Unit-3

Lecture -3

Semiconductor LED, DH- Structure,
Coupling Efficiency

SEMICONDUCTOR LIGHT-EMITTING DIODES

- Semiconductor LEDs emit incoherent light.
- Spontaneous emission of light in semiconductor LEDs produces light waves that lack a fixed-phase relationship.
- Light waves that lack a fixed-phase relationship are referred to as incoherent light

SEMICONDUCTOR LIGHT-EMITTING DIODES Cont…

- The use of LEDs in single mode systems is severely limited because they emit unfocused incoherent light.
- Even LEDs developed for single mode systems are unable to launch sufficient optical power into single mode fibers for many applications.
- LEDs are the preferred optical source for multimode systems because they can launch sufficient power at a lower cost than semiconductor LDs.

Semiconductor LDs

- Semiconductor LDs emit coherent light.
- LDs produce light waves with a fixed-phase relationship (both spatial and temporal) between points on the electromagnetic wave.
- Light waves having a fixed-phase relationship are referred to as coherent light.

Semiconductor LDs Cont..

- Semiconductor LDs emit more focused light than LEDs, they are able to launch optical power into both single mode and multimode optical fibers.

- LDs are usually used only in single mode fiber systems because they require more complex driver circuitry and cost more than LEDs.

Produced Optical Power

- Optical power produced by optical sources can range from microwatts (mW) for LEDs to tens of milliwatts (mW) for semiconductor LDs.

- However, it is not possible to effectively couple all the available optical power into the optical fiber for transmission.

Dependence of coupled power

The amount of optical power coupled into the fiber is the relevant optical power. It depends on the following factors:

- ***The angles over which the light is emitted***
- ***The size of the source's light-emitting area relative to the fiber core size***
- ***The alignment of the source and fiber***
- ***The coupling characteristics of the fiber (such as the NA and the refractive index profile)***

- Typically, semiconductor lasers emit light spread out over an angle of 10 to 15 degrees.
- Semiconductor LEDs emit light spread out at even larger angles.
- Coupling losses of several decibels can easily occur when coupling light from an optical source to a fiber, especially with LEDs.
- Source-to-fiber coupling efficiency is a measure of the relevant optical power.
- The coupling efficiency depends on the type of fiber that is attached to the optical source.
- Coupling efficiency also depends on the coupling technique.

- Current flowing through a semiconductor optical source causes it to produce light.

- LEDs generally produce light through spontaneous emission when a current is passed through them.

Spontaneous Emission

- Spontaneous emission is the random generation of photons within the active layer of the LED. The emitted photons move in random directions. Only a certain percentage of the photons exit the semiconductor and are coupled into the fiber. Many of the photons are absorbed by the LED materials and the energy dissipated as heat.