PUMPING METHODS OF LASER

Pumping: The process of achieving population inversion by supplying is called pumping.

- **Pumping methods:** Most commonly using pumping methods are
  - * Optical pumping
  - * Electric discharge/Electrical pumping
  - * Chemical pumping/Chemical reaction
  - * Direct conversion/Direct pumping
  - * Thermal pumping
  - * Inelastic atom-atom collision/atomic colloidal pumping

Optical pumping:

- In optical pumping a light source is used to provide enough energy to ground state (E_1), electrons in the Laser medium jump into the higher (excited) state (E_3) in a 3-level pumping, then the process of 3-level gain medium starts and achieves population inversion.
- **Example:** This method was first used by Maiman in his Ruby Laser and is widely used in solid state lasers.

Electrical pumping:

- In electrical pumping, a high voltage electric discharge (electric charge) is passing through a laser medium.
- The intense electric field accelerates the electrons to high speed and they collide with neutral atoms in the medium (gas). As a result, the electrons in the Ground state jump to excited state by gaining sufficient energy from external electrons, which can achieve population inversion.
- **Example:** This method of pumping is used in gas Lasers such as Argon Lasers.

Chemical pumping:

- In chemical pumping, the electrons in the Ground state jump to excited state by gaining energy, released by chemical reactions in an active medium and achieve population inversion.
- **Example:** Hydrogen can react with fluorine to produce Hydrogen Fluoride.
- $H_2 + F_2 \rightarrow 2HF + Heat$

❖ Direct pumping:

- ❖ In direct pumping electrons and holes are made to combine across the depletion region by applying a forward bias, then it emits radiation.
- ❖ **Example:** This direct conversion of electrical energy into radiation occurs in semiconductor lasers and LEDs.

❖ Thermal pumping:

- ❖ In thermal pumping, heat acts as the pump source or energy source.
- ❖ In this pumping population inversion is achieved by supplying heat into the Laser medium.
- ❖ When heat is supplied to the Laser medium, the electrons in ground state gain this heat energy and jump to excited state.
- ❖ **Example:** These thermal pumping methods are used in gaseous and solid lasers.

❖ Inelastic atomic colloidal pumping:

- ❖ This method is used in gas lasers containing two species of atoms:
- ❖ By pumping electrical discharge, one type of atoms rises to their excited states & these excited atoms collide inelastically with another type of atoms, which provide population inversion.
- ❖ **Example:** This type of pumping occurs in He-Ne Laser.