كلية المستقبل الجامعة

قسم تقنيات البصريات

الفيزياء البصرية الطبية

المحاضرة الثامنة

Laser

Laser : a device that stimulates atoms or molecules to emit light at particular wavelengths and amplifies that light, typically producing a very narrow beam of radiation. The emission generally covers an extremely limited range of visible, infrared, or ultraviolet wavelengths. Many different types of lasers have been developed, with highly varied characteristics. Laser is an acronym for “light amplification by the stimulated emission of radiation.”

Fundamental principles Energy levels and stimulated emissions

Laser emission is shaped by the rules of quantum mechanics, which limit atoms and molecules to having discrete amounts of stored energy that depend on the nature of the atom or molecule. The lowest energy level for an individual atom occurs when its electrons are all in the nearest possible orbits to its nucleus (see electronic configuration). This condition is called the ground state. When one or more of an atom’s electrons have absorbed energy, they can move to outer orbits, and the atom is then referred to as being “excited.” Excited states are generally not stable; as electrons drop from higher-energy to lower-energy levels, they emit the extra energy as light.

Laser Components

1. Gain medium capable of sustaining stimulated emission
2. Energy source to pump the gain medium
3. Total reflector to reflect energy
4. Partial reflector
5. Laser beam output

The gain medium and resonator determine the wavelength of the laser beam and the power of the laser.

How is Laser Technology Used?

Lasers are key components of many of the products that we use every day. Consumer products like Blu-Ray and DVD players rely on laser technology to read information from the disks. Bar code scanners rely on lasers for information processing. Lasers are also used in many surgical procedures such as LASIK eye surgery. In manufacturing, lasers are used for cutting, engraving, drilling and marking a broad range of materials.

1. There are many applications for laser technology including the following:
2. Laser Range Finding
3. Information Processing (DVDs and Blu-Ray)
4. Bar Code Readers
5. Laser Surgery
6. Holographic Imaging
7. Laser Spectroscopy
8. Laser Material Processing such as :-

- Cutting
- Engraving
- Drilling
- Marking

Types of lasers

Lasers are classified into 4 types based on the type of laser medium used:

1. Solid-state laser
2. Gas laser
3. Liquid laser
4. Semiconductor laser

1. Solid-state laser

A solid-state laser is a laser that uses solid as a laser medium. In these lasers, glass or crystalline materials are used.Ions are introduced as impurities into host material which can be a glass or crystalline. The process of adding impurities to the substance is called doping. Rare earth elements such as cerium (Ce), erbium (Eu), terbium (Tb) etc are most commonly used as dopants.Materials such as sapphire (Al2O3), neodymium-doped yttrium aluminum garnet (Nd:YAG), Neodymium-doped glass (Nd:glass) and ytterbium-doped glass are used as host materials for

laser medium. Out of these, neodymium-doped yttrium aluminum garnet (Nd:YAG) is most commonly used.The first solid-state laser was a ruby laser. It is still used in some applications. In this laser, a ruby crystal is used as a laser medium.solid state laser example is ruby laser In solid-state lasers, light energy is used as pumping source. Light sources such as flashtube, flash lamps, arc lamps, or laser diodes are used to achieve pumping. Semiconductor lasers do not belong to this category because these lasers are usually electrically pumped and involve different physical processes.

2- Gas laser

A gas laser is a laser in which an electric current is discharged through a gas inside the laser medium to produce laser light. In gas lasers, the laser medium is in the gaseous state. A gas laser is a laser in which an electric current is discharged through a gas inside the laser medium to produce laser light.Gas lasers are used in applications that require laser light with very high beam quality and long coherence lengths.In gas laser, the laser medium or gain medium is made up of the mixture of gases. This mixture is packed up into a glass tube. The glass tube filled with the mixture of gases acts as an active medium or laser medium.A gas laser is the first laser that works on the principle of converting electrical energy into light energy. It produces a laser light beam in the infrared region of the spectrum at 1.15 μm.Gas lasers are of different types: they are, Helium (He) – Neon (Ne) lasers, argon ion lasers, carbon dioxide lasers (CO_2 lasers), carbon monoxide lasers (CO lasers), excimer lasers, nitrogen lasers, hydrogen lasers, etc. The type of gas used to construct the laser medium can determine the lasers wavelength or efficiency.

3- Liquid laser

A liquid laser is a laser that uses the liquid as laser medium. In liquid lasers, light supplies energy to the laser medium.A dye laser is an example of the liquid laser. A dye laser is a laser that uses an organic dye (liquid solution) as the laser medium. A dye laser is made up of an organic dye mixed with a solvent. These lasers generate laser light from the excited energy states of organic dyes dissolved in liquid solvents. It produces laser light beam in the near ultraviolet (UV) to the near infrared (IR) region of the spectrum.

4-Semiconductor laser

Semiconductor lasers play an important role in our everyday life. These lasers are very cheap, compact size and consume low power. Semiconductor lasers are also known as laser diodes. Semiconductor lasers are different from solid-state lasers. In solid-state lasers, light energy is used as the pump source whereas, in semiconductor lasers, electrical energy is used as the pump source. In semiconductor lasers, a p-n junction of a semiconductor diode forms the active medium or laser medium. The optical gain is produced within the semiconductor material.