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## NET, IAS, State-SET (KSET, WBSET, MPSET, etc.), GATE, CUET, Olympiads etc.: Science and Technology Holography

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### Holography

#### Principle of Holography

1. Holography is actually a two-step process that involves recording of the hologram and reconstruction of the image from the hologram. For recording the hologram, a highly coherent laser beam is divided by a beam splitter into two beams. One of these beams, known as the reference beam, hits the photographic plate directly. The other beam illuminates the object whose hologram is to be recorded. The reflected beam, called the object beam, falls on the photographic plate. The object beam and the reference beam are made to mix with each other to form the interference pattern on the photographic plate. The resulting interference pattern forms the hologram.
2. However, unlike a photograph, a hologram is quite unintelligible and gives no idea about the image embedded in it. But, it contains information not only about the amplitude but also about the phase of the object wave. It has, therefore, all the information about the object.
3. For viewing the image, the hologram is illuminated with another beam, called the read-out or reconstruction beam. In most cases, this beam is identical with the reference beam used during the formation of hologram. This process is termed as reconstruction.

#### Applications of Holography

1. Holography finds application in many diverse fields.
2. Security: Another major application of holography is in the coding of information for security purposes and in preventing counterfeiting. Such holograms, called security holograms, are replicated from a master hologram that requires very expensive, specialized and technologically advanced equipment, such as electron-beam lithography system. This kind of technique allows creation of surface holograms with a resolution of up to 0.1 micrometre.
3. The security holograms are widely used in many currency notes. Security holograms in multiplecolour are created with several layers. They are used in the form of stickers on

credit and bankcards, books, DVDs, mobile phone batteries, sports equipments, branded merchandise etc.

4. **Cryptography:** Holographic methods may also be used in cryptography for secret communication of information. This is done by recording the holograms of secret communication of information. This is done by recording the holograms of secret documents, maps and objects. The images can be reconstructed at the receiver end.
5. **Holographic Microscopy:** Holographic microscopy is yet another potential application of holography. A conventional microscope has a small depth of field (the range of depth over which an object is in focus at any microscopic setting) . Biological specimen, generally suspended in a fluid, move about making them sometimes in and sometimes out of focus of the microscope. However, this motion can be freezed in a hologram taken through a microscope. The reconstructed 3 – D image can then be studied at leisure.
6. **Holographic Interferometry:** One of the most promising applications of holography lies in the field of interferometry. They can be used for testing stresses, strains and deformations of objects under the effect of mechanical stress or thermal gradient.
7. **Holographic interferometry** can also be used for studying vibrations in objects. This has been used to study the vibration modes of both string and percussion musical instruments. The technique can also be applied for non-destructive testing of materials, to detect cracks, disorders, voids and residual stresses in a test sample without destruction of the sample. Holographic interferometry can be used for testing automobile engines, aircraft tyres, artificial bones and joints.
8. **Data Storage:** An important application of holography is in the field of information or data storage. The ability to store large amounts of information in some kind of media is of great importance as many electronic products incorporate storage devices. The advantage of holographic data storage is that the entire volume of recoding media is used instead of just the surface. In 2005, holographic versatile disk (HVD) , a 120 mm disk that used a holographic layer to store data, was produced by some companies. This had the potential or storing 3.9 TB (terabyte) data. Further developments in the field are going on and it is expected that holographic data storage would become the next generation of popular storage media.

## Medical Applications

1. Some of the prominent fields of medical science in which holographic technique is used include endoscopy, dentistry, urology, ophthalmology, otology, orthopaedics and pathology.
2. In the field of ophthalmology any retinal detachment or intraocular foreign body can easily be detected. In corneal surgery, holographic technique can be used for measurement of elastic expansion of the cornea, which is a very vital information for the surgery. Holographic lenses can make one lens provide several different functions,

such as correcting regular vision and also acting as magnifiers for reading, all in the same lens and throughout the entire lens at the same time.

3. Endoscopic holography, which combines the features of holography and endoscopy, provides a powerful tool for non-contact high-resolution 3 – D imaging and non-destructive measurements for natural cavities found inside the human body or any difficult-to-access environment.
4. In otology, different parts of the human peripheral hearing organs are studied using double exposure and time-average holographic interferometric techniques.
5. In urology, holographic techniques can be used for detecting kidney stones and for the diagnosis of other urinary problems e. g. Tumors in the urinary bladder.
6. For applications of holography in dentistry both continuous wave and pulse laser holography have been used. Besides other applications in dentistry, holograms can be employed as training aids in the disciplines of dental anatomy and operative dentistry.

*Courtesy: Science Reporter*