

## EC 2405 OPTICAL AND MICROWAVE LAB

1. What is a fiber optic?

Fiber optics are long lenses. A cylinder or rod of transparent material forming a core surrounded by an external cladding with a slightly different material. Light, when entering the fiber, rebounds on the outer cladding towards the core. This way the light advances through the fiber in bounds or steps, until it exits at the other end.

2. Define Attenuation loss?

Attenuation loss (or path propagation loss) is the reduction in power density (attenuation) of an electromagnetic wave as it propagates through space.

3. Define Bending loss?

Attenuation occurring as a result of either a bend in an optical fibre that exceeds the minimum bend radius or an abrupt discontinuity in the core/cladding interface is called bending loss.

4. What are the sources used in optical communication?

LED's and LASER diodes are the commonly used sources in optical communication systems, whether the system transmits digital or analog signal. It is therefore, often necessary to use linear Electrical to Optical converter to allow its use in intensity modulation & high quality analog transmission systems.

5. State Snell's law.

It gives relationship between angle of incident and refraction for a wave impinging on a interface between two different media with different refractive index.

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\frac{\sin \theta_1}{\sin \theta_2} = \frac{n_2}{n_1}$$

6. Define critical angle.

It is minimum angle angle of incident beyond which the total internal reflection occurs for light travelling from a medium of higher to one of lower refractive index is called critical angle.

7. Define TIR.

At angles of incident greater than the critical angle the light is reflected back into the originating dielectric medium, which is known as Total internal reflection.

8. Give a reason behind  $n_2 > n_1$ .

During manufacturing of fiber, certain impurities (dopants) are introduced in the core and cladding, so that the refractive index is slightly higher in core than cladding.

9. What are leaky modes in optical fiber?

A leaky mode or tunneling mode in an optical fiber or other waveguide is a mode having electric field that decays monotonically for a finite distance in the transverse direction but becomes oscillatory everywhere beyond that finite distance.

10. What are degenerated modes in optical fiber?

In weakly guiding fibers  $\Delta$  is small then HE-EH mode pair occurs which have almost identical propagation constants and electromagnetic patterns such mode are called degenerate modes.

11. Define MFD.

MFD ( mode field diameter) determines the fundamental mode by the radial extend of its electromagnetic field including losses at launching and joining, microbend losses, waveguide dispersion and width of radiation pattern.

12. What are the mechanisms of losses occurs in optical fiber?

- Absorption (fiber material)
- Scattering ( fiber material + structural imperfection)
- Radiative effects
- Pulse broadening.

13. What is macro bend and micro bend losses?

Macrobend losses occurs when radius of curvature that all large compared with fiber diameter

Microbend losses are small scale fluctuation in radius of curvature of fiber axis.

14. Define Lambertian pattern.

Isotropic pattern from a surface emitter is called a lambertian pattern. In this pattern source is equally bright when viewed from any direction, but power diminishes as  $\cos\theta$ .

15. Define modal or speckle noise.

The speckle pattern observed in multimode fiber as fluctuation which have characteristics times longer then the resolution time of the detector is know as modal or speckle noise.

16. What are the essential components of laser?

- Amplifying medium
- An optical feedback
- Pumping source.

17. What are demountable connectors?

These are the removable joints which allow easy, fast manual coupling and uncoupling of fiber analogous to electrical plugs and sockets.

## 18. Define polarization.

Polarization refers to the electric field orientation of a light signal, which can vary significantly along the length of a fiber polarization state is fundamental property of an optical signal.

## 19. What are the possible noises occur in optical receiver?

- Photo detector noise
  - Quantum noise
  - Dark current noise ( bulk dark current, surface dark current )
- Amplifier noise
  - Thermal noise or Johnson noise

## 20. Define quantum limit.

It is possible to find the minimum received optical power required for a specific bit error rate performance in a digital system. This minimum received power level is known as quantum limit.

## 21. LED

In optical fiber communication system electrical signal is first converted into optical signal with the help of electrical to optical conversion device as LED

## 22. .PHOTODETECTOR

Optical signal is transmitted through optical fiber it is retrieved in its original electrical form with the help of optical to electrical conversion device such as photo detector

## 23. .NECESSITY OF CLADDING FOR AN OPTICAL FIBER

- Provide proper light guidance inside the core
- Avoid leakage of light from the fiber

## 24. .USES OF OPTICAL FIBER

- To transmit the information which are in the form of coded signals of the telephone communication, computer data
- To transmit the optical images(ex: endoscopy)

## 25. ACCEPTANCE ANGLE

The maximum angle  $\phi_{max}$  with which a ray of light can enter through the entrance end of the fiber and still be totally internally reflected

## 26. MERIDIONAL RAYS

-Rays following the zigzag path when they travel through fiber and for every reflection it will cross the fiber axis

## 27. SKEW RAYS

-Rays following the helical path around the fiber axis when they travel through the fiber and they would not cross the fiber axis at any time

## 28. MIE SCATTERIN

The scattering created by such inhomogeneities is mainly in the forward direction

## 29. DISPERSION

Dispersion of the transmitted optical signal causes distortion for both digital and analog transmission along optical fiber

## 30. DISPERSION FLATTENING

The reduction of fiber dispersion by spreading the dispersion minimum out over a wider range this approach

## 31. CUTOFF WAVELENGTH OF FIBER

The cutoff wavelength is defined as the minimum value of wavelength that can be transmitted through the fiber. The wavelength greater than the cutoff wavelength can be transmitted

## 32. MENTION THE LOSSES RESPONSIBLE FOR ATTENUATION IN OPTICAL FIBERS

- Absorption
- scattering
- Bending

## 33. FIBER SPLICING

A Permanent joint formed between two individual optical fibers in the field or factory is known as a fiber splicing

## 34. FIBER COUPLER

An optical fiber coupler is a device that distributes light from a main fiber into one or more branch fibers. To combine and split optical signals in an optical network a directional coupler is used

### 35. ADVANTAGES OF LED

Simpler fabrication

-Cost-The simpler construction of the LED leads to much reduced cost

-Reliability

### 36. WHY DO WE PREFER LASER DIODE OVER LED'S FOR COMMUNICATION APPLICATIONS

-High intensity radiation

-Narrow spectral width of the laser source is the preferable feature of laser compared to LED

### 37. DARK CURRENT NOISE

The dark current noise arises from electrons/holes which are thermally generated in the PN junction of the photodiode. This current continues to flow through the bias circuit of the device when no light is incident on the photodiode

### 38. REQUIREMENTS OF OPTICAL FIBER

-Light detector

Equalizer

-Signal discriminator circuits

### 39. DEFINE THRESHOLD LEVEL

A Decision circuit compares the signal in each time slot with a certain reference voltage

### 40. DEFINE BER

An approach is to divide the number of errors occurring over a certain time interval  $t$  by the number  $N$  of pulses transmitted during this interval.

### 41. ADVANTAGES OF PREAMPLIFIER

-Low noise level

-High bandwidth

-High gain

### 42. DEFINE SONET/SDH

SONET is a set of standards defining the rates and formats for optical networks. A similar standard, synchronous digital hierarchy (SDH) has also been established in Europe

43. DEFINE ANOMALIES

An anomaly is the smallest discrepancy that can be observed between the actual and desired characteristics of an item

44. ADVANTAGES OF SDH

- High transmission rate
- Reliability
- High availability and capacity

45. .BROADCAST AND SELECT NETWORK

A broadcast and select network is a second generation network in which each transmitter sends messages at a fixed frequency to the central star coupler through fiber path

46. .SINGLE HOP NETWORK

- All network nodes are connected to the central hub node
- Single hop WDM networks are based on central passive star coupler(PSC) or array waveguide grating(AWG)

47. DEFINE LIGHT PATH

A connection between two end nodes whose traffic is switched only in the optical domain at intermediate nodes is referred to as a lightpath

48. DEFINE WDM

WDM is wavelength division multiplexing .The optical beam consists of different wavelength and several channel information is transmitted over a single channel

49. .IMPORTANT PHOTO DETECTOR MATERIAL

- InGaAs
- InAlGaAs

50. VARIOUS ERROR SOURCES

- Quantum noise
- Bulk dark current noise
- surface leakage current noise

51. .SONET LAYER

- Path layer
- Line layer
- section layer,
- Physical layer