SYED AMMAL ENGINEERING COLLEGE
(Approved by the AICTE, New Delhi, Govt. of Tamilnadu and Affiliated to Anna University, Chennai)
Established in 1998 - An ISO 9001:2008 Certified Institution
Dr. E.M.Abdullah Campus, Lanthai, Ramanathapuram – 623 502.
Phone: 304000, 304222, 304101 (04567)
Fax: 304123 (04567) Web: www.syedengg.ac.in, E.mail:saec@syedengg.ac.in
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

# EC6702-OPTICAL COMMUNICATION AND NETWORKING
# TWO MARKSQUESTIONSAND ANSWERS

## UNIT -1 INTRODUCTION

**1.Write Short notes on ray optics theory**

Laws governing the nature of light are called as ray optics. These laws are stated as:

1. Light rays in homogenous media travel in straight lines.
2. Laws of reflection: Angle of reflection $\theta_r$ equals angle of incidence $\theta_i$
3. Snell's Law: The angle of refraction $\theta_t$ is related to angle of incidence $\theta_i$ by

$$n_1 \sin\theta_i = n_2 \sin\theta_t$$

**2. What are the advantages and disadvantages of the ray optics?**

**The advantages of ray optics are:**

a) Ray optics is used to develop some of the fundamental parameters like acceptance angle, numerical aperture that are associated with optical fiber transmission.

b) It provides an excellent approximation, when the wavelength is very small compared with the size of structures, with which the light interacts.

**The disadvantages of the ray optics are:**

a) Ray optics fails to account for optical effects such as diffraction and interference.

**3. What is meant by refractive index of the material?**

The refractive index (or index of refraction) 'n' is defined as the ratio of the velocity of light in vacuum to the velocity of light in the medium.

$$n = c/v$$

c = speed of light in free space

$v$ = speed of light in a given material

4. **What is the energy of the single photon of the light whose λ = 1550nm in eV? (N/D2011)**

The energy of the single photon of the light is given by the equation

$$E = h \times f$$

Sub $f = \frac{}{}$ in the above equation

$$E = h \times \frac{}{}$$

**Given data:**

$h = 6.625\times10^{-34}$ **c** $= 3\times10^{8}$ m/sec

$= 1550 \times10^{-9}$ m

E (eV) $= 0.0128 \times 10^{-17} / 1.609\times10^{-19} =$ **0.7985eV**

**5. What are the conditions for total internal reflection?**

The conditions for total internal reflection are:

a) The ray should travel from denser to rarer medium i.e. from core to clad region of the

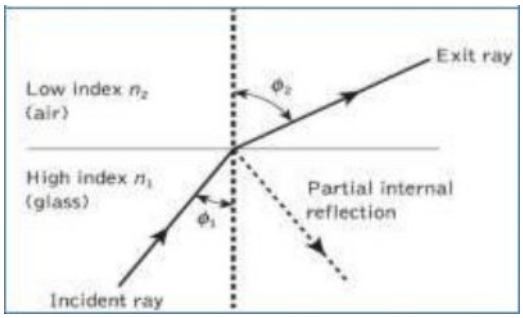
b) The angle of incidence in the denser medium should be greater than the critical angle of that medium.

**6. State Snell's law.**

The Snell's law is an expression that describes the relationship between the angles of incidence $\phi_1$ and refraction $\phi_2$ and to the refractive indices of the dielectrics, when referring to waves passing through a boundary between two isotropic medium.

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

where $n_1$ is the refractive index of the core and $n_2$ is the refractive index of the cladding




**7. Define - Numerical Aperture**

Numerical Aperture (NA) of the fiber is the light collecting efficiency of the fiber and is the measure of the amount of light rays that can be accepted by the fiber. It is equal to the sine of acceptance angle $\theta_a$

$$\text{NA} = \sin\theta_a = (n_1^2 - n_2^2)^{1/2}$$

where $n_1$ and $n_2$ are the refractive indices of core and cladding respectively.

**8. Define – Relative Refractive Index Difference**

The relative refractive index difference is the ratio of the refractive index difference between core and cladding to refractive index of core.

**9. A step index fiber has the normalized frequency of 26.6 at 1300nm. If the core radius is 25µm, find the numerical aperture.**

**Given data:**

V= 26.6

$\lambda = 1300\times10^{-9}$m

$a = 25\times10^{-6}$m

**Formula:**

Normalized frequency V is given by

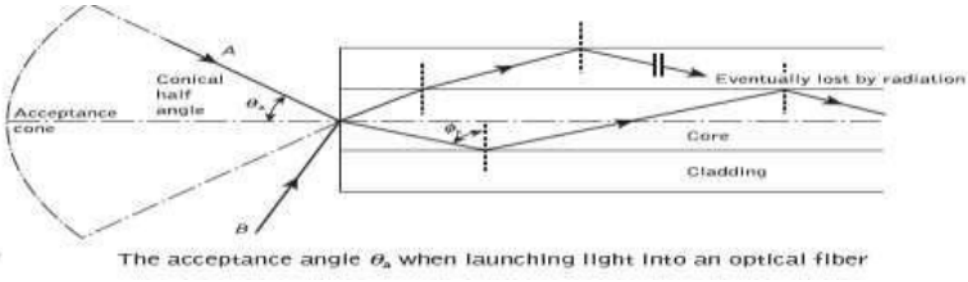
$V = 2\pi a (NA) / \lambda$

$NA = \lambda V/2\pi a$

NA=0.22

**10. Define - Acceptance angle**

The maximum angle '$\theta_a$' with which a ray of light can enter through the fiber and still be totally internally reflected is called acceptance angle of the fiber.



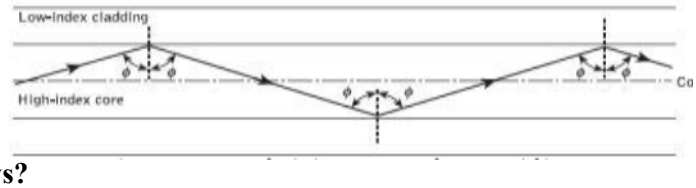
The acceptance angle $\theta_a$ when launching light into an optical fiber

**11. A silica optical fiber with a large core diameter has a core refractive index of 1.5 and a cladding refractive index of 1.47.Determine the acceptance angle in air for the fiber.**

**Given data:** $n_1$= 1.5
$n_2$= 1.47
**$\theta_a = 17.36^\circ$**

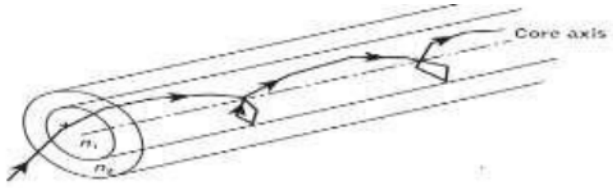
**12. What are meridional rays?**

Meridional rays are the rays following zig- zag path when they travel through fiber and for every reflection it will cross the fiber axis. The figure below shows the meridional rays.




**13. What are skew rays?**

Skew rays are the 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. The figure below shows the propagation of skew rays.




**14. Write the acceptance angle condition for the skew rays.**

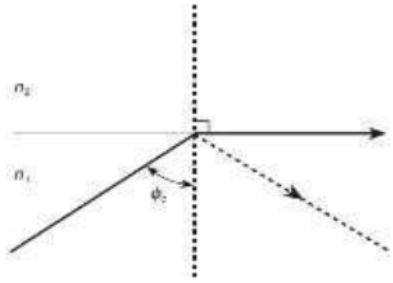
The acceptance conditions for ~~skew~~ rays is given by the equation

$$\theta_{as} = \sin^{-1}\frac{\cos\gamma}{}$$

where NA is the numerical aperture and γ is the angle between the projection of the ray in two dimensions and the radius of the fiber core at the point of reflection.

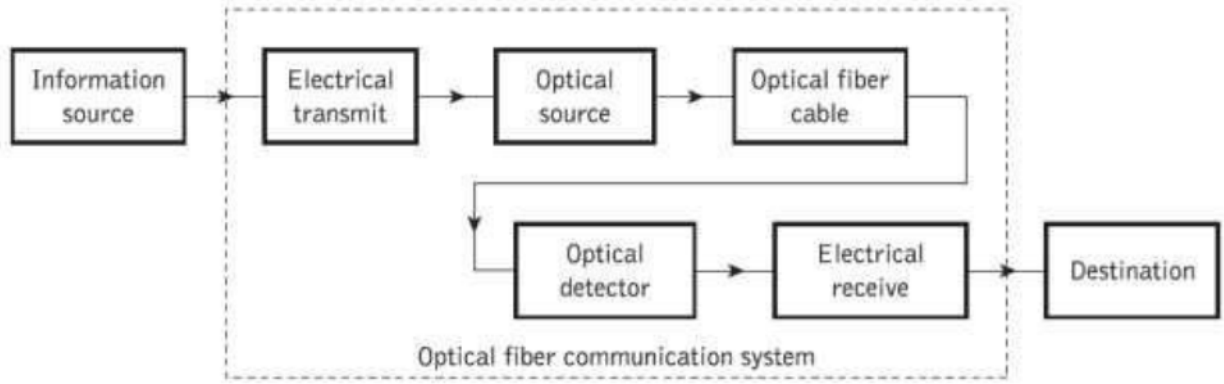
**15. Define – Critical Angle**

The critical angle is defined as the minimum angle of incidence ($\phi_1$) at which the ray strikes the interface of the two medium and causes an angle of refraction ($\phi_2$) equal to 90°.



**16. Draw the block diagram of an optical communication system.**

The block diagram of an optical communication system is represented as,




**17. Which photodiode is used for a low power optical signal and Why?**

Avalanche Photo Diode (APD) is used for a low power optical signal because it has a greater sensitivity due to an inherent internal gain mechanism produced by avalanche effect.

**18. What is V number of a fiber?**

Normalized frequency or V number is a dimensionless parameter and represents the relationship among three design variables of the fiber i.e. core radius **a**, relative refractive index Δ

**19. What are guided modes?**

Guided modes are a pattern of electric and magnetic field distributions that is repeated along the fiber at equal intervals.

**20. Define – Phase Velocity**

As a monochromatic light wave propagates along a waveguide in the *z* direction the points of constant phase travel at a phase velocity $V_p$ given by

$V_p = \omega / \beta$

where ω is the angular frequency and β is the propagation constant

**21. Define – Group Velocity**

Group of waves with closely similar frequencies propagate so that their resultant forms packet of waves. This wave packet does not travel at the phase velocity of individual but it moves with the group velocity $V_g$

**22. What is meant by mode coupling? What causes it?**

The effect of coupling energy from one mode to another mode is known as mode coupling. The cause of mode coupling is due to waveguide perturbations such as deviations of the fiber axis from straightness, variations in the core diameter, irregularities at the core -cladding interface and refractive index variations.

**23. What are the uses of optical fibers?**

The uses of optical fiber are

a) To transmit analog and digital information.

b) To transmit the optical images.(Endoscopy Images)

c) To act as a light source at the inaccessible places.

d) To act as sensors for mechanical, electrical and magnetic measurements.

**24. What is the necessity of cladding for an optical fiber?**

The necessity of cladding for an optical fiber is:

a) To provide proper light guidance inside the core.

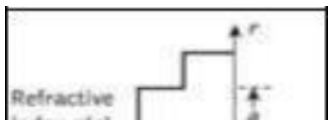
b) To avoid leakage of light from the fiber.

c)To provide mechanical strength for the fiber.

d)To protect the core from scratches and other mechanical damages

**25. What is step index fiber?**

Step index fiber is a cylindrical waveguide that has the central core with uniform refractive index of $n_1$, surrounded by outer cladding with refractive index of $n_2$. The refractive index of the core is constant and is larger than the refractive index of the cladding. It makes a step change at the core cladding interface as indicated in the figure,



**26. Write the refractive index expression for step index fiber.**

In step index fiber, the refractive index of a core is constant and is larger than the refractive index of the cladding. The refractive index profile is defined as

$$n(r) = \begin{cases} n_1; & r < a \text{ (core)} \\ n_2; & r \geq a \text{ (cladding)} \end{cases}$$

**27.What are the advantages of Graded Index Fiber?**

The advantages of Graded Index Fiber are

a) It exhibits **less intermodal dispersion** because the different group velocities of the modes tend to be normalized by the index grading.

b) It provides **higher bandwidth**

28.**Write the refractive index expression for graded index fiber.**

Graded index fibers does not have a constant refractive index in the core but a gradually decreasing core index $n(r)$ with radial distance from a maximum value of $n_1$ at the axis to a constant value $n_2$ beyond the core radius 'a' in the cladding. This index variation may be Represented as

$$n(r) = \{ n_1 = (1 - 2\Delta(r/a)^{\alpha})^{1/2};\ r < a \text{ (core)}\}$$

$$\{n1\ (1 - 2\Delta)^{1/2} = n_2;\ r \geq a \text{ (cladding)}\}$$

Where,

$n_1$ is the refractive index of the core

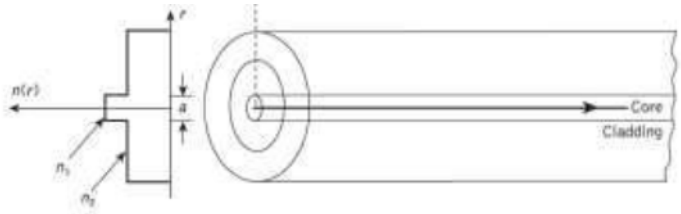
$n_2$ is the refractive index of the cladding

$\Delta$ is the index difference

$\alpha$ is the index profile

**29.Write a short note on single mode fiber.**

For single-mode operation, only one mode (the fundamental $LP_{01}$) can exist and it does not suffer from mode delay. The core diameter is small so that there is only one path for light ray to propagate inside the core. Typical core sizes are 2μm to 5μm. It provides larger bandwidth and less coupling efficiency. It is used for long haul transmission.



**30. List out the advantages of multimode fiber over single mode fibers. (A/M2008)**

**The advantages of multimode fiber are:**

a) The larger core radii of multimode fibers make it easier to launch optical power into the fiber. Connecting together of similar fibers is easy.

b) Light can be launched into a multimode fiber using an LED source, whereas single-mode fibers with LASER diodes. LED's are easier to make, less expensive, less complex circuitry and have longer life times.

**31. List the advantages and disadvantages of monomode fiber. The advantages of single mode fiber are:**

a) No intermodal dispersion

b) Information capacity of single mode fiber is large

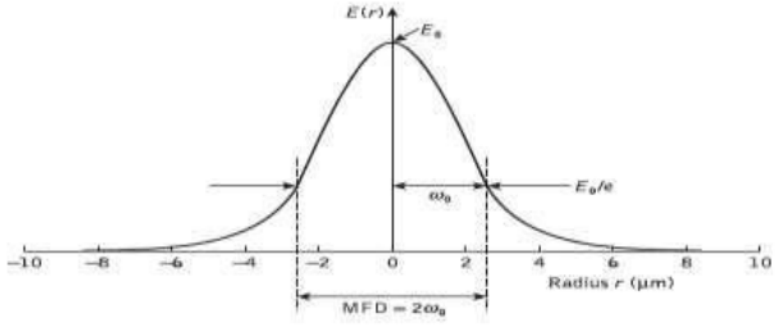
**The disadvantages of single mode fiber are:**

a) Launching of light into single mode and joining of two fibers are very difficult

b) Fabrication is very difficult and so that fiber is so costly

**32.Define – Mode Field Diameter**

Mode-Field Diameter is an important parameter for characterizing single mode fiber properties that accounts the wavelength dependent field penetration into the fiber cladding. This can be determined from the mode field distribution of the fundamental $LP_{01}$ mode. The MFD equals $2\omega_o$ where $\omega_o$ is the nominal half width of the input excitation




**33. Why is step index single mode fiber preferred for long distance communication?**

The step index single mode fiber is preferred for long distance communication because,

a) They exhibit higher transmission bandwidth because of low fiber losses.

b) They have superior transmission quality because of the absence of modal noise.

c) The installation of single mode fiber is easy and will not require any fiber replacement over twenty plus years.

**34. Define – Birefringence**

Manufactured optical fibers have imperfections, such as asymmetrical lateral stresses, non circular cores, and variations in refractive index profiles. These imperfections break the circular symmetry of the ideal fiber and lift the degeneracy of the two modes. These

Birefringence is expressed as

$$B_f = \beta_x - \beta_y / \frac{}{}$$

where $\beta$ is the propagation constant.

## UNIT- II TRANSMISSION CHARACTERISTICS OF OPTICAL FIBER

**1. What is meant by attenuation coefficient of a fiber?**

Attenuation coefficient is defined as the ratio of the input optical power $P_i$ launched into the to the output optical power $P_o$ from the fiber.

$\propto = \frac{}{}$

where $\propto_{dB}$ is the attenuation coefficient in decibels per kilometer.

**2.What are the types of material absorption losses in silica glass fibers?**

The types of material absorption losses in silica fiber are:

a) Absorption by atomic defects in the glass composition
b) Extrinsic absorption by impurity atoms in the glass material
c) Intrinsic absorption by the basic constituent atoms in the glass material

**3.What is meant by intrinsic absorption in optical fibers?**

The absorption caused by the interaction of one or more of the major components of the glass is known as intrinsic absorption.

**4. What is meant by extrinsic absorption in optical fibers?**

The absorption caused by the impurities within the glass is known as extrinsic absorption.

**5. Differentiate linear scattering from nonlinear scattering.**

Linear scattering mechanisms transfers linearly some or all of the optical power contained within one propagating mode to a different mode.

Non-linear scattering causes the optical power from one mode to be transferred in either the forward or backward direction to the same or other modes at different frequencies.

**6. What are the types of linear scattering losses?**

Linear scattering is of two types. They are:

a) Rayleigh scattering
b) Mie scattering

**7. What are the types of nonlinear scattering losses?**

Non-linear scattering is of two types. They are a) Stimulated Brillouin Scattering (SBS) b) Stimulated Raman Scattering (SRS)

**8. What is meant by Fresnel Reflection?**

When the two joined fiber ends are smooth and perpendicular to the axes, and the two fiber

axes are perfectly aligned, small proportion of the light may be reflected back into the transmitting fiber causing attenuation at joint. This is known as Fresnel reflection.

**9. What is meant by linear scattering?**

Linear scattering mechanisms transfers linearly some or all of the optical power contained within one propagating mode to a different mode.

**10. What are the factors that cause Rayleigh scattering in optical fibers?**

The inhomogeneties of a random nature occurring on a small scale compared with the wavelength of the light in optical fiber causes Rayleigh scattering. These inhomogeneities manifest themselves as refractive index fluctuations and arise from density and compositional variations that are frozen into the glass lattice on cooling.

**11. What are the factors that cause Mie scattering in optical fibers?**

**The factors that cause Mie scattering in optical fibers are:**

a) Fiber imperfections such as irregularities in the core – cladding interface
b) Core – cladding refractive index differences along the fiber length, diameter fluctuations

**12. What are the ways to reduce macro bending losses?**

The ways to reduce macro bending losses are

a) Designing fibers with large relative refractive index differences
b) Operating at the shortest wavelength possible.

**13. What is meant by dispersion in optical fiber?**

Different spectral components of the optical pulse travel at slightly different group velocities and cause pulse broadening within the fiber. This phenomenon is referred as dispersion.

**14. What are the different types of dispersion?**

There are two types of dispersion. They are

a) Intramodal Dispersion:
   (i) Material Dispersion
   (ii) Waveguide Dispersion
b) Intermodal Dispersion:
   (i) Multimode step index
   (ii) Multimode graded index

**15. What is meant by intermodal dispersion?**

Pulse broadening due to propagation delay differences between modes within a multimode fiber is known as intermodal dispersion.

**16. Define – Group Velocity Dispersion (GVD)**

Intra-modal dispersion is pulse spreading that occurs within a single mode. The spreading arises from the finite spectral emission width of an optical source. This phenomenon is known as Group Velocity Dispersion (GVD).

**17. What is meant by modal noise?**

The speckle patterns are observed in multimode fiber as fluctuations which have characteristic times longer than the resolution time of the detector. This is known as modal or

**18. What is meant by chromatic dispersion?**

The dispersion due to the variation of the refractive index of the core material as a function of wavelength is known chromatic dispersion. This causes a wavelength dependence of the group velocity of any given mode. Pulse spreading occurs even when different wavelengths follow the same path.

**19. What is meant by polarization mode dispersion?**

Polarization refers to the electric - field orientation of a light signal, which can vary significantly along the length of the fiber.

**20. Distinguish between dispersion shifted and dispersion flattened fibers.**

Reduction in the fiber core diameter with an increase in the relative or fractional index difference to create dispersion is known a dispersion shifted fiber. Fibers which relax the spectral requirements for optical sources and allow flexible wavelength division multiplexing are known as dispersion flattened fibers.

**21.What are the two types of fiber joints?**

**The two types of fiber joints**

a) Fiber splices: These are semi permanent or permanent joints.
b) Demountable fiber connectors or simple connectors: These are removable joints.

**22.What is meant by fiber splicing?**

A permanent joint formed between two individual optical fibers in the field or factory is known as fiber splice.

**23.What are the techniques used in splicing?**

Generally used splicing techniques are:

a) Fusion splice
b) V-groove mechanical splice
c) Elastic tube splice

**23. List the types of mechanical misalignments that occur between two joined fibers.**

There are three types of mechanical misalignments:

b) Lateral/radial/axial misalignment
c) Longitudinal misalignment
d) Angular misalignment

## UNIT-III SOURCES AND DETECTORS

**1. What is meant by heterojunction? List out the advantages of heterojunction.**

A heterojunction is an interface between two adjoining single crystal semiconductors with different bandgap energies. Devices that are fabricated with heterojunction are said to have hetrostructure.

**Advantages of heterojunction are:**

a) Carrier and optical confinement
b) High output power
c) High coherence and stability

**2. Distinguish between direct and indirect band gap materials.**

| Sl.No | Direct bandgap materials | Indirect bandgap material |
|---|---|---|
| 1. | The electron and hole have the same momentum value | The conduction band minimum and the valence band maximum energy level occur at different values of momentum. |
| 2. | Direct transition is possible from valence band to conduction band | Direct transition is not possible from valence band to conduction band |

**3. Why is silicon not used to fabricate LED or Laser diode?**

**Silicon is not used to fabricate LED or Laser diode because**

a) It is an indirect bandgap semiconductor

b) It has $E_g$ level of 1.1eV, the radiated emission corresponds to infrared but not the visible light.

**4. What are the advantages of LED?**

**The advantages of LED are:**

a) Less expensive
b) Less complex
c) Long life time
d) Used for short distance communication

**5. What is the principle of operation of LASER?**

The principle of operation of LASER is population inversion, the most photons incident on the system. The population of the upper energy level is greater than lower energy level i.e. $N_2 > N_1$. This condition is known as population inversion.

**6. Write the three modes of the cavity of LASER diode.**

**The three modes of the cavity of LASER are:**

a) Longitudinal modes, related to the length L of the cavity

b) Lateral Modes lie in the plane of the P-N junction. These modes depend upon the side wall preparation and width of the cavity.

c)Transverse modes are associated with the Electro Magnetic Field and beam profile in the direction perpendicular to the plane of the PN junction. These modes determine the radiation pattern of the LASER.

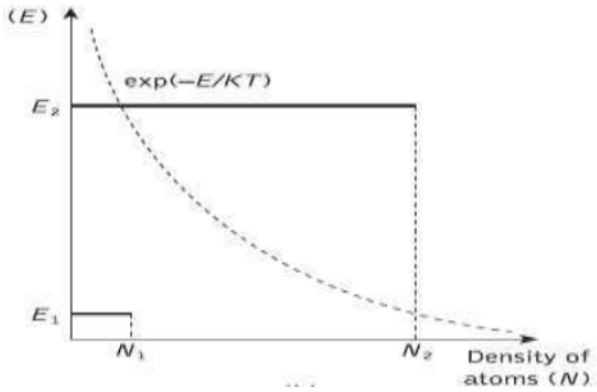
**7. What is a DFB Laser? Differentiate DFB LASER from other types of LASER.**

In DFB Laser, the lasing action is obtained by periodic variations of refractive index, which are incorporated into multilayer structure along the length of the diode. DFB LASER does not require optical feedback unlike the other LASERs.

**8. What is population inversion?**

Under thermal equilibrium, the lower energy level $E_1$ of the two level atomic system contains more atoms than upper energy level $E_2$.To achieve optical amplification it is necessary to create non-equilibrium distributions of atoms such that population of the upper

energy level is greater than lower energy level i.e. $N_2 > N_1$ as shown in the figure. This condition is known as population inversion.




**9. Compare LED and ILD sources.**

| Sl.No | LED | ILD |
|---|---|---|
| 1. | Incoherent | Coherent |
| 2. | For multimode fibers only | For multi and single mode fibers |
| 3. | Large beam divergence due to spontaneous emission | Low beam divergence due to stimulated emission |

**10. Write the three key processes of laser action.**

The three key processes of laser actions are:

1. The atomic system must have population inversion. This means the number of atoms in the excited state should be more than that of ground state
2. There should be photons with proper energy to start the stimulated emission
3. There should be an arrangement for multiple reflections to increase the intensity of LASER beam

**11. What are the advantages of Quantum Well Lasers?**

**The advantages of Quantum Well Lasers are:**

a) High threshold current density
b) High modulation speed
c) High line width of the device

**12. Define – Internal Quantum Efficiency**

Internal Quantum Efficiency is defined as the ratio of radiative recombination rate to the total recombination rate.

**13. Define – External Quantum Efficiency**

The external quantum efficiency is defined as the ratio of photons emitted from LED to the number of photons generated internally.

Quantum efficiency is defined as the number of the electron-hole carrier pairs generated per incident photon of energy $h$ , is given by

$$\eta = \frac{\text{number of electron hole pairs generated}}{\text{number of incident photons}}$$

$$\eta = \frac{I_p / q}{P_o / h\nu}$$

where $I_p$ is the photon current
q is the charge of the electron
$p_o$ is the optical output power
h is the Planck's constant
$\nu$ is the frequency of the optical signal

**14. What are the necessary features of a photo detector?**

**The necessary features of a photo detector are:**

(a) High Quantum efficiency
(b) Low rise time or fast response
(c) Low dark current

**15. Define – Responsivity of a photodetector**

Responsitivity is defined as the ratio of output photo current to the incident optical power.

$$R = \frac{I_p}{P_o} \quad P_o = \frac{\eta q}{h\nu}$$

where, R=Responsivity.
$I_p$=Output photo current
$P_o$=Incident optical power

**16. Compare the performance of APD with PIN diode.**

| Sl.No | APD | PIN |
|---|---|---|
| 1 | No internal gain | Internal gain is high |
| 2 | Thermal current noise dominates photo detector noise current | Photo detector noise current dominates thermal noise current |
| 3 | Low responsivity | High responsivity |
| 4 | Low dark current | High dark current |
| 5 | Suitable for high intensity application | Suitable for low intensity application |
| 6 | Required low reverse bias voltage | Required high reverse bias voltage |

**17. List out the operating wavelengths and responsivities of Si, Ge, and InGaAs photodiodes.**

**The Operating Wavelengths and Responsivities of Si, Ge, and InGaAs photodiodes are:**

**Silicon (Si) :**

(i) Operating wavelength range $\lambda$ = 400 - 1100 nm

(ii) Responsivity R = 0.4-0.6

**Germanium (Ge) :**

(i) Operating wavelength range $\lambda$ = 800 - 1650 nm

(ii) Responsivity R = 0.4 - 0.5

**Indium Gallium Arsenide (InGaAs):**

(i) Operating wavelength range $\lambda$ = 1100 - 1700 nm

(ii) Responsivity R = 0.75 - 0.95

**18. List the benefits and drawbacks of avalanche photodiodes. Benefits of APD are:**

a) Carrier multiplication takes place.

b) Sharp threshold

**Drawbacks of APD are:**

a) High biasing voltage.

b) Noisy

**19.Photons of energy $1.53\times10^{-19}$ J are incident on a photodiode that has the responsivity of 0.65Amps/W. If the optical power level is 10µW, find the photo current generated.** **(M/J 2012)**

**Given data :** E = $1.53\times10^{-19}$ J, R = 0.65Amps/W, $P_0 = 10\times10^{-6}$ W

**Formula** : $I_p = R\times P_0$

**Solution** : $I_p = 0.65\times 10\times10^{-6}$ = **6.5 µA**

**20. Ga As has band gap energy of 1.43ev at 300k. Determine the wavelength above which an intrinsic photo detector fabricated from this material will cease to operate.**

**Given data:** Eg(eV) = 1.43ev

**Formula:** $\lambda(\mu m)$ = 1.24/Eg(eV)

**Solution:** $\lambda(\mu m)$ =1.24/1.43

$\lambda(\mu m)$ =**0.86 µm**.

## UNIT-IV FIBER OPTIC RECEIVER AND MEASUREMENTS

**1. Define – Quantum Limit**

(BER) of an optical receiver is known as the quantum limit.

**2. What is meant by (1/f) noise corner frequency?**

The (1/f) noise corner frequency is defined as the frequency at which (1/f) noise, which
dominates the FET noise at low frequencies and has (1/f) power spectrum

**3. Why silicon is preferred to make fiber optical receivers?**

**Silicon is preferred to make fiber optical receivers because**

27.It has high sensitivity over the 0.8–0.9 μm wavelength band with adequate speed
28. It provides negligible shunt conductance, low dark current and long-term stability

**4. Define – Modal noise and Mode Partition Noise.**

Disturbances along the fibre such as vibrations, discontinuities, connectors, splices and source/detector coupling may cause fluctuations in the speckle patterns. It is known as modal noise.

Phenomenon that occurs in multimode semiconductor lasers when the modes are not well stabilized is known as mode partition noise.

**5. Mention the error sources in fiber optical receiver.**

There are three main error sources in fiber optical receiver. They
are: a) Thermal noise
b) Dark current noise
c) Quantum noise

**6. Define – Bit Error Rate**

Bit Error Rate (BER) is defined as the ratio of the number of errors occurred over a certain time interval‘t’ to the number of pulses transmitted during this interval

**7. How does dark current arise?**

When there is no optical power incident on the photo detector a small reverse leakage current flows from the device terminals known as dark current. Dark current contributes to the total system noise and gives random fluctuations about the average particle flow of the photocurrent.

**8. What is Inter Symbol Interference?**

Each pulse broadens and overlaps with its neighbors, eventually becoming indistinguishable at the receiver input. This effect is known as Inter Symbol Interference.

**9. Define – Extinction ratio**

The extinction ratio ε is usually defined as the ratio of the optical energy emitted in the ‘0’ bit period to that emitted during the ‘1’ bit period

**10. What are the types of pre - amplifiers?**

The types of pre-amplifier are

a) Low- impedance preamplifier
b) High – impedance preamplifier
c) Transimpedance preamplifier

**11. List the advantages of preamplifiers.**

The advantages of pre amplifiers are

a) Low noise level
b) High Bandwidth
c) High dynamic range
d) High Sensitivity
e) High gain

**12. What are the standard fiber measurement techniques?**

The standard fiber measurement techniques are

1. Fiber attenuation measurement
2. Fiber dispersion measurement
3. Fiber refractive index profile measurement
4. Fiber cutoff wavelength measurement
5. Fiber numerical aperture measurement
6. Fiber diameter measurement

**13. Define – Bend Attenuation**

A peak in the wavelength region where the radiation losses resulting from the small loop are much higher than the fundamental mode is known as bend attenuation.

**14. What is the technique used for measuring the total fiber attenuation?**

Total fibre attenuation per unit length can be determined using cut-back method. Taking a set of optical output power measurements over the required spectrum using a long length of fibre usually at least a kilometre is known as cut back technique. The fibre is then cut back to a point 2 meters from the input end and maintaining the same launch conditions, another set of power output measurements are taken.

**15. What are the factors that produce dispersion in optical fibers?**

The factors that produce dispersion in optical fibers are:

1. Propagation delay difference between the different spectral components of the transmitted signal.
2. Variation in group velocity with wavelength

**16. What are the methods used to measure fiber dispersion?**

The methods used to measure fiber dispersion are:

1. Time domain measurement
2. Frequency domain measurement

**17. What are the methods used to measure fiber refractive index profile?**

The methods used to measure fiber refractive index profile are

1. Interferometric method

2. Near infra scanning method
3. Refracted near field method

## UNIT-VOPTICAL NETWORKS

**1. What are the three topologies used for fiber optical network?**

The three topologies used for fiber optical network are:

a) Bus
b) Ring
c) Star

**2. Calculate the number of independent signals that can be sent on a single fiber in the 1525-1565 nm bands. Assume the spectral spacing as per ITU-T recommendation G.692.**

**Given data**: Mean frequency spacing as per ITU-T is 0.8 nm
Wavelength = 1565 nm -1525 nm = 40 nm

**Solution**:
Number of independent channel = (40 nm/0.8 nm) = 50 Channels

**3. What are the drawbacks of broadcast and select networks for wide area network applications? (M/J 2012)**

The drawbacks of broadcast and select networks for wide area network applications are:

a) More wavelengths are needed as the number of nodes in the network grows
b) Without the use of optical booster amplifiers splitting losses occurs

**4. Define – WDM**

In fiber-optic communications, wavelength-division multiplexing (WDM) is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths (i.e. colors) of laser light. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity.

**5. What are the advantages of WDM?**

The advantages of WDM are

a) Various optical channels can support different transmission formats
b) Increase in the capacity of optical fiber compared to point-to-point link

**6. What is the purpose of rise-time budget analysis?**

Rise-time budget ensures that the link is able to operate for a given data rate at specified BER. All the components in the link must operate fast enough to meet the band width or rise time requirements.

**7. What is EDFA?**

An erbium-doped fiber amplifier (EDFA) is a device that amplifies an optical fiber signal. A trace impurity in the form of a trivalent erbium ion is inserted into the optical fiber's silica core to alter its optical properties and permit signal amplification.

**8. Distinguish between fundamental and higher order soliton.**

The optical pulse that does not change in shape is called fundamental solitons.

The pulses that undergo periodic shape changes are called higher order solitons.

**10. What are the advantages of using soliton signals through fiber?**

The advantages of using soliton signals through fiber are, it is very narrow, high-intensity optical pulses that retain their shape through the interaction of balancing pulse dispersion with the nonlinear properties of an optical fiber.

**11. What is chirping?**

The d.c. modulation of a single longitudinal mode semiconductor laser can cause a dynamic shift of the peak wavelength emitted from the device This phenomenon, which results in dynamic line width broadening under the direct modulation of the injection current, is referred to as frequency chirping.

**12. What are solitons?**

Solitons are nonlinear optical pulses that have the potential to support very high optical transmission rates of many terabits per second over long distances.

**13. What is SONET/SDH?**

Synchronous Optical NETworking (SONET) or Synchronous Digital Hierarchy (SDH) is a standardized protocol that transfers multiple digital bit streams over optical fiber using lasers or highly coherent light from light emitting diodes. At low transmission rates data can also be transferred via an electrical interface.

**14. Draw the frame format of SONET.**