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Internal Assessment Test 1 – March 2025									
Sub:	CONSUMER ELECTRONICS				Sub Code:	BEC654B	Branch:	[CSE, ISE, AIML, AIDS, CSE-AIML]	
Date:	27-03-2025	Duration:	90 minutes	Max Marks: 50	Sem/Sec:	6th [CSE, ISE, AIML, AIDS, CSE-AIML]		OBE	

	ANSWER ANY 5 FULL QUESTIONS	MARKS	CO	RBT
1	**Explain Moving Coil Microphone in detail with relevant diagram.**	10	CO1	L2
2	**Explain Crystal Microphone with relevant figure.**	10	CO1	L2
3	**Explain Moving Coil (Cone Type) Loudspeaker in detail with relevant figures.**	10	CO1	L2
4	**Explain in detail the optical recording process in CD with relevant diagrams.**	10	CO2	L3
5	**Explain in detail the playback process in a CD player with relevant diagrams.**	10	CO2	L3
6	**a) What is a Compact Disc (CD). Compare CD and Tape.** **b) Explain with a circuit diagram the binary ladder network for Digital to Analog (D/A) conversion.**	4 + 6	CO2	L2
7	a) **Explain additive and subtractive mixing of colours with relevant diagrams.** b) **Explain generation of Y and colour difference signals with relevant block diagram.**	4 + 6	CO3	L2

Course Instructor **Chief Course Instructor** **HOD**

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Course Instructor **Chief Course Instructor** **HOD**

Q1) Solution :

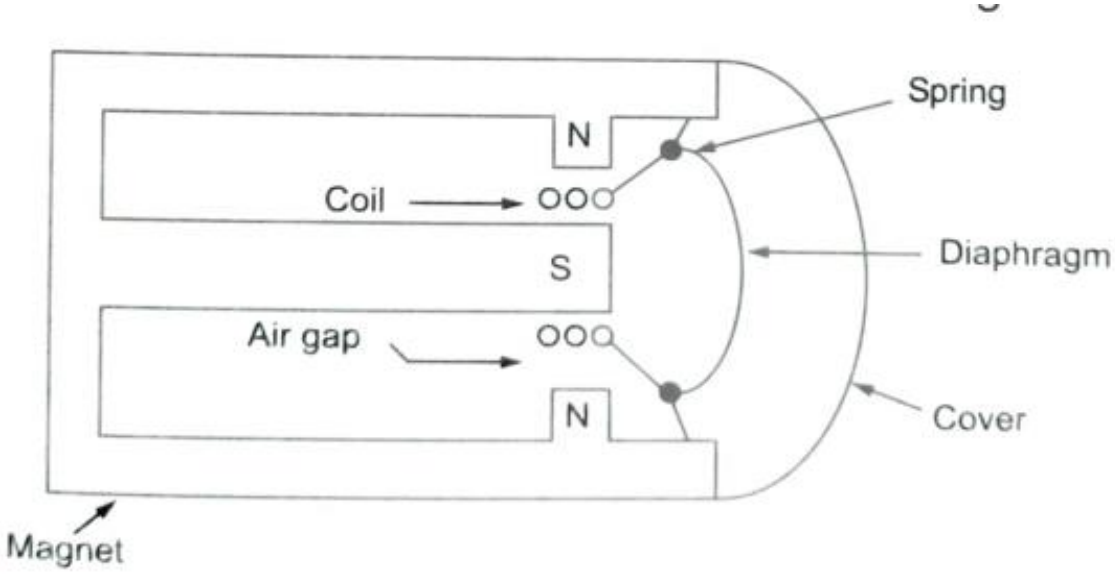


Fig. 5.4: *Moving Coil Microphone*

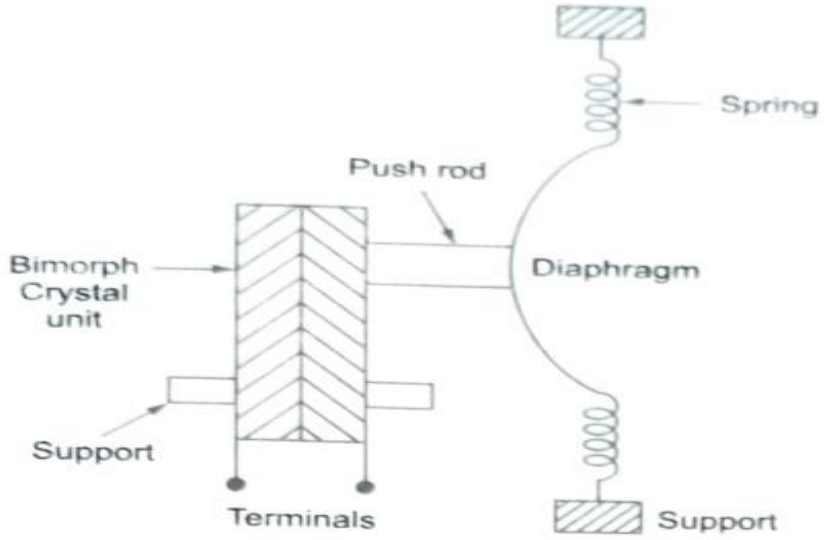
- **(a) Principle:** A moving coil microphone works on the principle of induced emf (Faraday's law of electromagnetic induction).
- The variations of sound pressure cause the motion of a coil in a magnetic field. Thus an emf is induced in the moving coil. It is also known as a dynamic microphone.
- **(b) 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.
- **(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) Solution :



5.7: *Crystal Microphone*

- **(a) Principle:** Its principle is based on piezoelectric effect.
- As per this effect, the application of pressure across the faces of a crystal, produces a voltage across the faces.
- The crystals which exhibit this property are Rochelle salt, quartz, ceramic etc.
- Ceramic is the most commonly used material.
- **(b) Construction:** The crystal is in the form of a bimorph crystal unit

(two plates put together form the unit).

- Metal foils are attached to the crystal surfaces to serve as terminals.
- A diaphragm, generally made of aluminium is held between supports through springs.
- The diaphragm is connected to the bimorph through a push rod.
- Fig 5.7 shows the construction.
- **(c) Working:** When sound waves impinge on the diaphragm, it vibrates.
- These vibrations are picked up by the bimorph element and a voltage is developed across its faces.

- The voltage developed is proportional to pressure of sound waves.
- This voltage is generally fed to an amplifier.
- **(d) Features:**
  1) Its sensitivity is good about 50 mV (i.e. 26 dB below 1V) for a sound pressure of 0.1 Pa.
  2) Almost flat frequency response between 80 Hz to 8000 Hz.
  3) The noise generated with in this microphone is low. Hence it has high signal to noise ratio (about 40 dB).
  4) Its output impedance is very high, about 1 MΩ or so.
  5) Its distortion is low, less than 1%.
  6) It is omni directional.
- **(e) Advantages:** Good sensitivity, high signal to noise ratio, low distortion, small size, omni

directional characteristics, low cost.

- **(f) Disadvantages:** Less rugged than moving coil, cannot withstand high temperature. Very low frequency sound waves are attenuated. It is affected by moisture.
- **(g) Applications :** Home recording, mobile communication systems, amateur communication.

Q3) Solution :

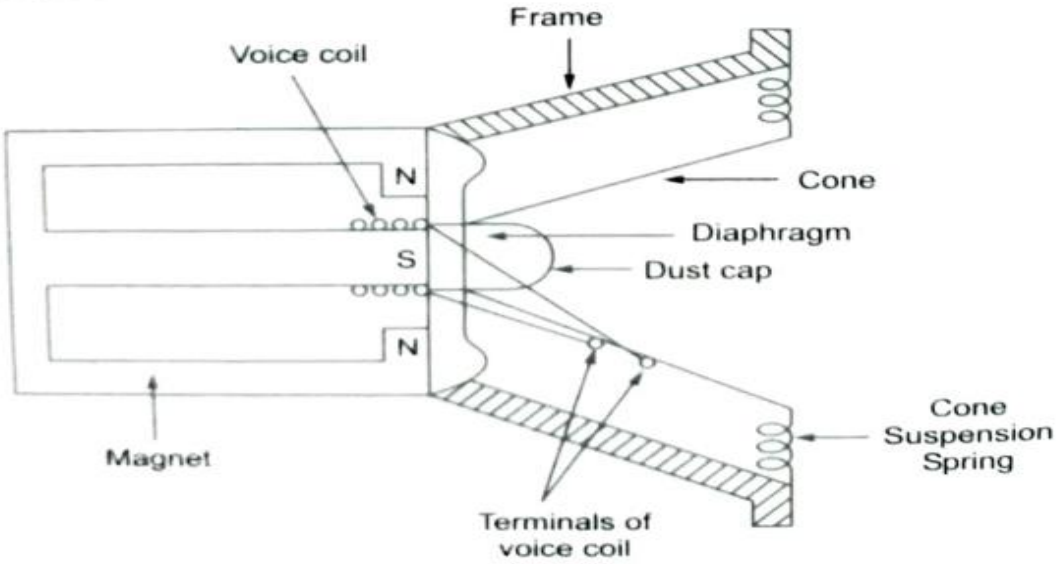


Fig. 6.1: *Moving Coil Loudspeaker*

- 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.

- 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.

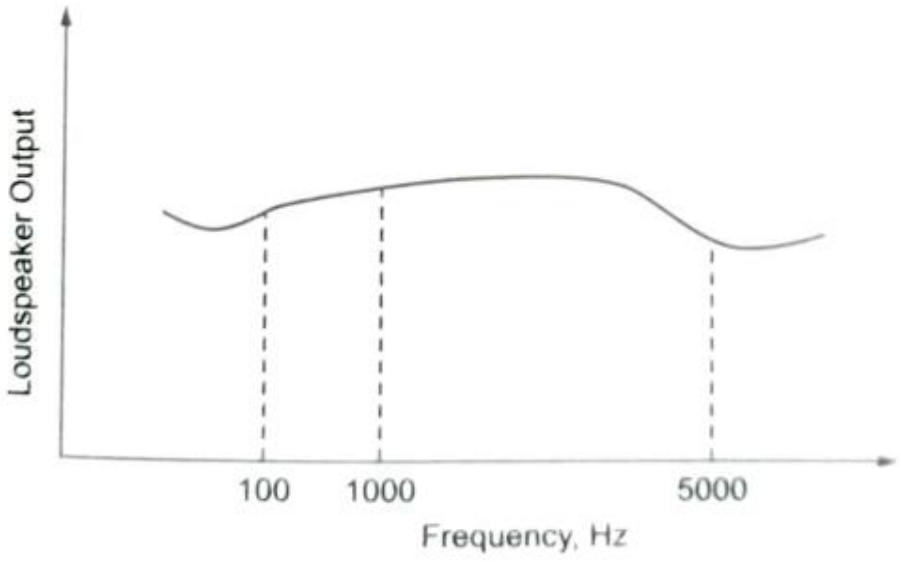


Fig 6.2: *Frequency Response of Moving Coil Loudspeaker*

- Fig 6.3 shows the equivalent circuit of a cone type loudspeaker.
- Source is the source of signals.
- r_c and L_c denote the resistance and self inductance of the voice coil.
- C_m is the mechanical compliance (stiffness) and L_m is the inductance which represents mass of the moving system (Mass opposes motion. Inductance opposes the flow of current. Therefore the effect of mass is always represented by inductance in the equivalent circuit).
- R_L is the load (i.e., resistance of air to the change in pressure).

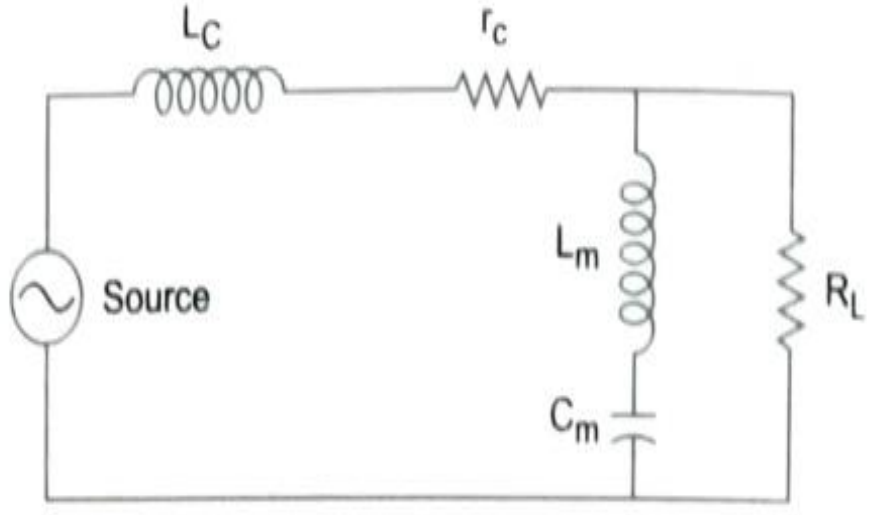


Fig. 6.3: *Equivalent Circuit of Moving Coil Loudspeaker*

- At low frequencies, the reactance of L_m (i.e. ωL_m) is

low and shunts the load resistance.

- Therefore, the output at low frequencies is reduced.
- At high frequencies, the reactance of series inductance (i.e. ωL_C) is high and causes attenuation of high frequency components of signal.
- Effect of C_m is small and negligible.

- **6.3.6 Advantages**
- Small size, low cost, satisfactory frequency response.
- **6.3.7 Disadvantages**
- Poor efficiency. Very low and high frequencies are attenuated.
- **6.3.8 Applications**
- Radio receivers, TV receivers, cassette players, record players. Used in all audio

appliances designed for small groups of people.

- **6.3.9 Capacity Available**
- Direct radiating cone type loudspeakers are available in a number of sizes up to about 25 W.

Q4) Solution :

- The audio signals from the microphone are converted into digital signals (strings of 0 and 1) by pulse code modulation (PCM).

- The audio signal is sampled and the sample converted to binary.
- The frequency of sampling should be twice the highest frequency in the signal.
- Since highest audio frequency is 20 kHz.
- The record of digital audio signals is in the form of pits.
- Fig 10.1 shows the pits on a CD.
- Each pit is 1 μm deep and 0.5 μm wide with length of pits varying from 0.9 μm to 3.3 μm.

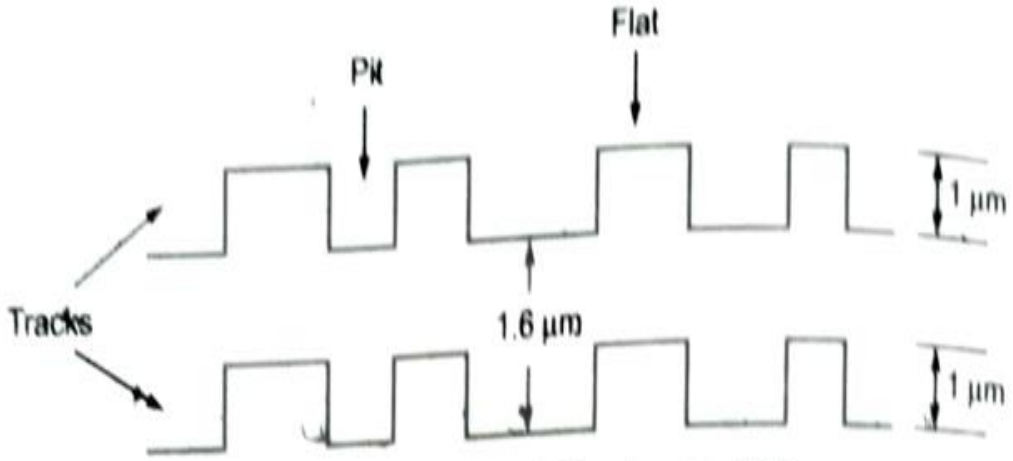


Fig. 10.1: *Pits and Tracks on CD*

- These pits are on circular concentric bands called tracks.
- The separation between tracks (known as pitch of track) is 1.6 μm.

- Each sample has 16 bits so that the number of bits per second is 44.1 $x10^3 x16 = 705600$.
- These are only audio bits.
- Successive blocks of audio bits have parity bits (i.e. bits for correction and controlling signals).
- These bits modulate the laser beam in on-off mode.
- When laser beam is off the output is 1 and when laser beam is on the output is 0.
- The modulation of laser beams is shown by block diagram in Fig. 10.2.

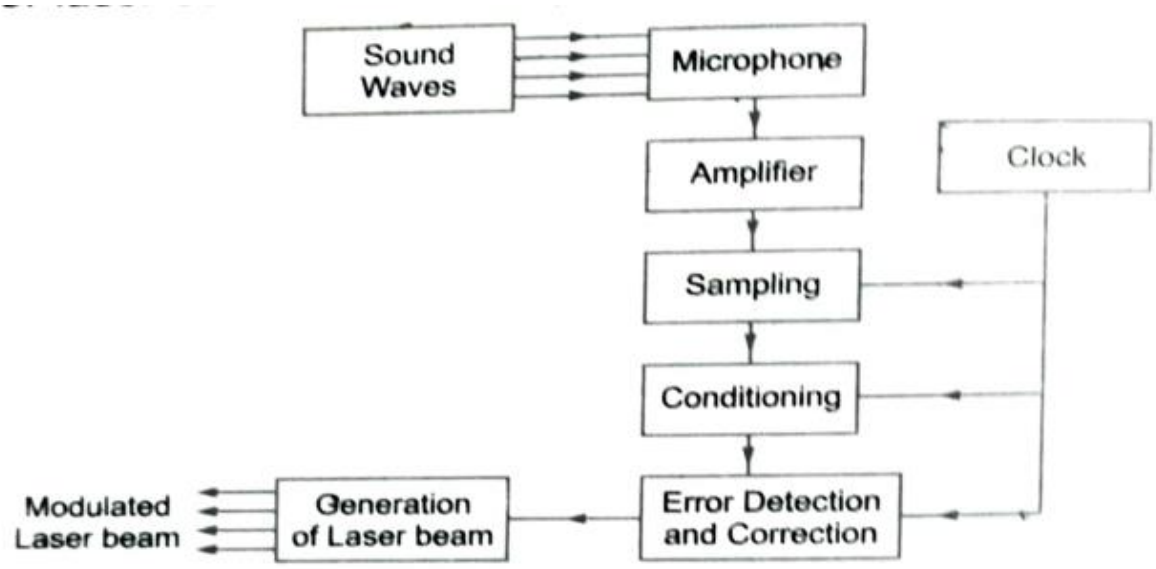


Fig. 10.2: *Block Diagram of Modulation of Laser Beam*

- The microphone converts the sound waves into electrical signals.
- After amplification these signals are sampled and conditioned.

- The next stage is error detection and correction.
- The sampling, conditioning, error detection and correction operations are controlled by clock pulses (as in a digital computer).
- The corrected signals modulate the laser beam.
- The modulated laser beam produces the record on a recording disc known as resist master disc (RMD).
- This disc is fixed on to a turn table which is rotated by a constant speed motor as shown in Fig.10.3.

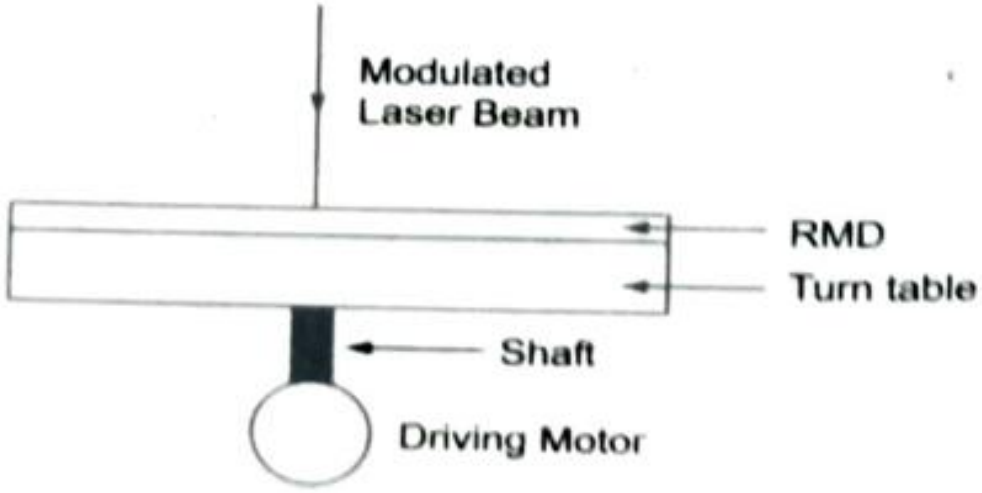


Fig. 10.3: *Optical Recording on CD*

Q5) 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.

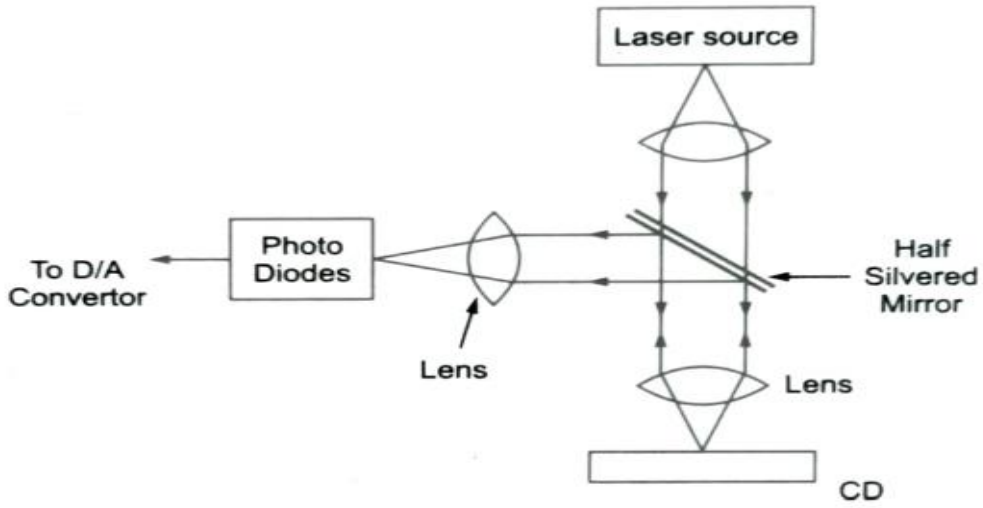


Fig. 10.4: *Reflection of Laser Beam in a CD Player*

- 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.

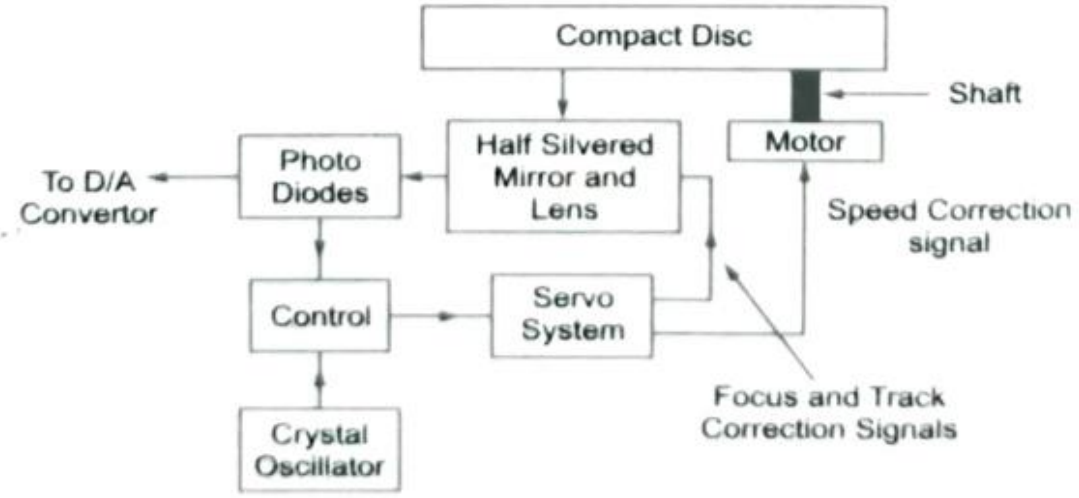


Fig. 10.5: *Block Diagram of Pick up System in CD Player*

Q6) a) Solution :

- Computers have entered almost every activity.
- Audio systems has also gone digital.

- A compact disc is a special disc in which the audio signals are stored in digital form.
- The recording and reproduction of sound on compact disc (CD) is much more complex than on cassettes.
- However compact discs offer complete noise free recording and reproduction.
- As on today compact discs are more costly than tapes but the costs are likely to come down in future.
- It is possible that tapes may become completely obsolete in the years to come.
- 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.

Q6) b) Solution :

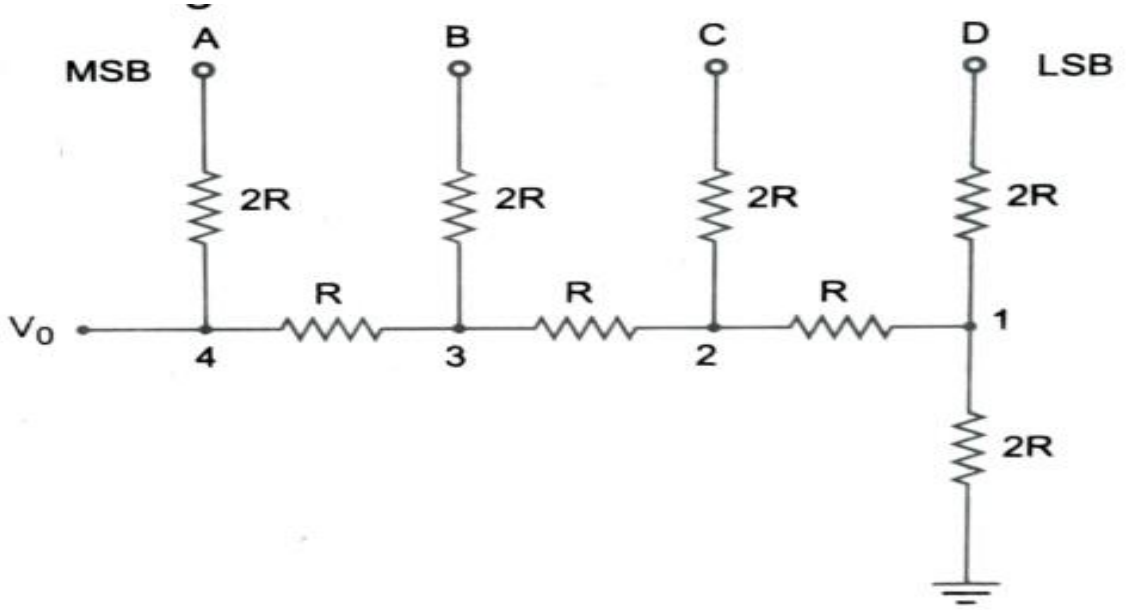


Fig. 10.11: *D/A Convertor*

- 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 V_o 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.

Q7) a) Solution :

- 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**.

- 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.

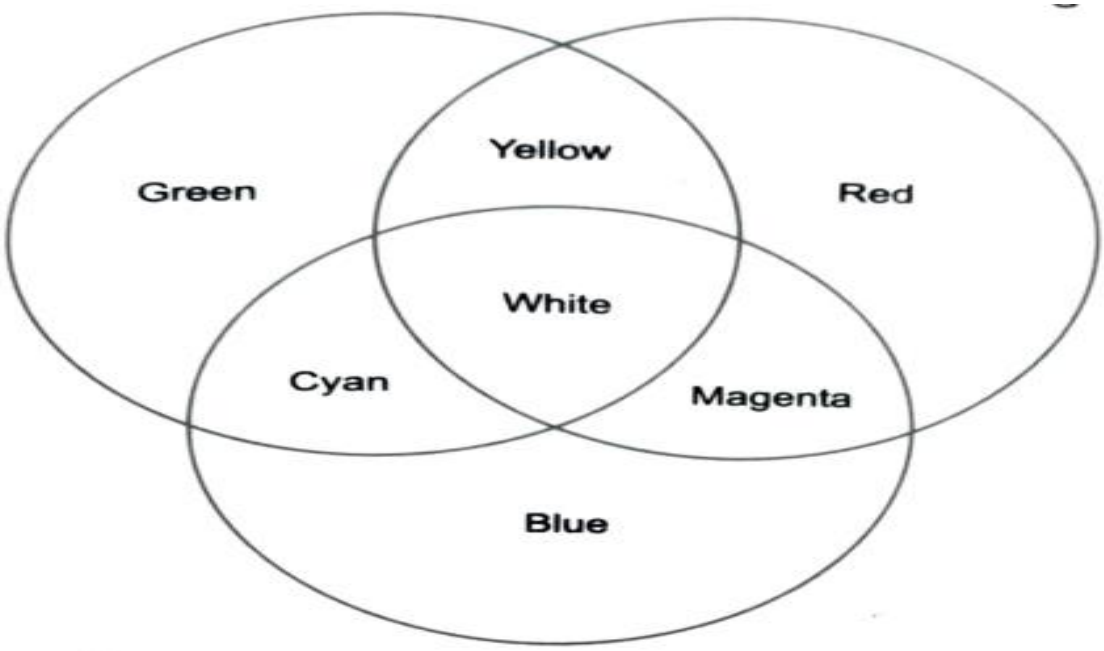


Fig 14.2: *Additive mixing of Colours*

- 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.

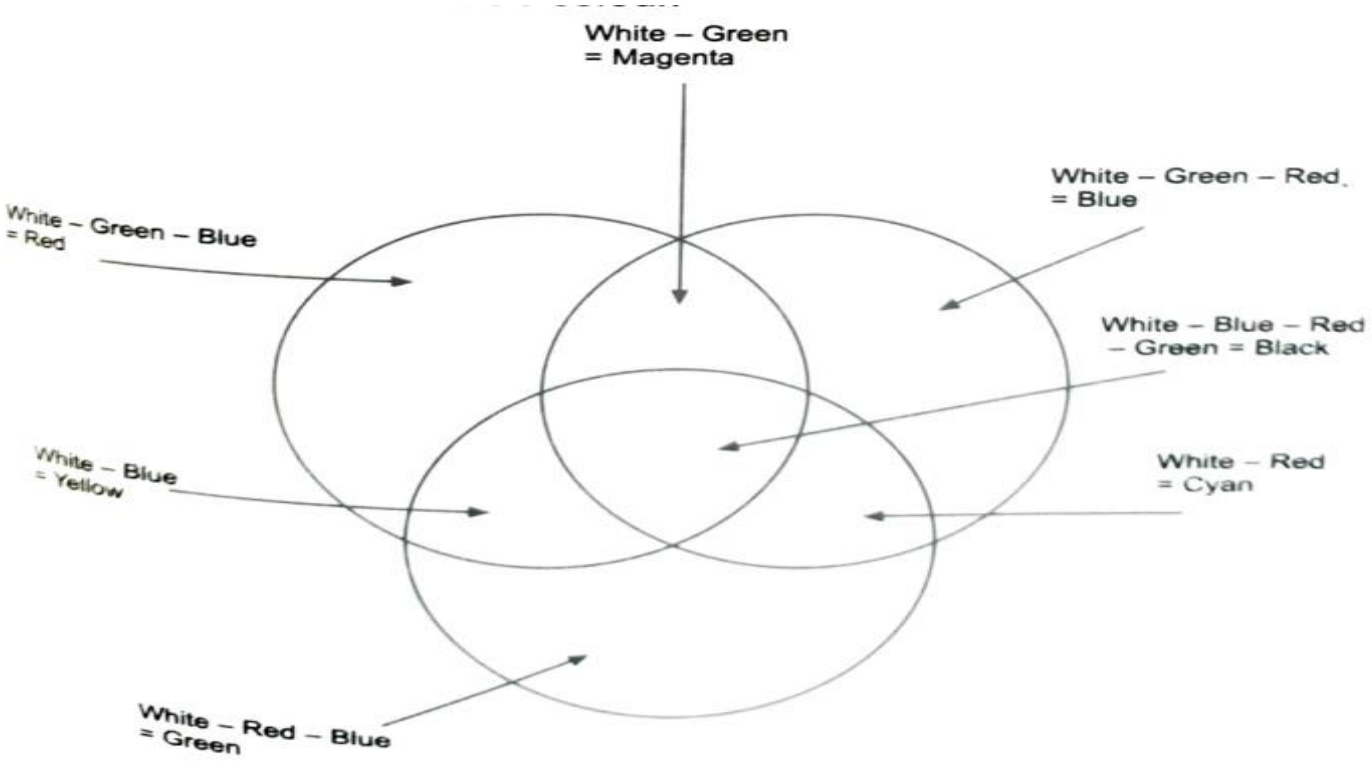


Fig 14.3: *Subtractive Mixing of Colours*

Q7) b) Solution :

- Fig.14.4 shows a simple circuit which illustrates generation of Y, (R-Y) and (B-Y) signal.

- The three camera tubes give V_R, V_G and V_B as outputs.
- These three are added in proportion of 30%, 59% and 11% by the resistances R_1, R_2 , and R_3 to give the Y signal.
- The values of R_1, R_2 , and R_3 are chosen so as to add V_R, V_G and V_B in the above proportions.
- In order to avoid cross-talk the resistance Rc is kept small.
- Therefore, the Y signal is amplified by an amplifier.
- Then Y signal is inverted (by using an inverter) to give -Y signal which is added to R and B signals to give (R-Y) and (B-Y) signals.

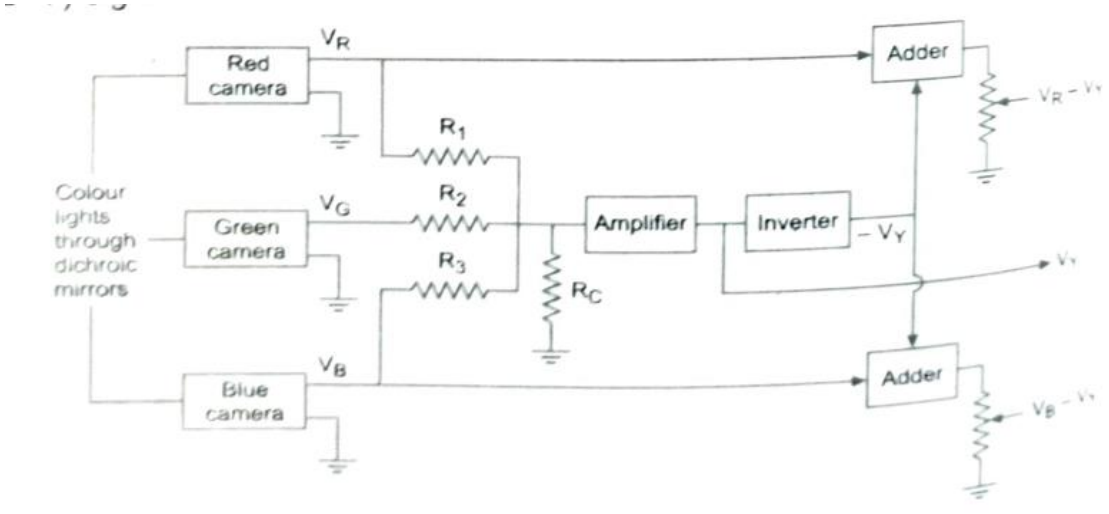


Fig. 14.4. *Generation of Y, (R-Y) and (B-Y) colour signals*

**********END**********