



B M S INSTITUTE OF TECHNOLOGY

[Approved by AICTE NEW DELHI, Affiliated to VTU BELGAUM]

DEPARTMENT OF PHYSICS

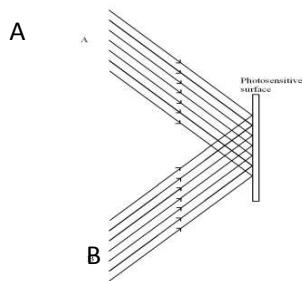
**COURSE MATERIAL
MODULE -3**

(Lasers, Holography and Optical fibers)

**SUBJECT: - Engineering Physics
SUBJECT CODE: - 14 PHY 12 /22**

Holography

Holography is the technique of producing 3-dimentional image of an object on 2-dimentional recording aid, by the phenomenon of interference. Holography is a Greek word, Holos means complete and graphos means writing. A and B are two identical or coherent beams incident on photosensitive surface at different angles. Due to interference effect, interference fringes are recorded on developing the photographic plate.



Principle of Hologram construction:

Light wave reflected from an object are characterized by their intensity (square of amplitude) and phase. When both intensity and phase attributes of the wave coming from three dimensional object is recorded on a photographic plate, it is called construction of hologram. When recorded photographic plate (hologram) is illuminated by a coherent light source, the three dimensional image of the original object is formed. This formation of image is known as reconstruction process.

Recording phase variation in a Hologram:

In recording hologram of an object a photographic plate is placed in front of an object at a suitable distance. Consider a coherent light incident on the object. The light reflected from two nearby points on the object travel slightly different distances in reaching the photographic plate due to variation in depth on the object. Thus the two wave fronts arrive at the photographic plate in a slightly different phase. Hence the light reflected from different points on the object will have different phases and interfere with the reference beam. The fringes recorded in the hologram carry information regarding the phase difference.

In holography there are two phases:

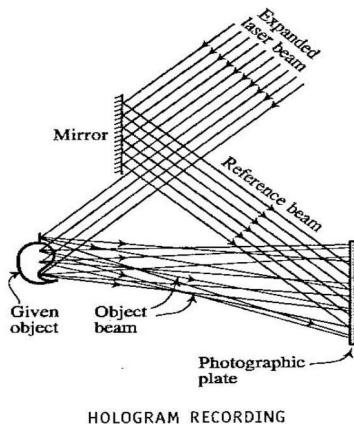
- 1) Recording
- 2) Reconstruction of the image.

Recording has two methods

- 1) Wavefront division technique.
- 2) Amplitude division technique.

1) Recording of the image of an object by wave front division technique

Expanded coherent laser beam from the laser source is obtained. A portion of it is made to incident on the mirror and other portion is made to incident on the object as shown in the fig.



HOLOGRAM RECORDING

Photographic plate is placed at a suitable position so that it receives the light reflected from both the mirror and the object. The light reflected from the mirror

form a plane wavefront. It is called reference beam. The light reflected from each point on the object form a spherical wavefront. It is called object beam. Thus the interference effects of the two beams are recorded on the photographic plate.

As the spherical wave intersect the plane wave in circular zones, the interference pattern consists of concentric circular rings having constructive and destructive interference. It is called *Gabor Zone plate*.

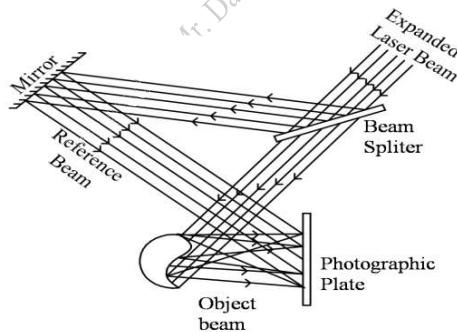


GABOR ZONE PLATE

Hologram consists of number of such zone plates. The centre of each is displaced from the other. In the recorded pattern the neighboring zones overlap each other and become apparent, once the film is developed. It is called a hologram.

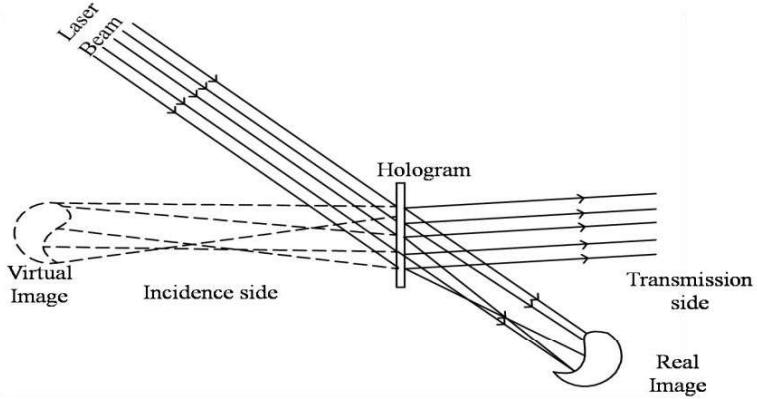
2) Recording the image of an object by amplitude division technique:

Expanded coherent laser beam from the laser source is obtained. It is made to incident on the beam splitter. The beam splitter reflects the portion of the light which is incident on the mirror. The transmitted light from the beam splitter is incident on the object. The reflected plane wavefront from the mirror and reflected spherical wavefronts from different points on the object undergoes interference on the photographic plate kept at a suitable place. The interference fringes are recorded on the photographic plate. The developed photographic plate becomes the hologram of the object.



Reconstruction of the image from the hologram:

Original Laser beam is made to incident on the hologram in the same direction as the reference beam was incident on it at the time of recording. The beam undergoes refraction in the hologram. Secondary wavelets originating from each constituting zone plate interfere constructively and generate real image on the transmission side and virtual image on the incident side.



Applications of holography:

1) Holography Microscopy: Large field of view with better resolution can be obtained using holography. In this technique, a grating divider is used to produce the object beam and the reference beam. First, the object beam is allowed to illuminate and the diffracted light is allowed to pass through a normal microscope. The reflected reference beam interferes with the object beam and the hologram is obtained. It is difficult to get the resolution by the microscope. The resolution of the photographic emulsion and coherence of the reference beam gives the depth of the field.

2) Size of the Particle: The fog like particle does not remain for a long time. It is very difficult to focus them. Holography can be used for particle analysis. The hologram of the particles in the volume is made and the reconstruction of hologram gives the idea of the size and geometry of the particle.

3) Holographic diffraction grating: The holography is based on the principle of interference. Interference pattern gives alternate dark and bright band. This method produces the rulings more accurate than the normal method.

4) Holographic Interferometry: This technique is used to measure vibration amplitudes and minute distortions of objects. The hologram of the stressed object is allowed to illuminate with a monochromatic light. During the reconstruction of hologram, the light reflected from the object interferes with the light reflected from the stressed object. It produces dark and bright interference pattern. By using this technique, we can measure the accurate changes in the body.

5) ROM (Read Only Memory) Devices: Since large amount of data can be stored, holograms are used in ROM devices.