UNIT - III: Laser and Fiber Optics

Author : Physics Department **Date :** 2025

Principles of Laser

Laser operation is based on stimulated emission of radiation. Key concepts include:
• Spontaneous emission: Atoms emit photons randomly.
• Stimulated emission: Photons trigger emission of additional photons with identical phase and frequency.

Einstein's Coefficients and Population Inversion

Einstein’s coefficients describe emission and absorption processes:
• (A) (Spontaneous emission rate)
• (B) (Stimulated emission rate)
• Population inversion: A state where more atoms occupy an excited state than the ground state, necessary for lasing.

Types of Lasers

• Nd:YAG Laser: Solid-state laser with neodymium-doped yttrium aluminum garnet.
• CO_2 Laser: Gas laser used in cutting and welding.
• GaAs Laser: Semiconductor laser used in optical communication.

Fiber Optics and Light Propagation

Fiber optics transmit light through total internal reflection. The refractive index difference between core and cladding enables light guidance.

Numerical Aperture and Acceptance Angle

The numerical aperture (NA) determines light-gathering ability:
[NA = \sqrt{n1^2 - n2^2}]
where (n1) and (n2) are the refractive indices of core and cladding.

Types of Optical Fibers

• Material-based: Glass fibers, plastic fibers.
• Refractive index-based: Step-index, graded-index fibers.
• Mode-based: Single-mode, multimode fibers.