Unit-1

Lecture -3

Nature of light, Basics Optical Laws Ray Theory Transmission

NATURE OF LIGHT

- <u>Concept</u>—Light can be explained as
 - **Rays**: using Optical Geometry
 - Waves: using Electromagnetic Theory
 - Photons: using Photoelectric Effect
- We will need
 - Optical Geometry \rightarrow to explain light propagation
 - Electromagnetic Theory \rightarrow to understan spectrum
 - Photoelectric Effect → to show lasers and photodetectors

Spectrum —Light as a wave



Basic Optical Laws

a. Refractive Index

b. Total Internal Reflection (TIR)

c. Numerical Aperture & Acceptance Angle

Refractive Index

- The fundamental optical parameter of the material is refractive index or simply index of refraction. Speed of light in free space is 3X108 m/s.
- It is related to frequency and light as. After entering a dielectric or non-conducting medium the wave travels at a different velocity v which is less than c.
- The ratio of the speed of light in a vacuum to that in any medium is known as refractive index *n*.

• Refractive index is given by:

For air n is 1.00, for water 1.33, for silica glass 1.45, and for diamond it is 2.42.

Total Internal Reflection (TIR)

- Consider 2 different medium with refractive indices n1 & n2respectively.
- When a ray encounters a boundary separating two different materials, some part of the ray is reflected back into the first medium and remaining is bent or refracted into second.
- This is because of the difference in speed of the light in the different medium.



- Let is the angle of incidence & is measured between the incident ray and normal to the surface.
- Let is the angle of refraction & is measured between the refraction ray and normal to the surface.
- Then according to the Snell's law

 $n_1 \sin \phi_1 = n_2 \sin \phi_2$

When becomes larger, approaches 90 degree.

• At this point, no refraction is possible.

- The light ray shown on next slide is known as meridional ray since this kind of ray passes through the axis of the fiber core.
- This kind of optical fiber is assumed to be perfect in nature.



The transmission of a light ray ${\rm H}{\rm i}$ a perfect optical fiber.