CBCS SCHEME

USN

BEC/BTE/BVL654B

Sixth Semester B.E./B.Tech. Degree Examination, June/July 2025
Consumer Electronics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	What is Microphone? Explain the desirable characteristics of a microphone.	10	L2	CO1
	b.	What is loudspeaker? Explain in detail the cone type loudspeaker.	10	L2	CO1
		OR			
Q.2	a.	Explain moving coil type microphone. List out the importance features of moving coil type microphone.	10	L2	CO1
	b.	Explain high fidelity system. List out the ideal characteristics of ideal speaker.	10	L2	CO1
		Module – 2			
Q.3	a.	Explain the details of compact disc.	10	L2	CO2
	b.	Explain playback process with necessary diagram.	10	L2	CO2
		OR			
Q.4	a.	Explain D/A converter. What are the care to be taken while handling CD?	10	L2	CO2
	b.	Explain geometry of audio disc. Explain the main differences between CD and magnetic tape.	10	L2	CO2
		Module – 3			
Q.5	a.	With the help of diagram demonstrate trichromatic coefficients and colour triangle.	10	L3	CO3
	b.	Explain recent advances in TV technology.	10	L2	CO3
		OR			
Q.6	a.	With the help of example demonstrate chromaticity diagram.	10	L2	CO3
	b.	Explain mixing of colours with necessary diagram.	10	L2	CO3
		Module – 4			
Q.7	a.	With a neat block diagram, explain the working of CCTV.	10	L2	CO4
	b.	With a neat block diagram, explain the working of electronic guessing game.	10	L2	CO4

		OR			
Q.8	**a.**	With a block diagram, explain the functioning of cable network.	**10**	**L2**	**CO4**
	b.	With a block diagram, explain the working of a calculator.	**10**	**L2**	**CO4**
		Module – 5			
Q.9	**a.**	Explain the working of UPS and inverter.	**10**	**L2**	**CO5**
	b.	Explain the working of ignition system for automobiles.	**10**	**L2**	**CO5**
		OR			
Q.10	**a.**	Explain the working of microwave oven.	**10**	**L2**	**CO5**
	b.	With example explain recent advances in consumer electronics.	**10**	**L2**	**CO5**

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Q1)a-Solution

In all audio systems, sound energy has to be transmitted to distant places.

This can be done by converting variations of sound pressure into electrical impulses.

A microphone is a transducer which converts variations of sound pressure into electrical signals of the same frequency.

The amplitudes of electrical signals are proportional to intensity of sound waves.

It is invariably necessary to amplify these electrical signals using an audio amplifier before these signals can be transmitted through wires (as in public address systems) or by wireless means (as in radio and television).

- It is necessary that electrical signals are a faithful reproduction of sound pressure.
- This is possible only if a microphone fulfils the following requirements:
  1) Its response should be independent of frequency in the complete audio frequency range i.e. 16 Hz to 20 kHz.
  2) The noise (extraneous signals) generated within the microphone should be as low as possible.
  3) Its performance should not be affected by adjacent strong electric and magnetic fields.

4) It should be mechanically robust.
5) Its response should be independent of the direction of sound waves.

Q1)b-Solution :

Loudspeaker is an essential component of all audio systems.

It converts electrical audio frequency signals into sound waves of the same frequency.

Thus, its work is opposite to that of a microphone.

The input to a loudspeaker may come from the audio system directly (as in two-in-one and public address systems) or from the antenna (as in radio and television).

MOVING COIL (CONE TYPE) LOUDSPEAKER

Its principle is the same as that of a motor.

It is also known as direct radiating loudspeaker.

A coil, known as voice coil, is placed in the magnetic field of permanent magnet.

When electric current passes through the coil, a force acts on the coil causing the coil to move(vibrate).

A paper diaphragm of the shape of a cone is attached to the coil.

Thus the diaphragm vibrates, produces pressure variations in air and the result is the sound waves.

The force acting on the voice coil causes vibration of the diaphragm resulting in compressions and rarefactions in the air.

Thus electrical signals are converted into sound waves of the same frequencies.

The main parts of this loudspeaker are magnet, voice coil, conical diaphragm (Fig 6.1).

This loudspeaker uses a pot type permanent magnet having central south pole and peripheral north pole.

To give a strong magnetic field, the magnet is made of special alloy Alnico (10% aluminium, 18% of nickel, 12% cobalt, 6% copper, and 54% iron.)

This material has very high retentivity and can thus retain magnetism almost indefinitely.

The magnet gives a strong magnetic field in the air gap.

A voice coil is suspended by a suitable suspension in the air gap and is free to move in the air gap when a force acts on it.

The coil is attached to a conical diaphragm made of special paper.

The cone has corrugated construction.

Terminals of the voice coil are fixed on the cone surface.

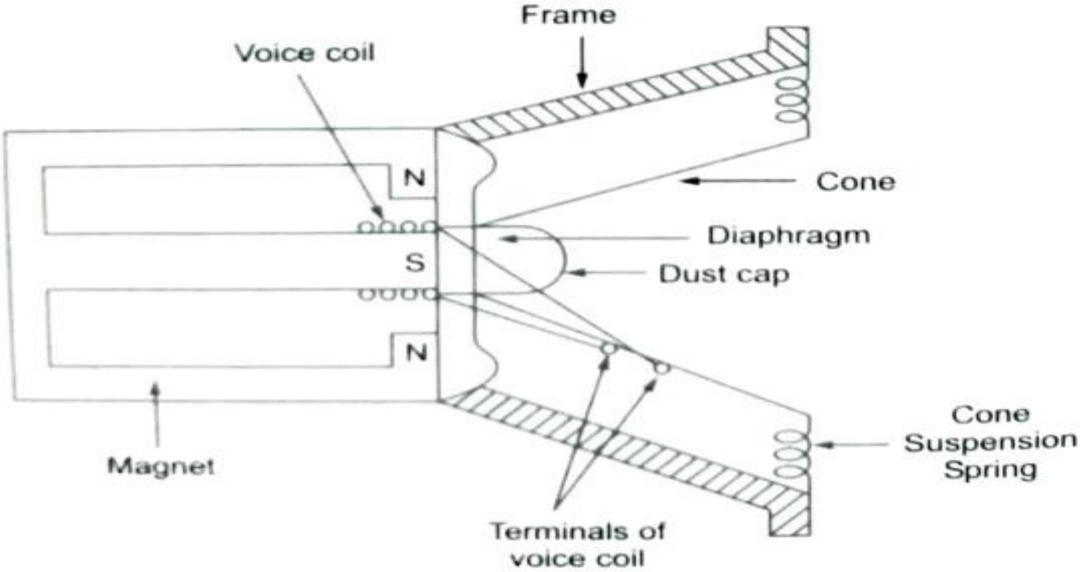

Fig. 6.1: *Moving Coil Loudspeaker*

When electric current flows through the voice coil, interaction between the field of permanent magnet and the magnetic field of current occurs.

Due to this interaction, a force acts on the voice coil causing its to and fro motion.

Since the conical diaphragm is attached to the voice coil, the diaphragm also vibrates causing compressions and rarefactions in air.

Thus the electrical signals are converted into sound waves of the same frequency.

The cone helps in spreading the sound over a large area and thus sound can be heard at a great distance.

1) The efficiency of this loudspeaker is rather poor. Only about 5-10% of the signal power is converted into sound.
2) The signal to noise ratio is about 30 dB.
3) It gives a nearly flat frequency response in the 200 Hz to 5000 Hz range as shown in Fig 6.2.

4) The non-linear distortion can be as high as 10%.
5) It is omni-directional. However, the directivity can be modified by using baffles and enclosures so that most of the sound waves go to the area in front of it.
6) The impedance of the voice coil is the input impedance of the loudspeaker. This impedance is a function of frequency because of the inductance of the voice coil. For transfer of maximum power, the input impedance of speaker should be equal to the output impedance of the system feeding signals to the loudspeaker. Since the input impedance is a function of frequency, perfect matching is possible only at one frequency. The input impedance is specified at 1000 Hz.

Q2)a-Solution :

Moving Coil Microphone

- **(a) Principle:** A moving coil microphone works on the principle of induced emf (Faraday's law of electromagnetic induction).
- The variations of sound pressure cause the motion of a coil in a magnetic field. Thus an emf is induced in the moving coil. It is also known as a dynamic microphone.
- **(b) Construction:** Fig. 5.4 shows the construction.
- It consists of a permanent magnet, generally POT type with a central south pole and peripheral north pole.
- The magnet is so shaped as to give a uniform field in the air gap.
- A diaphragm made of non-magnetic material is fixed to the body by springs.
- A coil wound on card board cylinder is attached to the diaphragm and is free to move in the air gap as the

diaphragm vibrates due to sound waves.

- A protective cover saves the delicate diaphragm and other parts from mechanical damage.

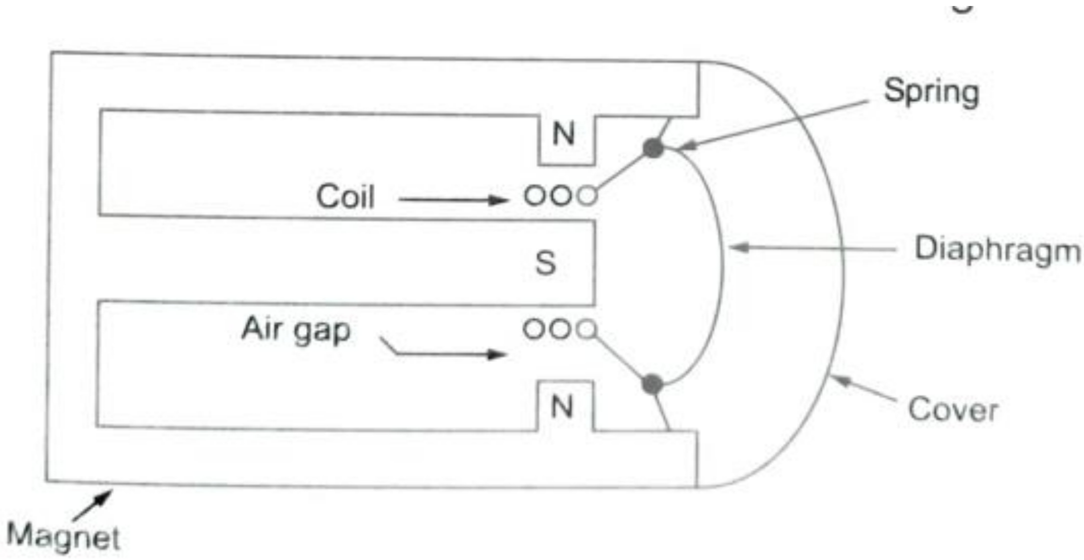

Fig. 5.4: *Moving Coil Microphone*

- **(c) Working :** When sound waves strike the diaphragm, it moves forward and backwards.
- The coil also moves along with the diaphragm and an emf is induced in the coil.
- The magnitude of emf is given by :
- **e = Blv (5.3)**
- Where e = emf, V

- B = flux density, Wb/m^2 or T
- l = Length of conductor/coil, m.
- v = velocity of coil, m/sec.
- Since the emf is proportional to the velocity of the coil, it is designated as velocity microphone.
- The motion of the coil depends on the pressure of the sound waves.
- Therefore, it is pressure microphone.

- **(d) Features :**
  1) Its sensitivity is about 90dB below 1V, when the sound pressure is 0.1Pa, the voltage induced is about 30μV.
  2) Its output impedance is low, around 30 to 40 ohms. If it is to feed a transmission line of impedance 250 ohms, an intervening setup transformer of turn ratio of about 3 is needed.

3) Its frequency response is nearly flat in the 40 Hz to 8 kHz range.
4) It is an omnidirectional microphone.
5) Its signal to noise ratio is about 25 dB.
6) Its distortion is less than 5%.

- **(e) Advantages:** All its features are good.
- Overall performance is satisfactory.
- It is mechanically robust and is not affected by weather.
- It is cheaper than ribbon and condenser microphones but is more costly as compared to crystal and carbon microphones.
- **(f) Disadvantages:** It has to be kept within 25 cm distance from source of sound.

- Its weight is considerable because of heavy magnet.
- **(g) Applications:** Public address systems and broadcast studios.

Q2)b-Solution :

For high fidelity sound systems, non-linear distortion should be less than 1%.

Loudspeaker is an essential component of all audio systems.

It converts electrical audio frequency signals into sound waves of the same frequency.

Thus, its work is opposite to that of a microphone.

The input to a loudspeaker may come from the audio system directly (as in two-in-one and public address systems) or from the antenna (as in radio and television).

FEATURES OF LOUDSPEAKER

A loudspeaker must convert the electrical signals into sound waves as faithfully as possible without any distortion and in the whole of audio-frequency range.

The main features of a speaker are sensitivity (also known as efficiency), frequency response, signal to noise ratio, distortion, directivity and input impedance.

Sensitivity is the input signal required to give a sound pressure of 0.1 Pa at a distance of one metre from the loudspeaker.

Sometimes the word efficiency (which is the ratio of output sound power to input audio frequency electrical power) is used to describe the ability of the speaker to convert electrical signals into sound waves.

The frequency response is the range of frequencies having an amplitude ±1 dB.

Ideally the frequency response should be flat over the whole audio range i.e. 16 Hz to 20 kHz.

However, the mass of the diaphragm of the speaker attenuates high frequencies.

The speaker will always have a natural resonant frequency.

The input signal at this frequency is strengthened giving rise to non-linearity.

As all other equipments, a loudspeaker also generates a noise in itself.

Signal to noise ratio is the ratio of output (with signal) to the output (without signal).

It should be as high as possible.

Distortion may be amplitude, frequency or phase.

Causes of distortion are

non-linear behaviour of magnetic field.

mass of diaphragm.

natural frequency of the mechanical parts etc.

It is defined as the ratio of sound intensity in the direction of maximum response to the sound intensity which would exist if the speak is omnidirectional.

It is expressed in ohms.

For maximum power output from speaker, its input impedance should be equal to the source impedance so that proper impedance matching is obtained.

Q3)a-Solution :

DETAILS OF A COMPACT DISC

- **The recorded compact disc has the following dimensions and features :**
  - **Thickness of Disc = 1.2 mm**
  - **Diameter of disc = 12 cm**
  - **Rotation: Anticlockwise**
  - **Velocity of Scanning = 1.2 m/s**
  - **Direction of pick up: Linear from centre towards circumference**
  - **Speed = 500 rpm to 200 rpm**
  - **Storage Capacity = 540 Mega bytes per side**
  - **Playing time = 60 minutes**
  - **Transducer: infra red photo diode**
  - **Sampling frequency = 44.1 kHz**
  - **Track pitch = 1.6 μm.**
  - **Pick up: Solid state laser using Aluminium Gallium Arsenide**
  - **Quantisation = 16 bit**
  - **Bit-rate = 43218 M bits/s**
  - **Error correction bit = 3548**
  - **Number of levels = 65536 per channel**

Q3)b-Solution :

The compact disc is scanned optically by a laser beam in a CD player.

The laser beam is solid state laser of aluminium gallium arsenide having a wavelength of 780 μm.

This laser beam is made to fall on the compact disc through a half silvered mirror.

The diameter of light spot is about 1 μm.

The half silvered mirror allows the beam to pass through it but does not allow passage of reflected beam.

The reflected beam passes through a lens and falls on a photodiode.

If the beam is reflected from a pit on the compact disc, the extent of reflection is very minute and it represents digits 0.

When the reflection is from flat of the disc, full reflection occurs and it represents digits 1.

Thus the reflection of beam from the CD generates binary numbers 0 and 1.

The output from photodiode is the audio output in binary form, it is converted into analog form by D/A (digital to analog) converter.

For converting the information on the CD into digital form, the entire disc (or the required portion) has to be scanned by the laser beam.

The optical pick up is mounted on a pivoting arm which describes a radial arc across the disc so that the complete track can be scanned.

On the disc surface the scanning is from centre towards circumference of the disc.

Each frame of the disc has locational bits which help in locating the required programme on the disc.

The pivotal arm is moved across the disc by a linear motor.

When the coil of the motor is energized, the pick up can be directed to any part of the disc.

After locating the required information, the pick up follows the track very accurately.

A tracking servo system ensures that any deviation of the pick up from the track is corrected.

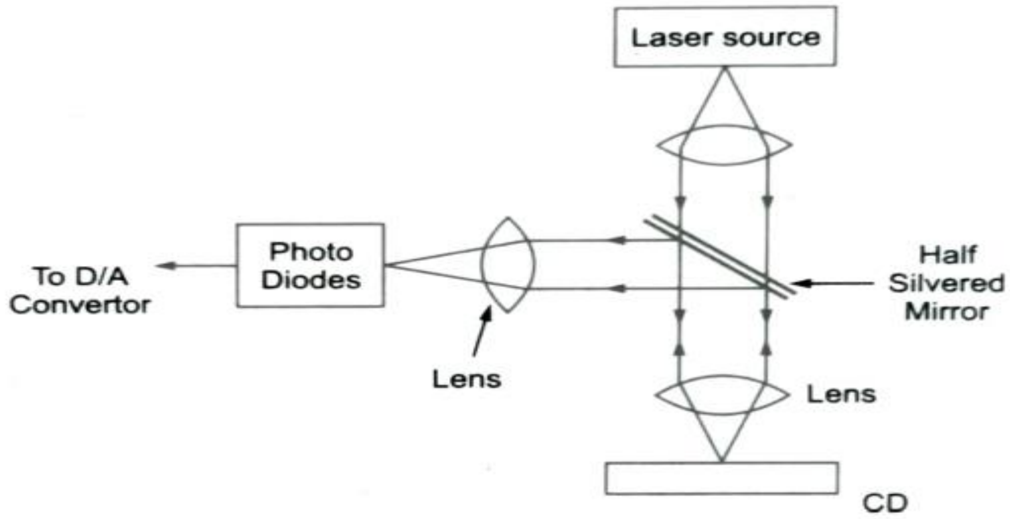

Fig. 10.4: *Reflection of Laser Beam in a CD Player*

Fig 10.4 shows the reflection of the laser beam from the CD so as to generate binary signals.

The block diagram of the optical pick up process is shown in Fig 10.5.

Control signals allow the disc to be scanned in any desired sequence.

This sequence can be controlled from a key board.

A clock signal obtained from the disc itself is compared with a signal from a crystal oscillator.

This discrepancy gives rise to an error signal/correction signal which is applied to the servo system.

Since the circumference of outer tracks is more than that of tracks near the centre, the rotational speed of the disc is varied from 500 rpm at centre to 200 rpm at the outermost edge.

This is done by varying the speed of the driving motor.

The disc is scanned at 1.2 m/s.

The total length of tracks on a CD is 6 km.

Thus we have a playing time of 60 minutes in addition to 20 minutes time for error correction.

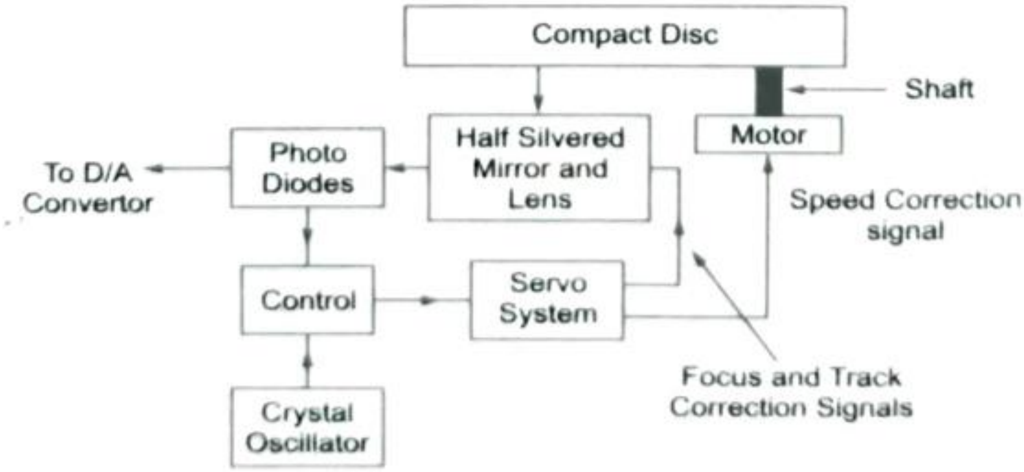

Fig. 10.5: *Block Diagram of Pick up System in CD Player*

Q4)a-Solution :

D/A CONVERTOR

Fig 10.11 shows a circuit known as binary ladder network for D/A conversion.

From node 1 the resistance to the digital source is 2 R and resistance to ground is also 2R.

From node 2 the resistance to digital source is 2 R as shown and resistance to ground is

= R + (2R)(2R)/(2R+2R) = 2R.

Thus from each of nodes 1, 2, 3, 4, the resistance to source and ground is 2 R each.

A digital input 0001 means that D is connected to a voltage V and all other inputs A, B, C are grounded.

The output voltage Vo is V/16.

A digital input 0010 means that C is connected to V and A, B, D are grounded giving an output of 2V/16.

Thus as input varies from 0000 to 1111, the output varies from 0 to V in steps of V/16.

A complete D/A converter consists of a number of such ladder networks (to deal with more bits of data) and other devices like gates, operational amplifiers etc.

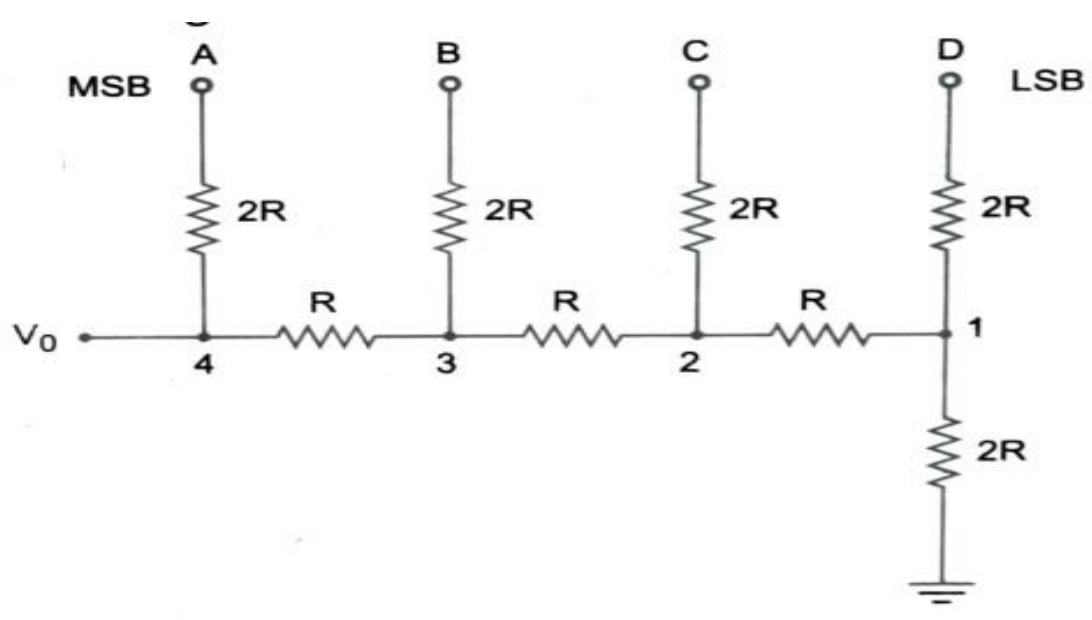

Fig. 10.11: *D/A Convertor*

HANDLING OF COMPACT DISCS

- Compact discs require care in handling. The following precautions in handling are necessary:
  1) Do not expose the disc to direct sunlight, high humidity or high temperature.
  2) Return the disc to case after use.
  3) Do not write anything on disc surface.
  4) Do not touch the playing surface. Handle by edge.
  5) Wipe off dust etc with soft cloth.
  6) Wipe in straight motion from centre to edge.
  7) Don't use any chemical or fluid for cleaning the disc.

Q4)b-Solution :

GEOMETRY OF AUDIO DISC

Fig. 10.6 shows the edge view of audio disc.

The disc is always played from inside to outside and rotates counter clockwise.

Moreover, the compact disc player operates at constant linear velocity.

Since the inner tracks have lesser lengths as compared to outer tracks, the angular velocity of the disc must change continuously during its operation.

The disc is read by a laser beam focussed on its signal surface from the underside.

The pitted surface is covered with a layer of evaporated aluminium to increase its reflecting power.

The laser beam passes through the polycarbonate plastic base and hits either a flat or a pit.

This plastic has an index of reflection n=1.5 and GaAI as laser used has an IR output with λ = 0.78 μm in air.

If n = 1.5, λ = 0.52 μm and λ/4 = 0.13 μm.

If the pits were 0.13 μm deep, the light reflected from pit would be shifted by λ/2 i.e. 180° as compared to light reflected from flat.

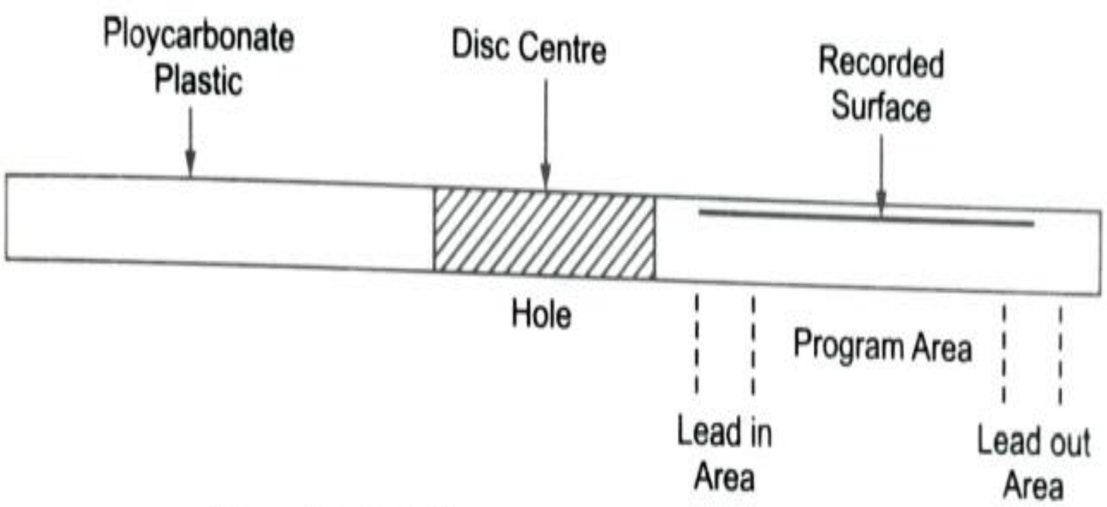

Fig. 10.6: *Edge view of Compact Disc*

This reflected beam is summed with the incident beam.

The reflected beam from flats would be in phase with incident beam and would interfere with the incident beam constructively.

The reflected beam from pits would be 180° out of phase with the incident beam and interfere with it destructively.

A photoconductor translates the variation in light intensity into a digital pulse train.

In actual practise the pits are 0.11 μm deep.

Still the difference between beams reflected from pit and flat are substantially different in phase.

The nominal linear velocity of disc is 1.3 m/s with 1.4 m/s and 1.2 m/s as the maximum and minimum values.

The innermost track of CD has radius of 25 mm and the outermost track has a radius of 58 mm.

The angular velocity varies from 500 rpm at the innermost track to 200 rpm at the outermost track.

The spacing between centres of adjacent tracks is called pitch and is 1.6 μm.

The pits along each track may have lengths varying from 0.9 μm and 3.3 μm.

The width of pits in radial direction is 0.5μm.

COMPARISON OF CD AND TAPE

- Recording and reproduction of audio signals on compact discs offer a number of advantages. Some of these are:

1) Complete elimination of noise and distortion. No Vow, flutter, rumble etc.
2) Better frequency response in the complete audio frequency range.
3) High signal to noise ratio.
4) Surface of CD is not affected by dust, grease etc.
5) Even if some bits are lost, error detecting codes can restore the information.
6) High channel separation.
7) More information can be stored over the same area.

Disadvantages

- High cost.
- Recording and reproduction

processes are more complex.

Q5)a-Solution :

As discussed above the three primary colours green, red and blue have to be in the proportion 0.59, 0.3 and 0.11 respectively to give white colour.

The three coefficients arise due to the fact that human eye has different sensitivity to these three colours.

But these three values 0.59, 0.3 and 0.11 are very inconvenient.

In Trichromatic units all the three primary colours are added in equal amount to yield white colour.

Thus T (trichromatic) units of white consists of (1/3)T unit of each green, red and blue.

The trichromatic coefficients x, y, z can be represented in terms of tristimulus value x' , y' , z' , as under

$$x = \frac{x'}{x' + y' + z'} \tag{14.1}$$

$$y = \frac{y'}{x' + y' + z'} \tag{14.2}$$

$$z = \frac{z'}{x' + y' + z'} \tag{14.3}$$

If we add the above three equations

$$x + y + z = \frac{x' + y' + z'}{x' + y' + z'} = 1$$

Since the sum of trichromatic coefficients is 1, it is necessary to find only two of them. If x and y can be found then z = 1-x-y.

The T coefficients x, y, z can be represented by a triangle called colour triangle shown in Fig.14.1.

In this triangle, red is shown on x axis and green on y axis.

The third axis z is perpendicular to the x - y plane.

Blue is along z-axis.

Since x + y + z = 1, the third axis need not be shown.

The extremity of each axis represents 1.

Therefore, the x, y, z coordinates of red colour are 1, 0, 0 coordinates for green colour are 0, 1, 0 and coordinates for blue are 0, 0, 1.

Using these x, y, z coordinates we can easily find the three coordinates for secondary colours e.g.

for magenta $x = 0.5$, $y = 0$ and $z = 1 - 0.5 = 0.5$

for yellow $x = 0.5$, $y = 0.5$ and $z = 0$

for cyan $x = 0$, $y = 0.5$ and $z = 0.5$

For white the x, y, z coordinates are 0.333 each.

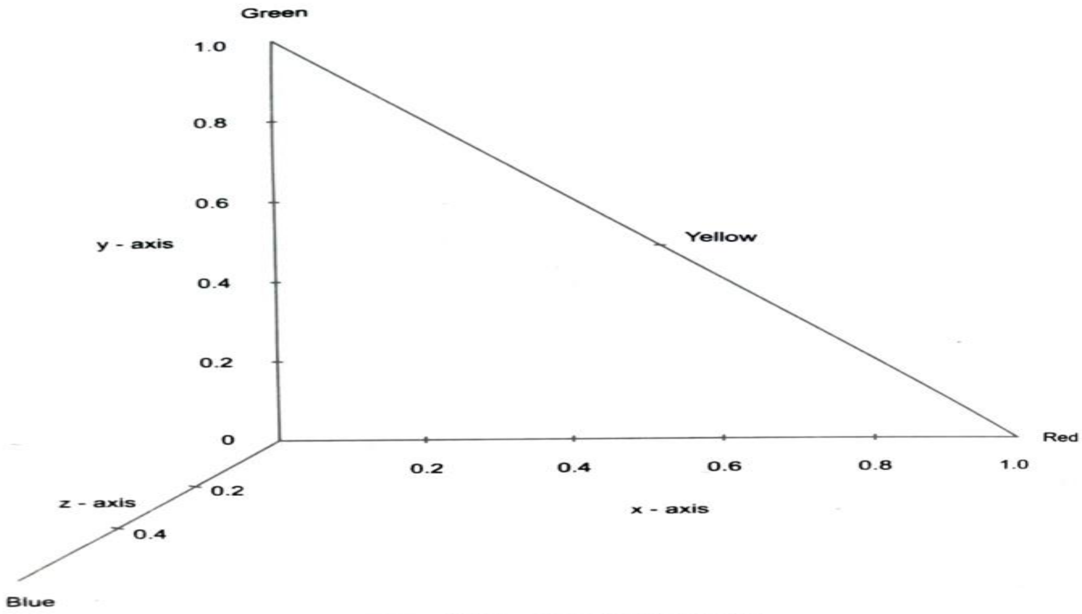

Fig. 14.1 Colour Triangle

Q5)b-Solution:

RECENT ADVANCES IN TV TECHNOLOGY

BBC introduced TV in 1930 and added colour TV to its broadcast in 1950.

By 1960 , all TVs in UK were colour TVs.

VHS video tapes were introduced in 1980.

The improvements and innovations continued and are still continuing even today to provide better viewing facilities to public.

LCD TV

LCD TV has slim design and flat viewing surface.

It allows larger screen, wide viewing angle and high quality picture.

Most of LCD TVs can be mounted on wall and double up as TV and personal computer.

LCD stands for liquid crystal display.

LCD TV is called transmissive display.

A high source behind the panel shines light through the LCD display.

A white diffusive panel behind LCD reflects and scatters the light evenly.

It consists of two polarising transparent panels with liquid crystal solution sandwiched between the panels.

The screen's front layer of glass is etched on the inside surface in a grid pattern to form a template for the layer of liquid crystals.

These liquid crystals are rod shaped molecules that bend light in response to electric current.

As a result, the crystals align so that light cannot pass.

Each crystal acts as a shutter either allowing light or blocking light.

The pattern of dark and transparent crystals form the image.

LCD TV uses advanced LCD called active matrix LCD. The design is based on thin film transistors (TFT).

These are basically tiny switching transistors and capacitors arranged in a matrix.

They rapidly switch LCD pixels on and off. Each colour pixel consists of three subpixels with red, blue, green filters.

Pixel response time has to be fast to respond to fast moving objects.

LCD TV is energy efficient and uses 60% less power than older TV.

LED TV

LED TV uses light emitting diodes (instead of cold cathode fluorescent lamp used in LCD TV).

Thus, it is a flat panel display using LED.

Use of LED means thinner panel and lower power consumption (than LCD).

Moreover, heat dissipation is better, display is very bright and contrast control is also better.

LED TV can be full array LED or Dynamic local dimming LED.

The dynamic local dimming control allows dimming of some areas darkness for better contrast.

Comparison of LED and LCD TV

1) LED TV has better dynamic control.
2) LED TV is extremely thin.
3) LED TV causes less environmental pollution at the time of disposal.
4) LED TV uses 20-30% less power than LCD TV.
5) LED TV is more reliable than LCD TV.
6) LED TV is more expensive than LCD TV.

- LED TV applies pulse width modulation to supply current for dimming control.

- Thus, lights can be switched on and off faster than what eye can perceive.

Plasma TV

Plasma TV uses tiny cells containing electrically charged ionized gas similar to that existing in a fluorescent lamp.

One panel has millions of tiny cells arranged between two panels of glass.

These cells hold mixture of noble gases and small amount of mercury.

When mercury is vaporised, the electric field causes plasma.

Some electrons strike mercury particles and the mercury particles shed energy so as to produce ultra violet plasma.

The plasma strikes phosphor painted on the inside of the cells.

Thus, energy is converted to visible light.

Depending on type of phosphor different colours are produced.

Plasma display are very bright (1000 luxs or more) and have wider colour gamut.

These can be produced in very big sizes.

Display panel is thin, less than 6 cm thickness, so that the total thickness is less than 10 cm.

Plasma TVs use more power.

For 50" screen the power rating is about 400 W.

Plasma screen is made of glass which can reflect more light than LCD screen.

Q6)a-Solution:

CHROMATICITY DIAGRAM

Colour is specified by Hue, Luminance and Saturation.

These three specifications of colour can be represented graphically by chromaticity diagram.

Hue and saturation are shown on x and y coordinates and Luminance is shown on z-coordinate.

Thus, this diagram is a three dimensional diagram.

In x- y plane the diagram looks like a horse shoe shaped triangle.

Both spectral and non-spectral colours can be depicted on this diagram, the spectral colours on the periphery and non-spectral colours on the base line as shown in Fig 14.7 (a).

White appears inside the curve.

The corners represent the three primary colours red, green and blue as shown.

When luminance (i.e. brightness) is shown on z-axis the diagram looks like a pyramid (Fig 14.7 (b).

Brightness is maximum at the base of pyramid and minimum at the vertex.

Thus vertex represents black.

As we move from base to vertex of pyramid the brightness changes from maximum to minimum (i.e. white to black).

Chromaticity diagram can be used to determine the result of additive mixing of colours graphically.

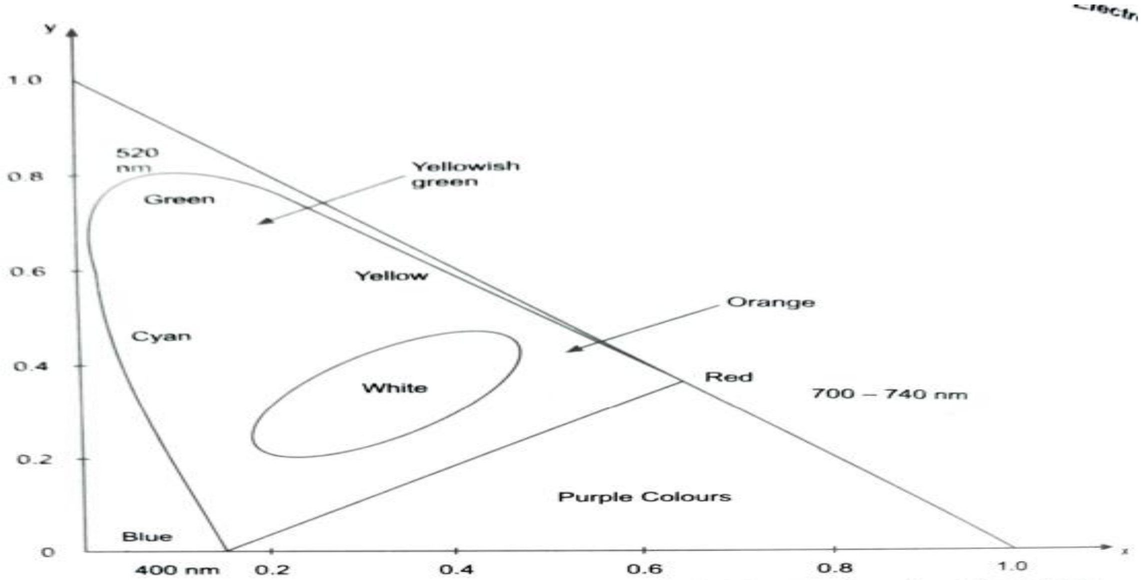

Fig. 14.7: *(a) Chromaticity Diagram (a) Hue and saturation along x and y coordinates*

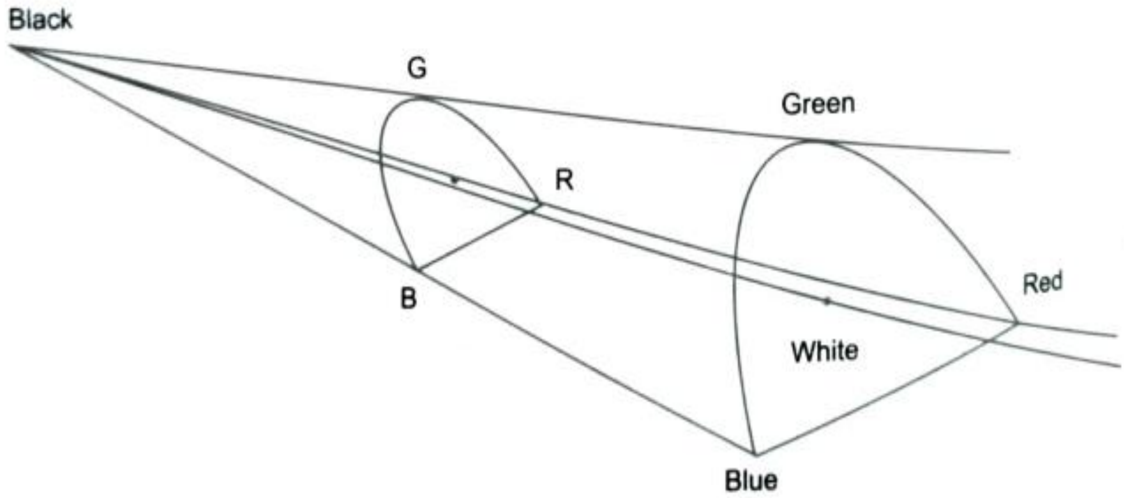

Fig. 14.7: (*b*) *Pyramid representing brightness.*

The three corners of the chromaticity diagram represent the three primary colours red, blue and green.

The colours along the perimeter (Fig 14.7) are pure saturated colour.

These are called spectral colours.

As we move away from the perimeter towards the centre the colours become less saturated.

White is the centre point having coordinates x = 0.31 and y = 0.32.

This point indicates pure white.

Other white colours i.e. sunlight, standard white etc. are around the point indicating pure white.

The purple colours are along the base line.

As we go from blue to green to red there is a gradual increase in wavelength.

The purple colours which lie along the base line are called non-spectral colours.

The hue, determined by the spectral colour at the radius from the point corresponding to white to the outer periphery, is the angular measure of the radius with reference line say red (wavelength 700 n - m).

The distance from white indicates saturation.

Q6)b-Solution:

MIXING OF COLOURS

Red, green and blue are the primary colours.

When these colours are mixed we get secondary colours.

The mixing of colours can occur in two ways i.e. additive mixing and subtractive mixing.

Additive Mixing of Colours

When we see different primary colours coming from independent sources, we see the combined effect.

Additive mixing of colours takes place in our eyes and we see a colour different from the original ones.

Red, green and blue mixed in equal intensities gives rise to white.

Mixing of red and green in equal intensities gives yellow colour. Thus,

Red + Blue + Green = white

Red + Green = yellow

Blue + Green = Cyan

Red + Blue = Magenta

When the intensities of primary colours being mixed are different, we get still some other colours.

One lumen of red mixed with 0.5 lumen of green gives reddish yellow.

Fig.14.2 illustrates additive mixing of colours.

Each circle represents one primary colour.

Some colours obtained as a result of additive mixing are also shown.

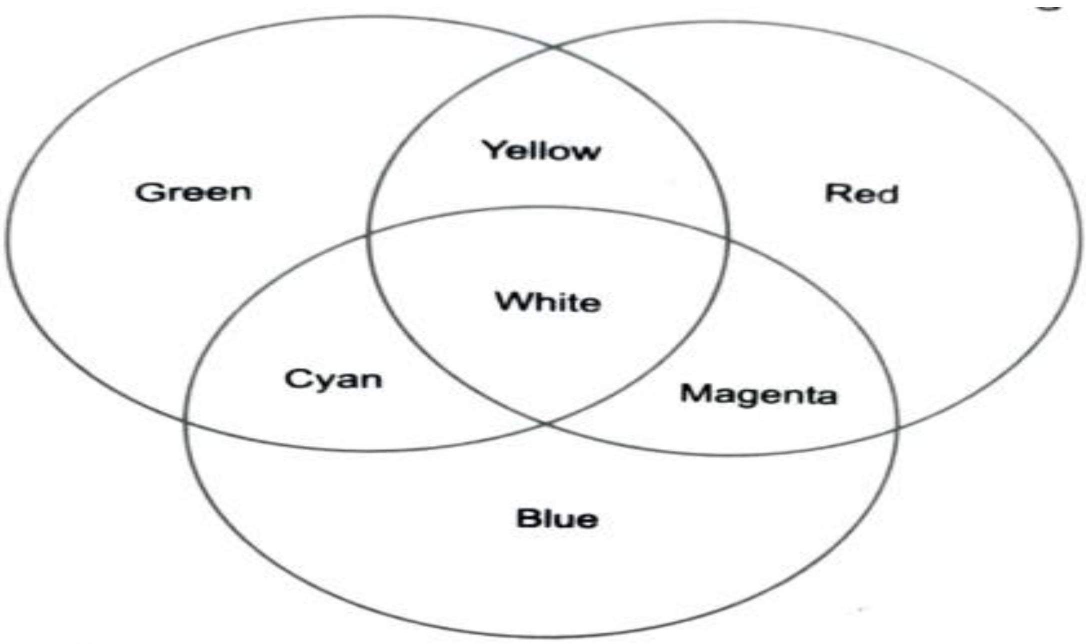

Fig 14.2: *Additive mixing of Colours*

Subtractive Mixing of Colours

When an object subtracts a colour from the incident light, subtractive mixing takes place.

The colour seen, in that case, will be the colour of the object.

When white light is incident on a blue object, the object absorbs green and red components of white light and we see the blue colour.

When yellow light-falls on a red rose, green portion is absorbed and we see only red colour of the rose.

Fig. 14.3 shows subtractive mixing of colours.

When green and red are subtracted from white, we see only blue colours.

When all the three i.e. green, blue and red are absorbed by the object, the result is black colour.

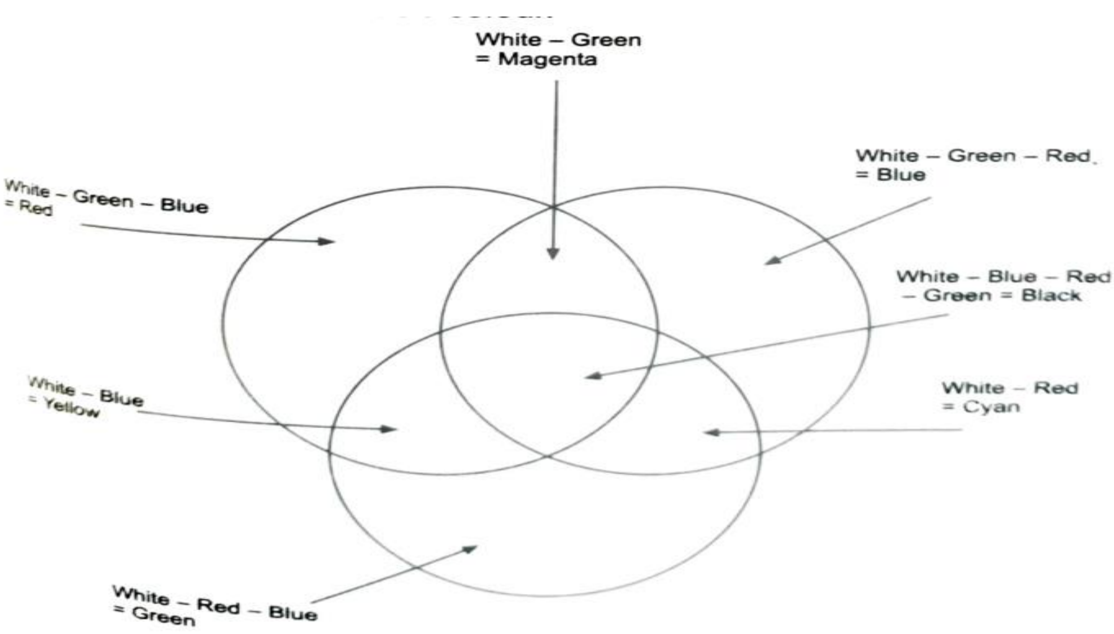

Fig 14.3: *Subtractive Mixing of Colours*

Q7)a-Solution:

CLOSED CIRCUIT TELEVISION (CCTV)

CCTV system is very useful and has applications in education and training, industry, security, surveillance etc.

These systems essentially consist of TV camera and video monitor along with associated circuitry.

The TV camera picturises the scene and it is displayed on monitor.

One camera may feed a number of monitors (placed at different locations) or a number of cameras may feed one or more monitors.

A CCTV system has a camera tube (along with scanning arrangement) and a video amplifier located at a central place.

The arrangement for generation of sync. and blanking pulses has also to be provided.

The composite video signal is transmitted through a coaxial cable to the video monitor.

The system may also have a number video monitors distributed uniformly over the area where viewing facility is to be provided.

Moreover, the number of video cameras may also be more than one (For surveillance in a big departmental store there may be about a dozen cameras situated at strategic locations on different floors).

Before feeding the signal to the video monitor it has to be amplified to compensate for loss in cable.

The sync. pulses have to be separated.

The picture tube and deflection circuits have to be provided for a proper display.

Fig. 15.2 shows a block diagram of CCTV syslem having one camera tube and one monitor.

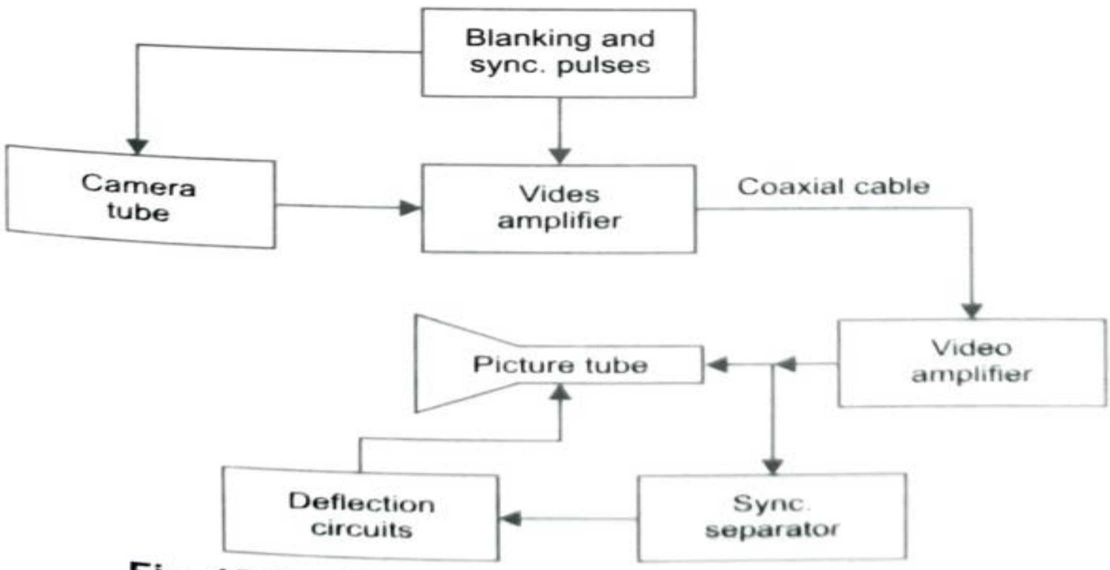

Fig 15.2: *Block Diagram of CCTV System.*

CCTV systems do not have master synchronising pulse generator.

The mains supply frequency of 50 Hz with suitable wave shaping circuit is used to trigger the vertical oscillator.

The horizontal oscillator is a crystal controlled astable multivibrator.

The output of astable multivibrator is in the form of clock pulses which are used to establish the timing sequences necessary for synchronisation.

In this system of synchronisation, the line spacing between the two fields may vary in a random fashion.

Therefore, it is known as random interface system.

CCTV system may have self contained camera units or remote operation type camera.

Self contained camera unit has all the equipment (i.e., camera, video processing circuitry, synchronisation and blanking pulses circuitry etc.) at one place.

The video signal from the unit is sent to monitors through cables.

Remote operation cameras have all the equipments except camera tube at a central place.

The camera is separate and is installed at the actual site e.g., on the ceiling above the operation table in a hospital.

The camera is connected to the remaining equipment through multicore cable.

In this arrangement the camera can be located very near the actual scene to be shown and at a convenient place.

A CCTV may have more than one camera to show different aspects of the scene e.g., demonstration of a surgical operation is done by using three cameras located at suitable positions around the body part to be operated on.

All these cameras can have a common synchronisation system.

The synchronisation pulses could be provided by a common synchronous pulse generator (SPG).

Fig. 15.3 shows a common synchronous pulse generator feeding four cameras and terminated finally in a 75Ω cable impedance.

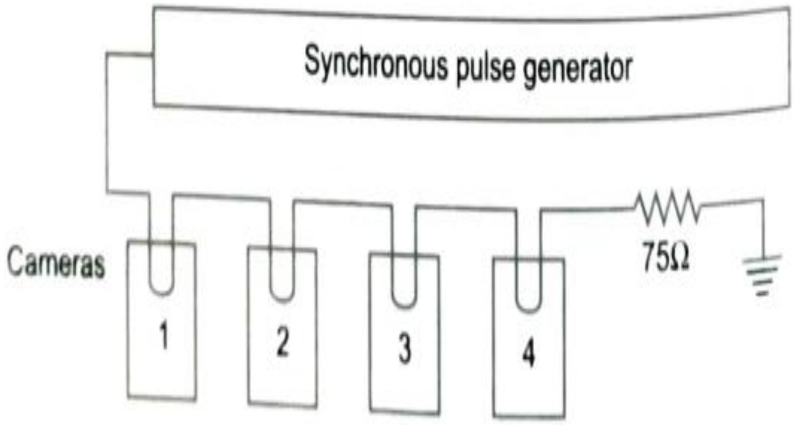

Fig. 15.3. *A Single Synchronous Pulse Generator Feeding 4 Cameras in a CCTV System*

Fig. 15.4 shows a single video camera feeding 4 monitors each terminated in cable impedance of 75 Ω.

When these monitors are situated a bit far away, the signal may suffer attenuation.

To compensate this loss, a distribution amplifier is added.

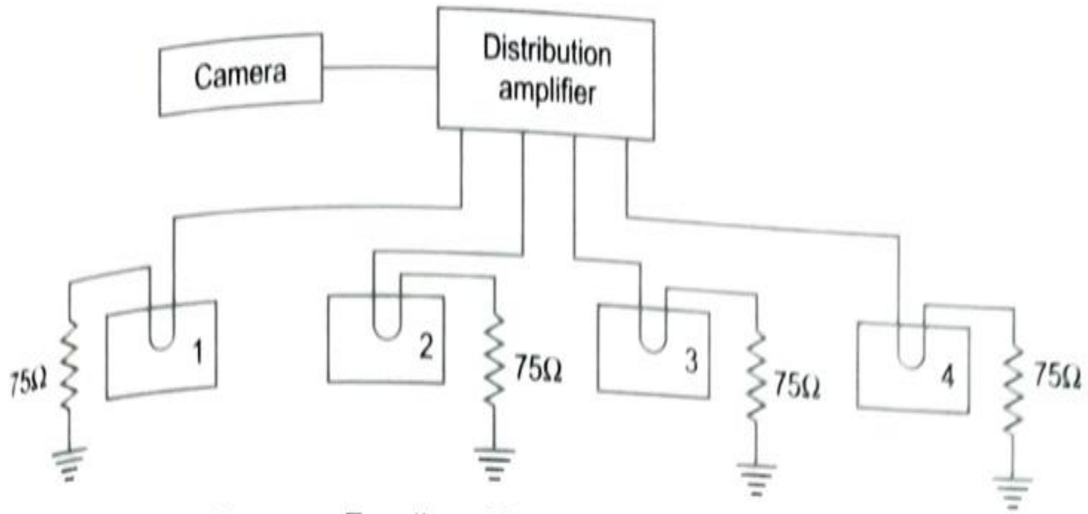

Fig. 15.4: One Camera Feeding Monitors 1–4 through Distribution Amplifier

More than one camera may be feeding one or more monitors.

Evidently these cameras would be switched on by turn but only one at a time.

A push button camera selector switch is used to switch on the camera.

The switches should have mechanical interlocking so that only one switch is operated at one time.

A 75 Ω terminating impedance is used on each camera and the group of monitors.

Fig.15.5 shows this configuration.

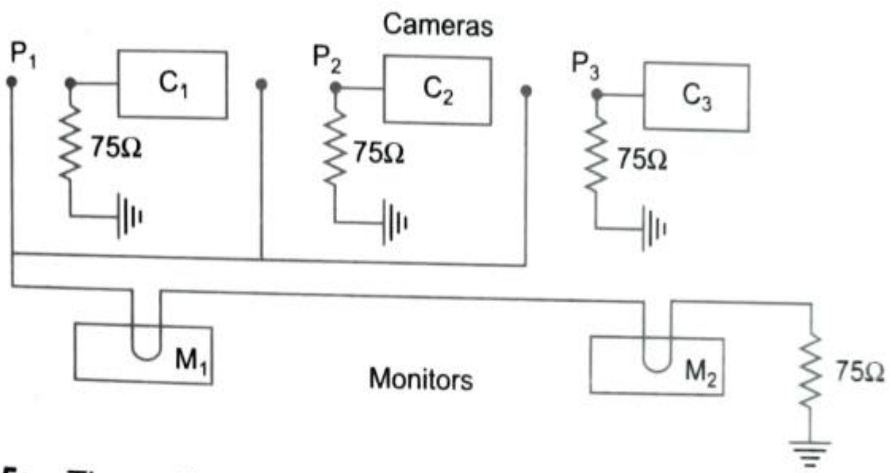

Fig. 15.5: *Three Cameras Feeding Two Monitors Through Interlocked Selector Switches P_i , P_z , P_s*

Applications of CCTV

Closed circuit television has a large number of applications. Some of these are:

a) Surveillance : CCTV is a boon for all places requiring constant surveillance.

Banks, shops, commercial establishments, traffic junctions etc. are some of the places where CCTV can be used to keep an eye on the people and their movements.

Surveillance through CCTV helps in solving many criminal acts at such places.

b) Industry : Many Situations and manufacturing processes require close inspection.

In some of these local inspection may not be possible.

CCTV can be used in these situations for remote inspection.

Nuclear reactions can be inspected from safe distances using CCTV.

c) Education : CCTV has enabled many complicated surgical operations to be shown to a large number of medical students.

It is possible to have one teacher sitting at a convenient place and his lecture and demonstrations telecast to a large number of students at different places using CCTV.

d) Miscellaneous : CCTV also finds application in oceanography, aerospace monitoring etc.

Q7)b-Solution:

AN ELECTRONIC GUESSING GAME

Fig. 17.7 shows the block diagram of an electronic guessing game using CMOS counter.

A random number is generated and the player tries to guess the number.

The computer gives the answer as too high or correct or too low.

The player again guesses the number till he hits upon the correct number.

The player who gets the answer in fewest guesses walks away with the prize.

The parts of the game are clock (about 1 kHz frequency), binary counter, magnitude comparator, and switches.

Initially the push button S1 is pressed thus connecting clock to the binary counter.

A random number (between 0000 to 1111 i.e. decimal 0 to 15) is generated when the push button S1 is released.

This random number is held by the counter at input B0-B3 of the magnitude comparator.

The player's guess input is A0-A3.

The three outputs are $A = B$ (green LED), $A < B$ (yellow LED) and $A > B$ (red LED).

Depending on the three possibilities one of these three LEDs will glow.

In the event $A > B$ or $A < B$, the player inputs another number A0-A3.

If $A = B$, the game is started again by pressing push button S1.

Now, a new random number is generated.

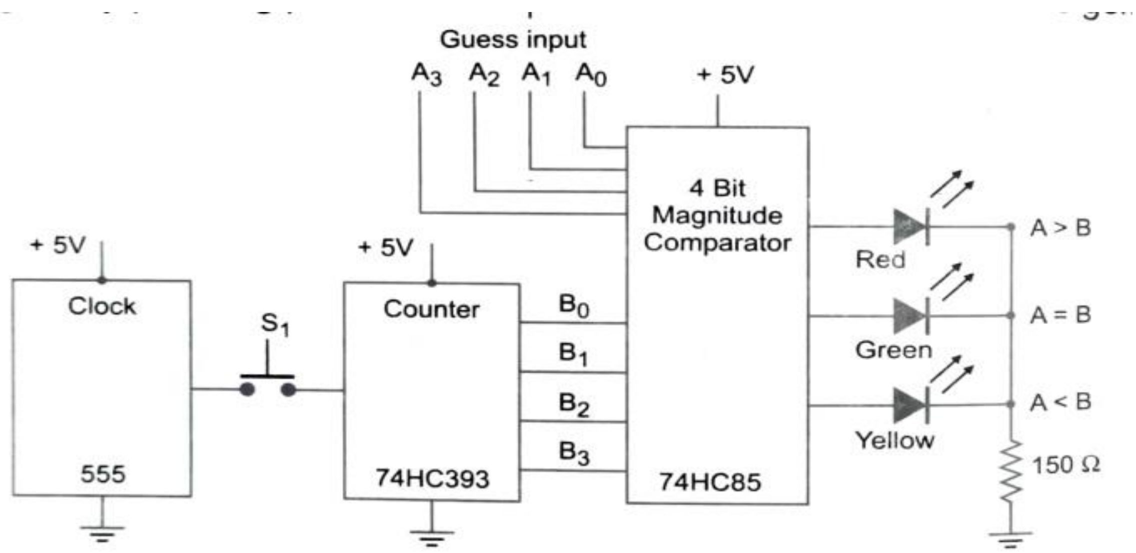

Fig. 17.7: *Block Diagram of Electronic Guessing Game*

Q8)a-Solution :

Cable Network

For providing service to consumers, an elaborate cable network is necessary.

Initially the signals are fed to trunk lines which feed the branches and finally the twigs.

The connections to subscriber may be direct or through a converter (for pay channels).

Converter is also called Set Top Box.

Fig. 15.7 shows one typical cable distribution system.

Signal suffers attenuation of about 15 dB in a 500 m cable.

Therefore, a number of booster amplifiers (also known as repeaters) have to be installed to compensate the signal loss.

An alternative system is a star system in which the VHF/UHF signal processor is at a central location and feeds a star network from which connections are given to subscribers.

It is necessary to convert all UHF channels to VHF.

The signal loss (expressed in dB) is lower at VHF than at UHF.

The dB loss increases as per square root of frequency (If dB loss is 3 at 40 MHz, it will be 6 at 1600 MHz).

Moreover, the signal processor can accept signals from dish antennas as well as local programmes.

These local programmes include feature films, announcements, cultural programmes etc.

The signal processor is also called head end in cable TV terminology.

Signal is amplified by trunk amplifier and distributed over the network.

The network consists of trunk lines, branch lines and twigs.

The connections to consumers are given from the twigs.

(Twigs are also called service lines).

At each stage an amplifier is necessary to boost the signal.

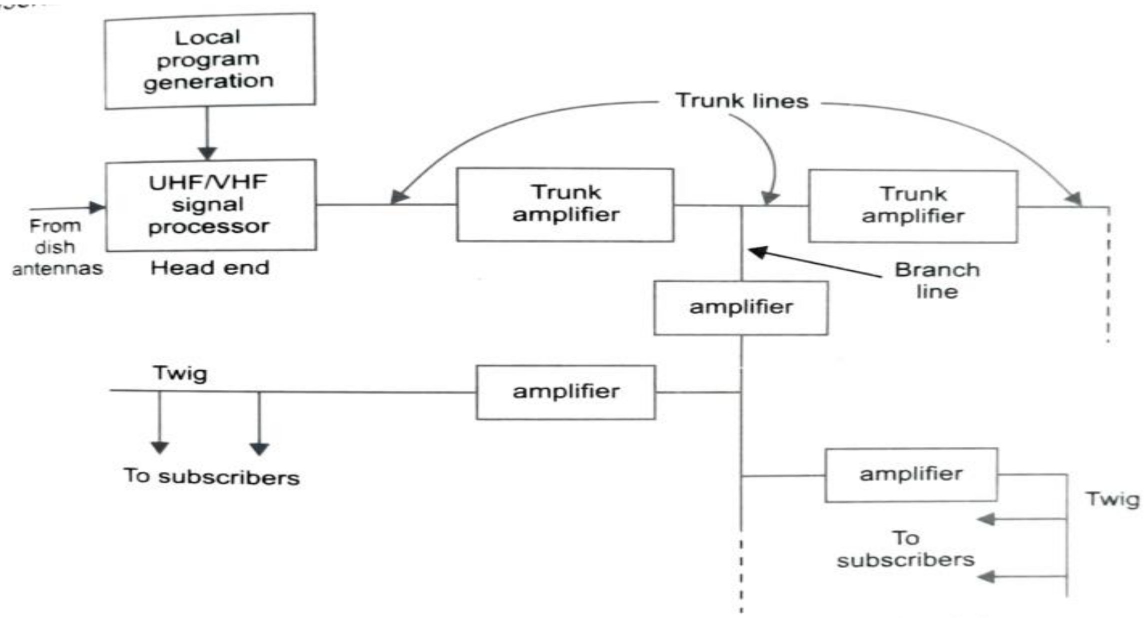

Fig. 15.7: *Block Diagram of Cable Television*

Q8)b-Solution:

CALCULATOR

An electronic calculator is a very cheap and convenient device for making calculations.

A general purpose pocket calculator has the following functions: Arithmetic functions(+, -, x, /), percentage %, reciprocal, square and square root.

It has a memory unit with corresponding push buttons : M+ (Add to memory), M- (subtract from memory), RM (recall memory) and CM (clear memory).

Scientific calculators for use by scientists and engineers have, in addition to above, the following functions also: Trigonometric (sin, cos, tan, sin-1, cos-1, tan-1), exponential, logarithmic and antilogarithmic (both natural and base10), polar to rectangular coordinate conversion, degrees to radians etc.

Some scientific calculators have hyperbolic and inverse hyperbolic functions also.

Calculators used in shops and commercial establishments have display printer, sub total/grand total facilities.

Fig. 17.5 shows a simple block diagram of an electronic calculator.

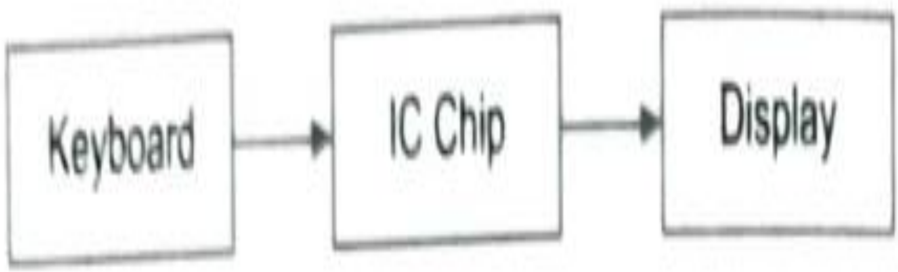

Fig. 17.5: Block Diagram of Electronic Calculator

The keyboard is the input device.

On the case are a number of press buttons for various digits and functions.

When a button is pressed, a corresponding signal is sent to the processing unit i.e. IC chip.

Processing unit consists of an integrated circuit chip.

The chip depends on the type of calculator (general purpose, scientific etc.).

It is the heart of the calculator.

All operations are performed by this unit.

The result of calculations is displayed on the display.

Most calculators use LED (light emitting diodes) for this purpose.

LCD is also used.

Calculators are powered by pencil cells.

Calculators with solar cells are also available.

Programmable calculators allow simple computer programs to be stored in its memory so that the program may be used when necessary.

Fig. 17.6 shows a block diagram illustrating the architecture of a calculator.

It has a keyboard (for input), display (for output) and an IC.

The IC has several subsystems whose functions are as under.

Clock : It sends constant frequency pulses to all the parts for synchronization of all operations. The clock frequency may range from 25 kHz to 500 kHz. When the calculator is turned on, the clock runs continuously and various circuits idle till a command comes from the key board.

Encoder : We work with decimal numbers. However, all computers and calculators use binary numbers in their operations. Encoder converts the decimal number into binary (or binary coded decimal i.e. BCD) numbers.

Decoder/Driver : The binary result is converted to decimal by the decoder. The driver drives the display unit.

Adder/Subtractor : The arithmetic operations are performed in this section.

Instruction Register : It contains the instructions necessary for bigger numbers with decimal points. The controller follows the directions in the instruction register.

ROM : Read only memory. The steps to be followed in the calculations are programmed into ROM. The memory size of ROM in a calculator is some thousands of bits.

Display register : It stores the latest numeral etc. which we input into the calculator.

Operand register : It stores the last but one numeral which we had put in the calculator.

Accumulator Register : The results of the arithmetic operation are stored in this register.

X Register (extra register) : It holds the sign of the arithmetic operation (e.g. +) in binary form.

Control Circuit : It controls all the operations in the calculator.

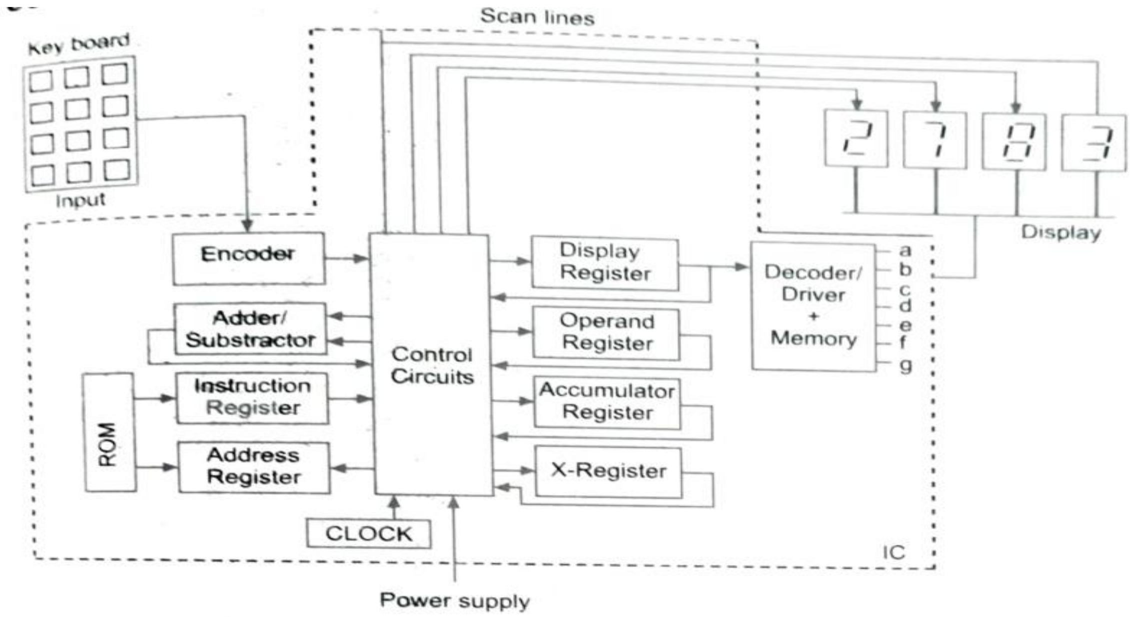

Fig. 17.6: *Architecture of Calculator*

Sample of Operations

To understand the working of calculator, let us see the process it follows in the operation 3 + 4.

Initially we press 3 on the key board.

The encoder converts decimal number 3 to BCD 0011.

The control circuit directs this number 0011 to the display register and it is stored in the display register.

The display register feeds this number to decoder/driver.

The lines a, b, c, d, g are activated and the number 3 is displayed (for decimal number 3 the lines a, b, c, d, g are activated as seen in the seven segment display in Fig. 17.2. (a).

Next we press + on the key board.

This sign is encoded and stored in X register in code form.

Next we press 4 on keyboard.

The encoder converts this decimal number 4 into BCD 0100 and transfers it to the display register.

The decoder converts it back to decimal.

Lines f, g, b, c are activated and this number is displayed.

In the mean time the controller has moved the previous number 3 (i.e. BCD 0011) to the operand register.

Next we press = key.

The control circuit checks the X register to see what to do.

This X register contains add (+) sign.

The control circuit applies the contents of display register (i.e. 0100) and operand register (i.e. 0011) to the adder which does the addition.

The results of addition are stored in accumulator register.

The control circuit directs this result to the display register.

The decoder converts the result (i.e. 0111) to decimal 7.

Lines a, b, c of the seven segment display are activated and the result 7 is displayed.

When the operation is complex (e.g. exponential, logarithm, trigonometric operation etc.) the control circuit may have to follow hundreds of steps as programmed into the ROM.

However, each operation takes less than a μ second so that even these hundreds of steps are completed in less than a second.

Q9)a-Solution :

UPS

UPS means uninterruptible power supply i.e. a power supply which continues to feed devices even in the event of main power supply failure.

Many equipments like computers give better performance when operated at constant voltage.

Moreover, failure of power supply can cause loss of data in computers.

Therefore, computers are invariably supplied through UPS.

Fig. 17.23 shows a block diagram of a UPS.

Its main constituents are rectifier, battery, inverter and by pass switch.

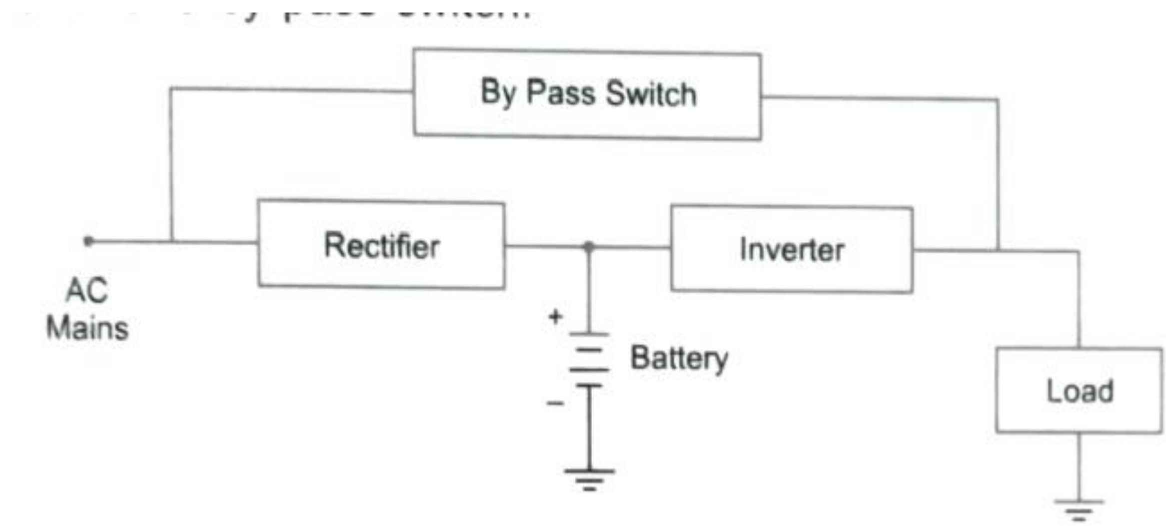

Fig. 17.23: *Block Diagram of UPS*

The rectifier converts AC to DC.

This DC supply feeds the inverter as well as charges the battery.

The inverter converts DC to AC and supplies the load.

In the event of failure of mains supply, the battery maintains the supply.

If the load on the inverter increases the bypass switch operates and protects the inverter.

UPS are generally provided with a filter circuit to smoothen the DC supply.

An automatic voltage regulator circuit is also added to regulate the voltage and keep it constant.

Present day UPS for computer systems use pulse width modulated inverter because its output is pure sine wave.

UPS can be classified as on line, off line.

On Line UPS

The load is always fed from inverter which remains on all the time.

The voltage at load terminals is constant.

In the event of failure of mains supply, the battery supplies the load through inverter.

The rectifier is also on all the time and feeds inverter and battery.

This system gives better performance, constant output voltage but is costly.

Off Line UPS

In this system the inverter is normally in the off state but a switch puts it on as and when the mains supply fails.

Automatic voltage regulation is not done.

Therefore, the output voltage does not remain constant.

INVERTER

Fig. 17.24 shows the block diagram of inverter commonly used in houses.

The various parts are: Rectifier, battery. inverter, overload relay, under voltage relay and switches.

Switch 3 is a normally closed switch so that AC mains supply feeds the load directly.

The rectifier converts AC to DC and keeps the battery in working condition.

Switch 1 is an overload relay which switches off the supply from inverter to prevent damage to inverter in the event of current through inverter being more than its rating.

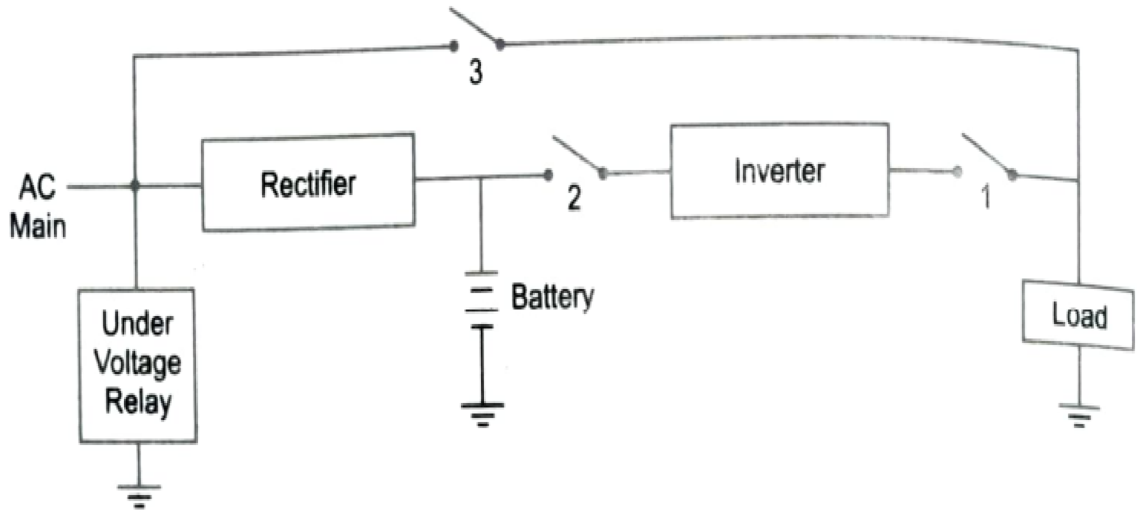

Fig. 17.24: *Block Diagram of Inverter*

Whenever the power supply fails or the voltage is very low, the under voltage relay senses this condition and closes switch 2 so that the load is supplied from inverter.

As and when the supply is restored the switch 2 opens so that load is fed directly from mains through switch 3.

Most of the inverters give a square wave output.

The ICs used in TV and other devices can get damaged if operated from such inverters.

As such it is advisable that such inverters are not used for TV, VCR etc.

However perfect sine wave inverters are also available.

They use pulse width modulation (PWM) to give sine wave output.

Such inverters can be used for TV, VCR also.

Q9)b-Solution:

ELECTRONIC IGNITION SYSTEM FOR AUTOMOBILES

Automobiles use multi cylinder engines.

The conventional ignition system has a battery, ignition switch, ignition coil, distributor, spark plugs and contact breaker.

The battery supplies the power.

The ignition switch is used to switch on the engine.

To ignite the petrol air mixture a spark is needed.

This spark is provided by the ignition coil through contact breaker and distributor.

The ignition coil is a transformer with a large number of turns in secondary.

When the primary circuit is opened by the contact breaker, a high voltage is induced in the secondary.

The distributor supplies this high voltage to the various spark plugs turn by turn.

This high voltage creates a spark between the contacts of the spark plug.

Generally, the primary and secondary are connected in auto transformer configuration.

The secondary has about 60 times the number of turns in the primary.

The dynamo is also driven from the engine and charges the battery.

Drawbacks of Conventional Ignition System

1. The ignition is not as per specifications as the speed is varied.

2. Wear at contacts, cam and erosion of contact surface, contact bounce.

3. Frequent servicing.

Previously a high voltage of about 10-15 kV was used.

Modern engines use 15-30 kV to ignite the weak petrol air mixtures needed to give good economy and proper emissions.

Transistor Assisted Contacts (TAC)

The system uses a mechanical contact breaker to drive a transistor which controls the current in the primary circuit.

The mechanical breaker handles only small current.

Therefore, erosion of contacts is reduced.

Accurate spark tunings can be achieved for a longer period.

Fig. 17.33 shows the circuit of ignition system with transistor assisted contacts.

The transistor performs the duty of the contact breaker of conventional system.

The transistor acts as a power switch to make and break the primary circuit.

The transistor is operated by the current supplied by cam operated contact breaker.

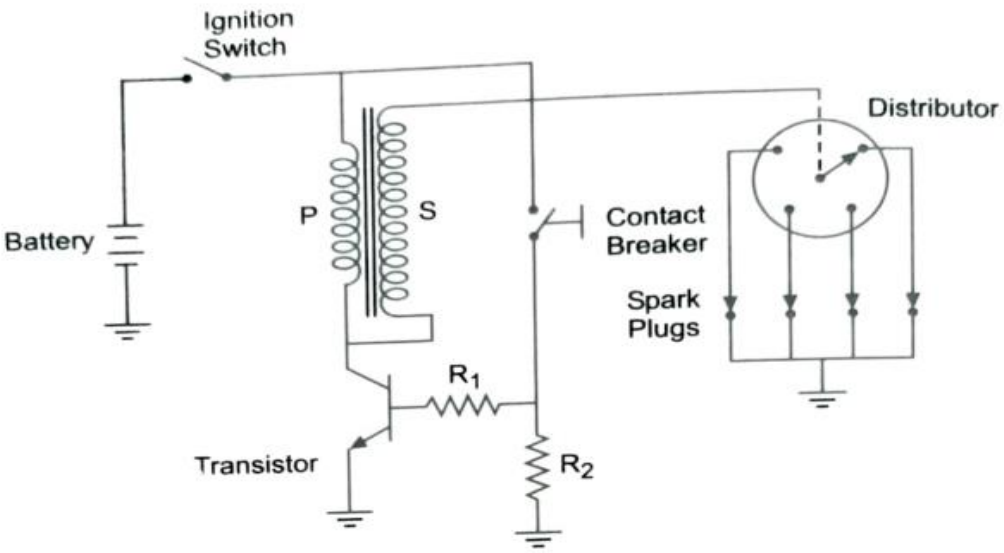

Fig. 17.33: *Transistor Assisted Contact System for Ignition*

When contact breaker is closed, a small current passes through the base emitter circuit of the transistor.

The transistor is turned on and allows current flow in the primary winding to energise the coil .

The base current is controlled by resistors R1 and R2 and is about 0.3 A.

When spark is needed, the cam opens the contact breaker and the base current is interrupted.

The transistor switches off.

The primary circuit is broken and a high voltage is induced in the secondary.

This high voltage is applied to the proper spark plug, through the distributor, and causes ignition.

The sequence is repeated to give the required number of sparks per cam revolution.

The circuit of Fig. 17.33 is only the basic circuit.

In actual practice refinements are needed to protect the transistor from overload.

These refinements require the use of additional transistor and associated circuitry.

Breaker-less Ignition System

Fig. 17.34 shows an electronic ignition system which eliminates the use of breaker completely.

The distributor ignition coil, spark plugs are the same as in conventional system.

The contact breaker is replaced by a pulse generator.

This pulse generator generates an electric pulse to signal the requirement of spark.

The control module makes and breaks the primary circuit of the ignition coil electronically.

For this purpose, it amplifies the signal received from the pulse generator.

The functions of control module are:

1. Switching duty.

2 It senses the engine speed and uses this information to vary the tuning so as to suit the engine speed.

Pulse generator may be an inductive circuit, a hall generator or an optical device.

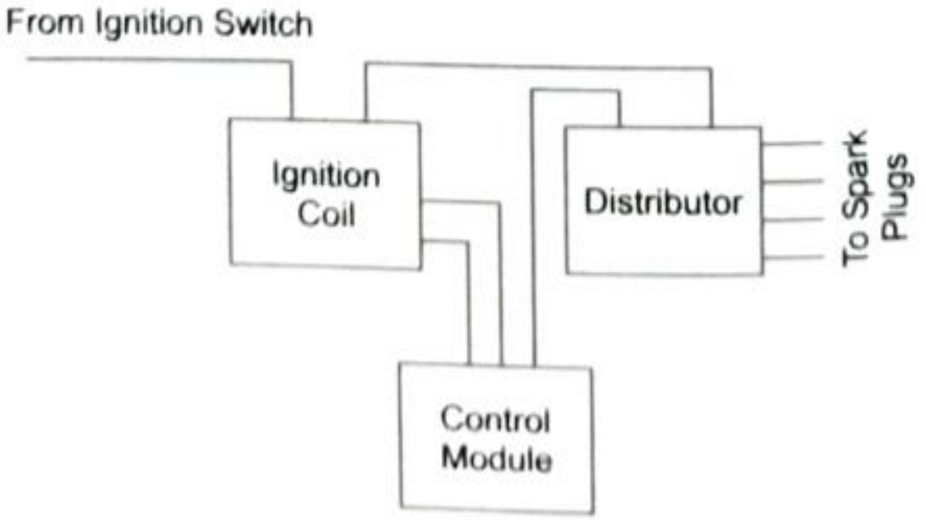

Fig. 17.34: *Breakerless Electronic Ignition System*

Q10)a-Solution:

MICROWAVE OVEN

Heating through microwaves has the following advantages over conventional electrical heating systems.

1. Penetration of heat into the material is much more than in conventional systems. This results in quicker heating.

2. System is very clean.

3. System can be combined with a conventional heating process (e.g. microwave pre-heating combined with conventional heating).

Microwave oven is a very suitable device for heating, baking and cooking.

It was invented by Dr. Percy spencer during world war II (1930-1945).

He got the idea from Radars used during this war.

The microwave tube magnetron was used in Radars in this war and Dr. Spencer used this magnetron for microwave cooking.

The first microwave oven appeared in market in 1947.

Since then, the design has been improved many times.

Now-a-days microwave ovens use power electronic devices and micro-controller.

(a) Principle :

Microwave oven is based on the principle of dielectric heating.

Every dielectric behaves as an imperfect capacitor.

When a voltage is applied to a dielectric the current leads the voltage by an angle less than 90° (In a perfect capacitor the currents leads the voltage by exact 90°).

The dielectric loss is given by

by

$$P_d = V^2 \omega c \tan \delta$$

where

P_d = dielectric loss watts

v = applied voltage, volts

ω = angular frequency rad/sec

c = Capacitance, Farads

δ = loss angle of dielectric = $90 - \theta$

where θ is the angle by which current in imperfect capacitor is leading the voltage.

The dielectric loss is converted to heat.

In microwave oven the food item behaves as dielectric.

Since the loss depends on voltage and frequency, a high voltage and high frequency is needed.

The frequency used in microwave ovens is 2.45 GHz (wave length 122 mm).

When nonionizing microwave radiation is impressed on the food item, the water, food and other substances absorb energy through dielectric heating.

Many molecules become electric dipoles with partial positive charge at one end and partial negative charge at the other end.

As these electric dipoles tend to align with the ac field (due to applied voltage), they rotate, collide with each other and dissipate energy which is converted to heat.

Typical rating of a microwaves oven is 1100 W.

Out of this power about 700 W is used for heating.

Thus the efficiency is about 64%.

The remaining 400 W is the power loss in different parts.

Fig 17.30 shows a block diagram of microwave oven.

As seen the different components are HV transformer, diode rectifier and filter, magnetron, wave guide, cooking chamber, control circuit using micro controller, timer, motor, LED for display numeric buttons for entering cooking time etc.

The functions of different parts are as under

1. HV transformer: It converts 230 V ac supply to high voltage.

2. Rectifier and filter: The rectifier converts ac to dc. Generally diode rectifier bridge is used. The filter is a high voltage capacitor which smoothen the wave shape.

3. Cavity Magnetron: It is the source of microwaves. Its operation is based on the interaction of electromagnetic fields with electrons moving in static electric and magnetic fields oriented at 90° with respect to each other. A cavity magnetron has a number of cavities in the interaction region.

4. Wave Guide: At microwave frequencies it is more convenient to use wave guide as transmission line to carry high frequency ac from magnetron to cooking chamber. The advantages of using wave guide include lesser attenuation and higher power capacity. Generally cylindrical and rectangular wave guides are used.

5. Triac : The functions of triac is voltage control. A change in firing angle changes the output voltage.

6. Motor : The food items have to be stirred slowly to ensure even heating. A single phase low speed induction motor is used along with a stirrer.

7. Control circuits : These include microcontroller, timer (to adjust cooking time), interlock switches (for safety). The interlock switch ensures that magnetron will be switched on only when door of oven is closed.

Fig 17.31 shows another simple diagram of microwave oven.

Some new models of microwave oven use power electronic inverter (for generating high frequency) with pulse width modulation.

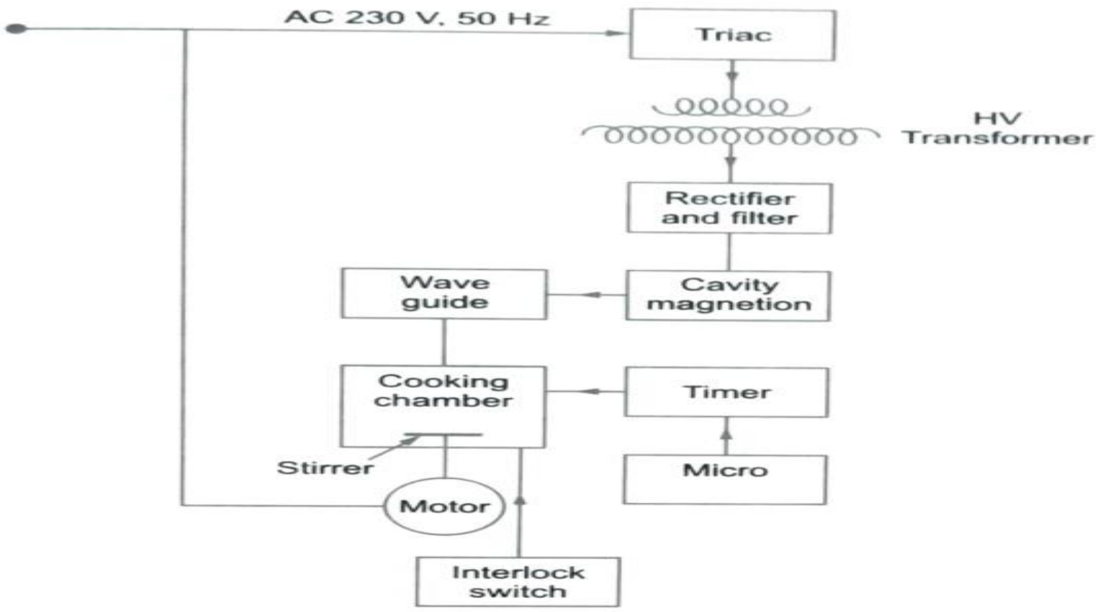

Fig. 17.30: *Block diagram of Microwave oven*

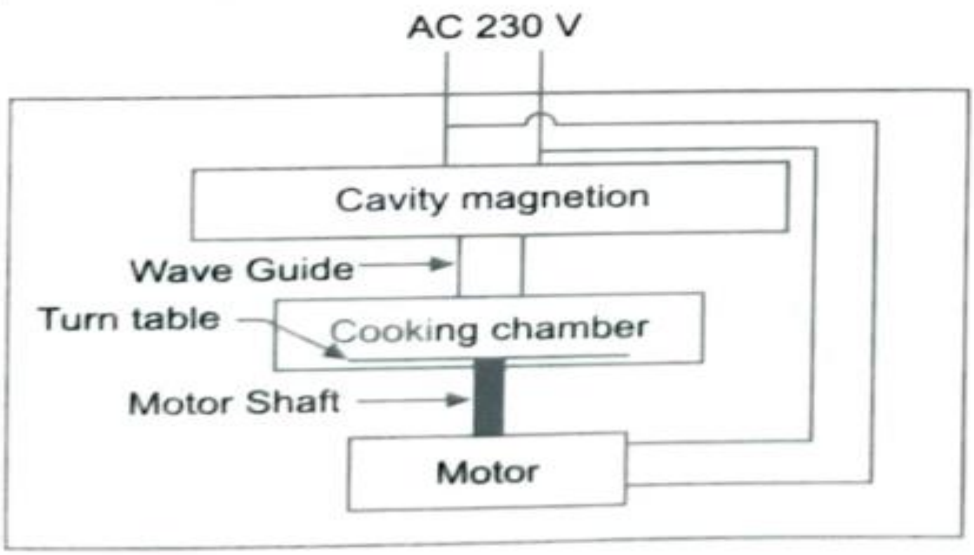

Fig. 17.31: *Microwave Oven*

(c) Uses: Microwave ovens can be used for cooking, heating and baking a variety of food items.

The cooking/heating times are as under :

Rice (Pulao, Biryani)	15–20 minutes
Mutton, Chicken	15–35 minutes
Fish	7–15 minutes
Vegetables	7–15 minutes
Dals	25–35 minutes
Sweets	15–20 minutes
Snacks and cakes	15–20 minutes

Microwave oven cannot be used to make chapattis.

Also, it cannot be used for deep frying.

The flavour, colour and taste of food is preserved better than conventional cooking.

The food material should be placed in ceramic, porcelain glass or thermoplastic container.

(d) Hazards :

It is necessary to ensure proper use of microwave oven to avoid mishaps. Some hazards associated with microwave ovens are as under.

1. Superheating : Liquids may superheat and eject from the container. Superheating may cause fire, explosion etc.

2. Some magnetrons use ceramic insulator. This insulator contains berrilium oxide which is a chemical hazard. Broken pieces of this insulator can be toxic.

3. If the container has some metal trimmings and pointed metal pieces, arcing may occur. The cutlery items if put in container can cause dangerous arcing.

4. Direct exposure to malfunctioning microwave oven can cause burns.

Q10)b-Solution:

RECENT ADVANCES IN CONSUMER ELECTRONICS

Consumer electronics devices are witnessing a sea change almost every year.

Some of these advances are as under:

1. Multi Touch Screens :

Earlier touch screens were clumsy, time consuming and inaccurate.

A styler was needed to pin point the selection.

Now multi touch screens are available.

In these screens the user can use many fingers simultaneously.

The finger gestures are instantaneously converted into commands and transmitted to the appliance.

These multitouch screens are available in mobile phones, T.V. remote controls etc.

2. Wireless Connectivity :

The days of use of wire in consumer electronic devices are over.

Wi-Fi standards have improved.

High speed broad band connectivity is available through mobile phones.

Wireless charging of mobile phone batteries is likely to become a reality very soon.

3. Ultra low Voltage CPU :

New models of cell phones, tablet computer, notebooks have ultra low voltage CPU.

The new microprocessor requires minimum charging but has still enough power capacity to handle the operating systems.

The batteries have long life.

4. 3D TV :

The new 3D TV has made a big impact on our life style.

One can view 3D films at home.

It is expected that in next five years all new TVs will be 3D.

5. HD Video Recording :

Now-a-days recording and transmitting videos through cell phones is very common.

Higher resolution is also making a big impact.

Earlier resolutions was 320 x 140 and 640 x 480.

Now-a-days, 1920 x 1080 resolution is possible.

Next Step is 4k resolution.

This results in recording minute details in pictures.

6. Next Generation Chip :

All the advances in electronic equipment is due to improved chips.

Next generation chip called ‘Ivy bridge' is likely to bring higher power efficiency, enhanced security and still smaller size.

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