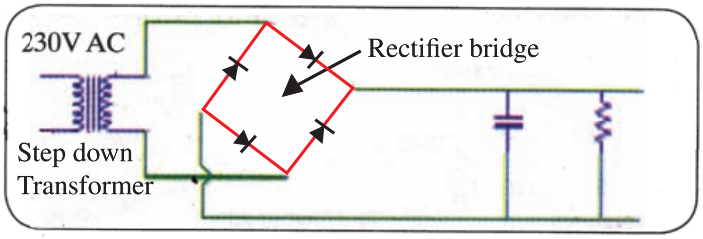


Fig 4.48 - Rectifier Bridge Circuit

Fig 4.49 - (a) Before smoothing the current

(b) After smoothing the current

In this type of rectification,negative cycles as well as positive cycles are rectified.That is why, it is called full wave rectification.Now there are no gaps seen in the wave form.Also,the current can be smoothed by adding a capacitor to the circuit.

DC Power pack

Electronic instruments like mobile phones,computers,radios,cameras,musical instruments etc.have a special unit to convert AC into DC.This unit is called '**power pack'.**

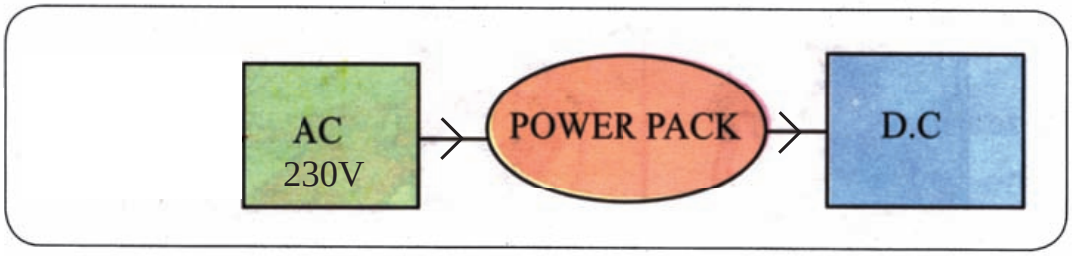


Fig 4.50 - Converting AC to DC

The function of the power pack is to convert alternating current in to a steady direct current with a required voltage.

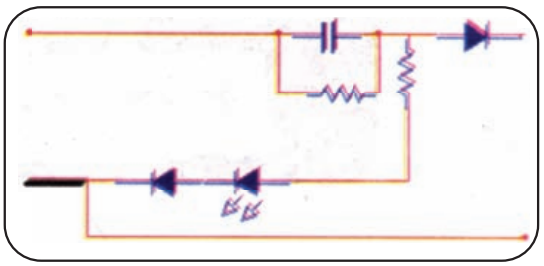


Fig 4.51
Power pack used to charge
Cellular phone batteries

Modern power pack circuits do not contain transformers. It consists of some capacitors, resistors and diodes. The voltage is decreased by using the above components and alternative current is converted to direct current by using rectifier diodes.Such power packs are used to charge the batteries of cellular phones.

4.5 Electric and electronic communication

Communication is the ability to share information.Communication is done by many means.

eg. Sending written messages and information (letters) Telephone, fax, etc

Humans are not the only ones to master communication. Various animals have different ways of communicating.

In humans,speech greately facilliated the transmission of information.But the human voice is not heard so far.Sign language is also a method of communication.But it is also rather limited in terms of distance.Using loud speakers is another way of communication. The transmission of signals over a distance began thousands years ago. Electrical telecommunication systems were started in 1790.

Fig 4.52

Fig 4.53

Then a method called **aeriel telegraph** was introduced and it was followed with the written telegraph form.Robert Staphenson developed a method to send messages by electro-magnetic means.

Guglielmo Marconi invented a method to sending messages by electro magnetic waves.This was later developed as the radio.

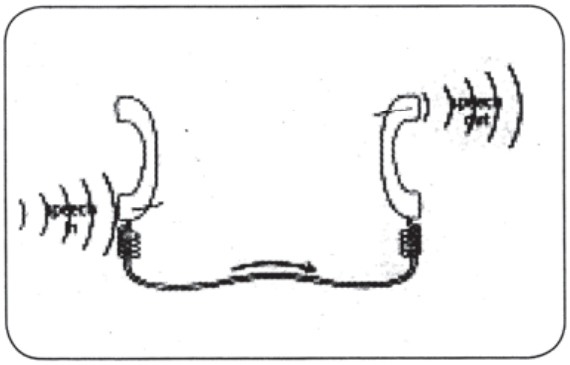
Electric media communication

This is used to fulfil educational, economic and health needs. Television medium plays an imporant role here.

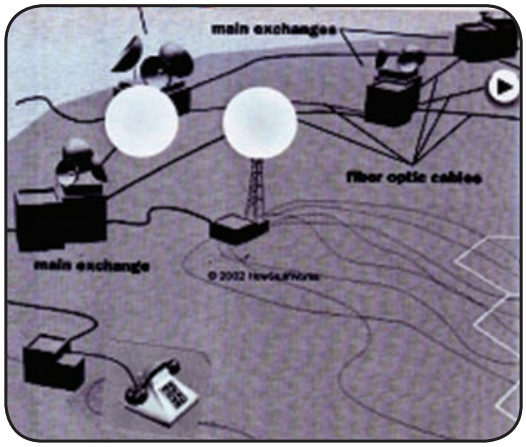
In communication,the **information converted to a form that could be transmitted** is called a '**signal**'.

Communication done by using wires

Scotish scientist Grahem Bell invented the telephone is 1875.



Simple telephone

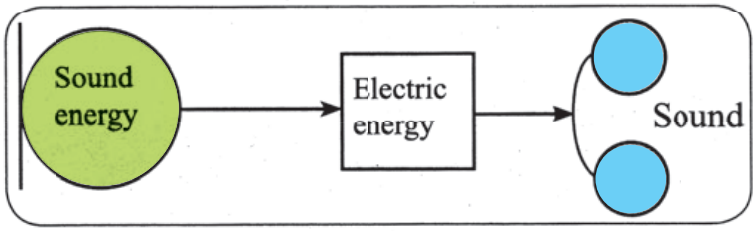


Network of telephones

Fig 4.54

When using the telephone to send information, the signal obtained from the receiver is directed to a telecommunication centre and then it is directed to the place you need. Here,sound energy is being converted into electric energy by the microphone and at the end electric energy is converted again into sound energy by means of the earphone.

Fig 4.55

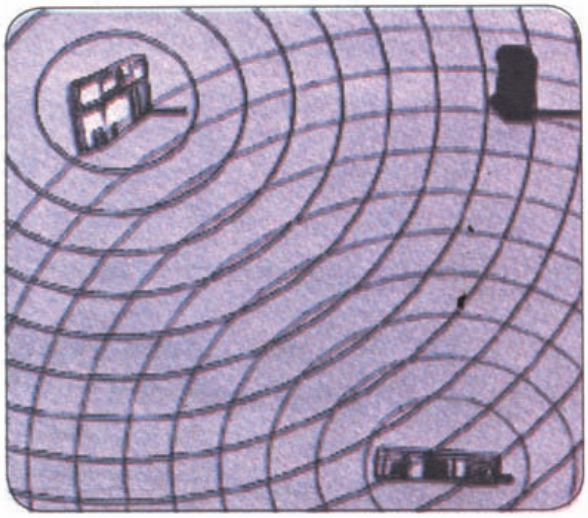


Electric signals produced by sound can be transmitted to distant places using carrier waves.This is done in telecommunication centres using electronic equipment.

Signals can be sent as light,in optical fibres.This method is highly used in telecommunication today. Here, the sound is transformed into electricity first and then into light to send through optical fibres. Then light is transformed into sound and we hear this sound from the receiver.

Fig4.56 - A bundle of optical fibres (optic cable)

Wireless communication



When telephone messages are sent to very distant areas it is always done using electro magnetic waves.

When it is between countries, satellite communication also has to be used.

Fig 4.57
Wireless communication network

In wireless communication, the cellular phone has become very popular.

There are two main parts in a cellular phone.They are,

1.Transmitter circuit

2.Receiver circuit

In cellular phones sound signals are sent as electromagnetic waves.

This process is done using transmitting aerials.
Cellular phone consists of electric components.
See Fig 4.58

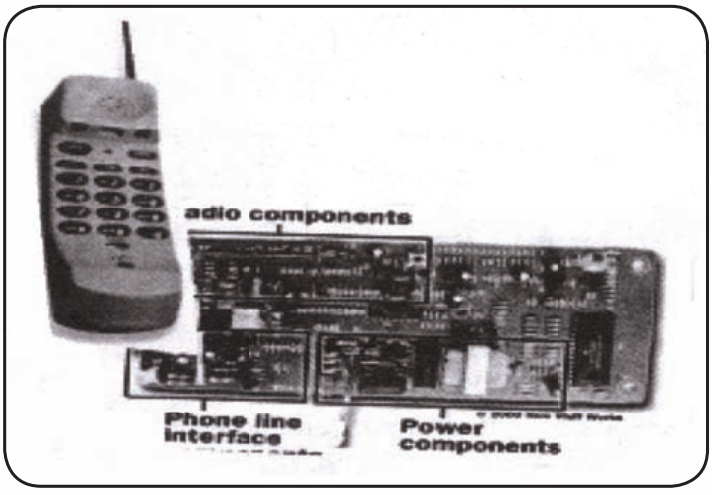


Fig 4.58
Some cellular phones.

In the modern world, communication work is mostly done using the computer.
eg. e-mail, Internet
Fax
Telegraph

Fig 4.59 - Message via fax

Radio communication

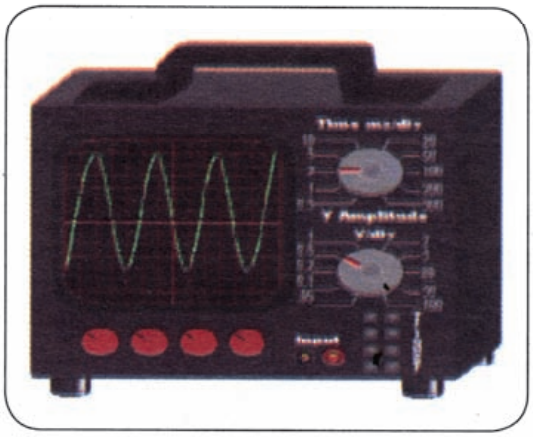


Fig 4.60

Radio communication is very popular. Electromagnetic waves are used in this kind of transmission.

The velocity of electromagnetic waves is $3x10^8 ms^{-1}$.No medium is necessary for the propagation of these waves. Practically, these waves were introduced for radio communication by **Hertz**; a German scientist.

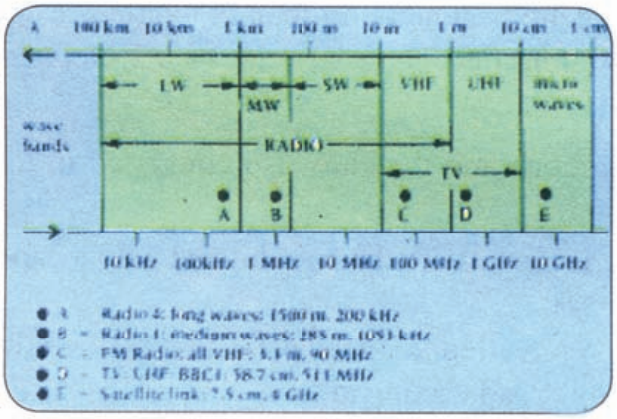


Fig 4.61 - Electromagnetic wave chart

Radio waves are produced by high frequency alternating currents.

Electronic circuits are designed to produce electric currents alternating at such high frequencies.

Such a circuit is called a radio frequency oscillator circuit.When such a circuit generates an alternating current that falls within the radio frequency range, radio frequency waves are emitted to the space around that circuit.

These audio frequency electric waves are modulated with radio waves.

There are two types of modulation.

1.AM-Amplitude modulation

2.FM-Frequency modulation

Modulated waves are further amplified and broadcast through a broadcasting tower.This is illustrated in the following block diagram.

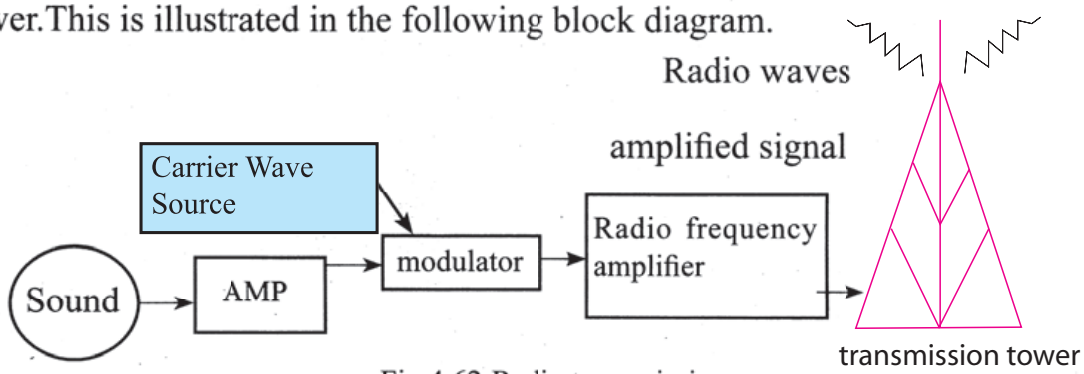


Fig 4.62 Radio transmission

Receiving Radio waves

We cannot sense radio waves.These waves are received by the aerial of the radio,and they are converted into sound frequencies with the help of components found in the radio.

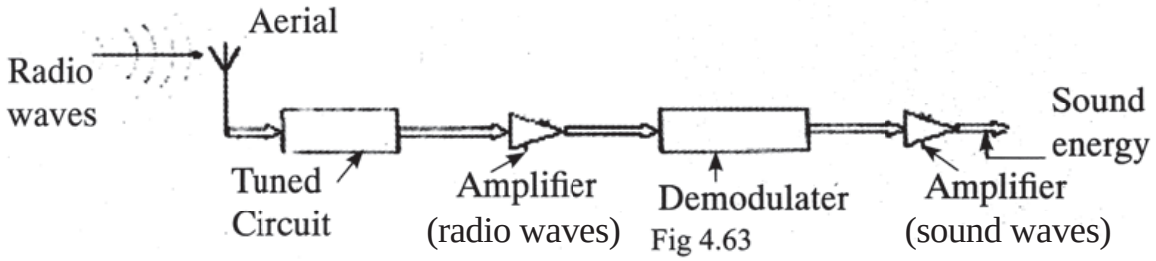


Fig 4.63
Receiving radio waves (block diagram)

Television transmission

The most important function in television transmission is done by the camera. Pictures captured by the camera are scanned and then converted into electric signals.These signals are then amplified.These are the visual electric signals.(Video signals)

Sound is received by the microphone and they are also converted into electric signals.These are audio signals.

Amplified video signals and audio signals are then modulated with a carrier

Radio waves in the VHF,UHF ranges are converted to one wave. These waves are then transmitted by means of a television broadcasting antenna.

Storing Information by electric media.

About 100 years ago information was stored in **discs**.These were named L.P disc. (Long play disks) (Fig 4.66)

Discs were placed on a **rotating plate** and sound was received with the help of a needle. This was named **gramaphone**.

This was first produced by Emil Berlliner.

Instead of LP discs,now information is stored in **compact discs**. (Fig 4.67)
They are named CD for short.

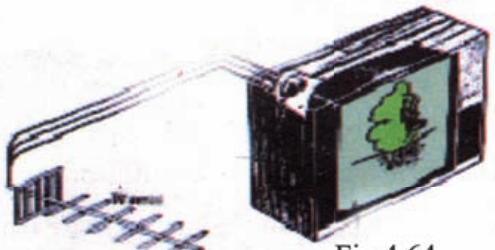


Fig 4.64

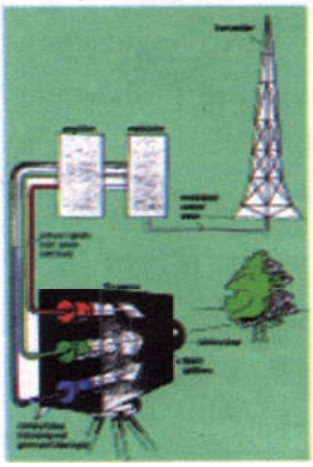


Fig 4.65

Fig 4.66

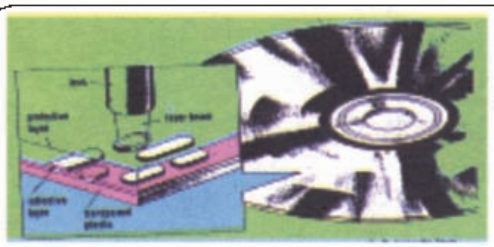


Fig 4.67

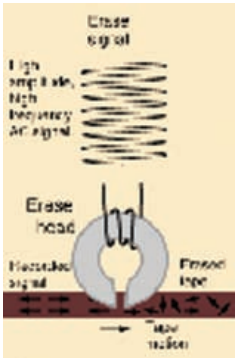
Let us see how an **audio cassette** is used to store information.Cassette tapes are made of polyester material and on one side of its surface a thin layer of magnetic material such as chromium oxide or Iron (II) oxide is plated.

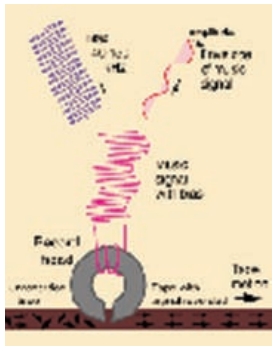
When sound is supplied to the microphone of a cassette recorder alternating current are produced and this varying alternating current is sent through the 'head' (Electro magnet).

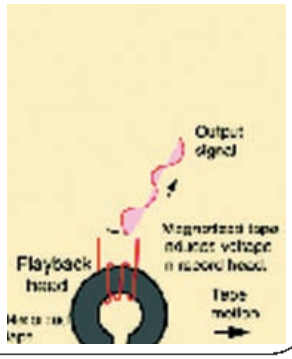
When this current flows through the head,the magnetic field varies and thus sound is recorded on the cassette tape.

In play back alternating current is produced in the coil of the head and this current is amplified. This will produce sound again.

Fig 4.68







Non electronic components used in the electronic circuits.

Some non electronic components found in electronic circuits are resistors, capacitors, transformers, speakers and microphones.

Capacitors and their uses

Capacitors are found in many electronic circuits, such as electrical appliances and vehicle lamps.

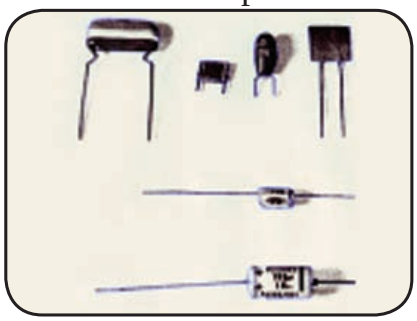


Fig 4.69

They are mainly of two types.

1.Electrolytic (polarized) capacitors

2.Non electrolytic capacitors.

Capacitors can be classified according to the dielectric substance present in between the plates.

Capacitors can store electric charges in small amounts.

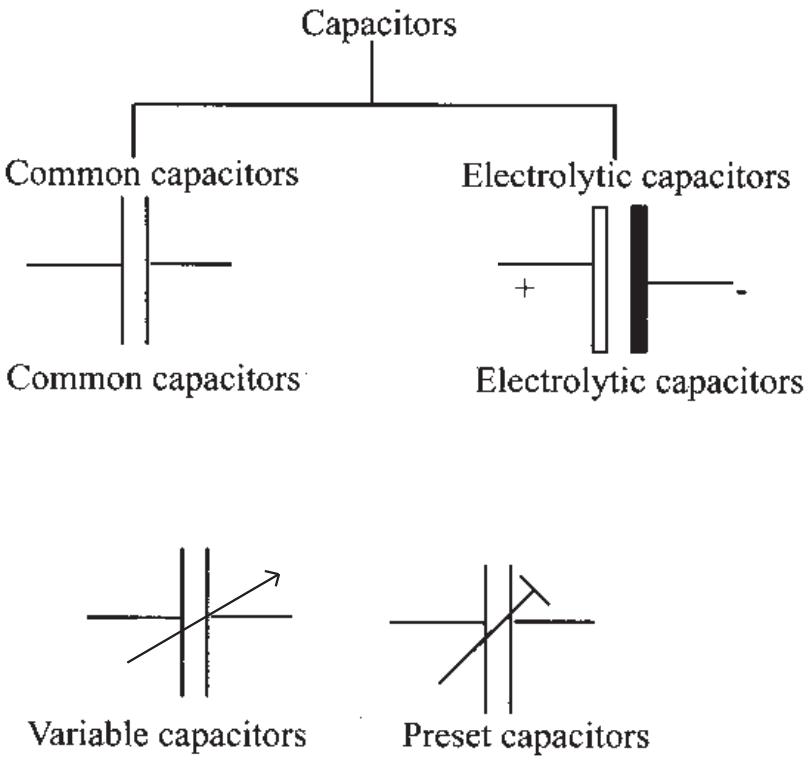


Fig 4.70 Symbols of capacitors

A capacitor can be charged by connecting its two terminals to a battery.

When the capacitor is charged it can give back a samll current.

Capacitance of a capacitor is measured in units such as farads, micro farads, pico farads.

$\frac{1}{1000}$ Farad = 1 milli farad

$\frac{1}{1000}$ mf = 1 µF. (micro farad)

$\frac{1}{1000}$ µf = 1 *n*F (nano farad)

$\frac{1}{1000}$ *n*f = 1 pF (pico farad)

Another speciality of a capacitor is that, it allows alternative current to flow through while does not allow direct current to do so.

Light and Heat Dependent Resistors

The quantity of electric current in electric circuits is controlled by the resistors.

Two special types of resistors used in electronic circuits,

- Light dependent resistors (LDR)
- Heat dependent resistors or **thermistors.**

In LDR, the resistance varied with the intensity of light. In dark, resistance will be around 100 kΩ, while in light it will be around 100 Ω.

Exercises

1) When energy is supplied to a diode as in column a,what type of output can be expected from b.

a	b
1.Alternating current.	Converted to audio waves
2.FM waves	Converted to direct current
3.AM waves	Converted to alternating current
4.Direct Current	Converted to magnetism.
	Converted to light

2) Draw the symbols of the following components.

I. Rectifier diode
II. Point contact diode
III. Zenor diode
IV. LED
v. Photo diodes

3) Write short notes on;

I. Covalent bonds
II. Extrinsic semi conductors
III P type semi conductors
IV n type semi conductors
V Free electrons
VI Bipolar junctions

4) Answer the following questions given about a p-n junctions.

1. Name the cathode & the anode
1. What charges are present in p and n.
2. How do you connect a battery to a p-n junction to send a current.
2. Name the cathode & the anode
(Forward bias)
3. How do you connect a battery to a p-n junction to send a current.(Forward bias)
3. Name four accessories using p-n junctions.
4. Where do you find holes in a p-n junction.
4. Where do you find holes in a p-n junction.

5) Classify the following electronic appliances in a proper manner.

Electric bulb
Electric fan
Radio
Calculator
Tape recorder
Electric Iron
Motor used to pump water
Computer
Telivision
Electric Kettle

6) If energy is supplied to the following,what output can be obtained.
(Eg. Electricity, Light, Sound)

1.Electrolytic capacitors

2.LED

3.Rectifier Diodes

4.Transistor

5.ICS