Laser

(i) The word laser is an acronym, which stands for light amplification by stimulated emission of radiation.

(ii) A laser differs from natural light in three ways:

1. Lasers emit intense parallel beams of single-frequency radiation (light). Natural light disperses widely as it travels.
2. Laser light is essentially monochromatic. Natural light contains a wide spectrum of wavelengths.
3. Laser light is coherent and its photons oscillate synchronously. In natural light the photons oscillate randomly.

Lasers are light beams that are powerful enough to travel miles into the sky and cut through lumps of metal. The first practical laser was built by Theodore H. Maiman at Hughes Research Laboratories in 1960.

A laser system is composed of four different parts:

- The first part is the laser medium, which may be a gas, liquid, or solid. In solid medium lasers, ionic impurities known as *dopants* are used to generate the laser light.
- An example of a laser with a dopant is the neodymium-yttrium-aluminum-garnet (Nd-YAG) laser. The dopant determines the wavelength of the emitted radiation.
- The second portion is the optical cavity wherein the laser medium is confined. One of the mirrors in the optical cavity allows the laser beam to escape the cavity instead of being reflected by the other mirrors.
- The third portion of the laser system is a pumping source, which supplies electrical discharge or high-energy photons from a xenon flash lamp.
- The fourth portion is a light guide, which directs the laser beam to the site of surgery.

Laser work:

The output of a laser is a coherent electromagnetic field. In a coherent beam of electromagnetic energy, all the waves have the same frequency and phase.

A basic laser consists of a chamber known as the cavity which is designed to reflect infrared, visible or ultraviolet waves so that they reinforce each other.

The cavity can contain solids, liquids or gases. The choice of the cavity material determines the wavelength of the output.

Mirrors are placed at each end of the cavity. One of the mirrors is totally reflective, not allowing any of the energy to pass through them. The other mirror is partially reflective, allowing 5% percent of the energy to pass through them. Through a process known as pumping, energy is introduced into the cavity through an external source.

Due to pumping activity, an electromagnetic field appears inside the laser cavity at the natural frequency of the atoms of the material that fills the cavity. The waves are reflected back and forth between the mirrors. The length of the cavity is such that the reflected waves reinforce each other. The electromagnetic waves in phase with each other emerge from the end of the cavity having a partially reflective mirror. The output is a continuous beam, or a series of brief, intense pulses.

Characteristics of Lasers:

We can separate the characteristics of laser beam into four major categories as:

- Superior Monochromatism
- Superior Directivity
- Superior Coherence
- High Output

Using these characteristics of lasers, they are applied in various fields such as optical communication and defence. In the next section, let us look at the various applications of lasers.

Uses of Laser:

When lasers were first invented, they were called “a solution looking for a problem”. Since then they have become ubiquitous finding utility in various applications of modern society ranging from consumer electronics to the military.

Tools:

- CO2 lasers are widely used in industries. They are precise, easy-to-automate and don't need sharpening, unlike knives.
- We use robot-guided lasers to cut pieces of cloth to make things such as denim jeans than using our bare hands. They are faster, more accurate and improve efficiency and productivity.
- The same precision is of utmost importance in the field of medicine. Doctors use lasers for everything from blasting cancerous tumors to correcting defective eyesight.

Communication:

- The barcode scanner uses a laser to convert a printed barcode into a number that a checkout computer can understand.
- Every time you play a CD or a DVD, a semiconductor laser beam bounces off the spinning disc to convert its printed pattern of data into numbers; a computer chip converts these numbers into movies, music, and sound.
- Lasers are used in fibre optic cables and a technology known as photonics which uses photons of light to communicate.

Defence:

The military uses laser guided weapons and missiles.

Difference between a Flashlight and Laser:

Flash Light	Laser Light
1. Flash light produces a white light which is a mixture of different colours of different frequencies	1. Laser produces a monochromatic light of single colour and frequency
2. Flash light spreads out through a lens into a short fuzzy cone	2. A laser shoots a much tighter, narrower beam over a much longer distance
3. Light waves in a flashlight beam are all jumbled up (the crests of some beams mixed with the troughs of others.)	3. Light waves in a laser beam are aligned (the crest of every wave is lined up with the crest of every other wave.)