**BE (2015)Pattern**

**404190 Broadband Communication Systems**

**UNIT I: Light wave System Components**

**1. Questions & Answers on Optical Fiber Waveguides**

The section contains questions and answers on ray theory, electromagnetic mode theory, cylindrical and single mode fibers, crystal fibers and attenuation.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Ray Theory Transmission”.

1. Who proposed the idea of transmission of light via dielectric waveguide structure? a) Christian Huygens b) Karpon and Bockham c) Hondros and debye d) Albert Einstein View Answer

Answer: c Explanation: It was in the beginning of 20th century where Hondros and debye theoretical and experimental study demonstrated that information can be transferred as a form of light through a dielectric waveguide.

2. Who proposed the use of clad waveguide structure? a) Edward Appleton b) Schriever c) Kao and Hockham d) James Maxwell View Answer

Answer: c Explanation: The invention of clad waveguide structure raised the eyebrows of the scientists. The proposals by Kao and Hockham proved beneficial leading in utilization of optical fibre as a communication medium.

3. Which law gives the relationship between refractive index of the dielectric? a) Law of reflection b) Law of refraction (Snell’s Law) c) Millman’s Law d) Huygen’s Law View Answer

Answer: b Explanation: Snell’s Law of refraction states that the angle of incidence Ø1 and refraction Ø2 are related to each other and to refractive index of the dielectrics.

It is given by n1sinØ1 = n2sinØ2 where n1 and n2 are the refractive indices of two mediums. Ø1 and Ø2 are angles of incidence and refraction.

4. The light sources used in fibre optics communication are \_\_\_\_\_\_\_\_\_\_\_\_ a) LED’s and Lasers b) Phototransistors c) Xenon lights d) Incandescent View Answer

5. The \_\_\_\_\_\_\_\_ ray passes through the axis of the fiber core. a) Reflected b) Refracted c) Meridional d) Shew View Answer

Answer: c Explanation: When a light ray is passed through a perfect optical fiber, any discontinuities at the core cladding interface would result in refraction rather than total internal reflection. Such light ray passes through the axis of fiber core and is called as meridional ray. This principle is used while stating the fundamental transmission properties of optical fiber.

6. Light incident on fibers of angles\_\_\_\_\_\_\_\_the acceptance angle do not propagate into the fiber. a) Less than b) Greater than c) Equal to d) Less than and equal to View Answer

Answer: b Explanation: Acceptance angle is the maximum angle at which light may enter into the fiber in order to be propagated. Hence the light incident on the fiber is less than the acceptance angle, the light will propagate in the fiber and will be lost by radiation.

7. What is the numerical aperture of the fiber if the angle of acceptance is 16 degree? a) 0.50 b) 0.36 c) 0.20 d) 0.27 View Answer

Answer: d Explanation: The numerical aperture of a fiber is related to the angle of acceptance as follows:

NA = sin Ѳa Where NA = numerical aperture Ѳ = acceptance angle.

8. The ratio of speed of light in air to the speed of light in another medium is called as \_\_\_\_\_\_\_\_\_ a) Speed factor b) Dielectric constant c) Reflection index d) Refraction index View Answer

Answer: d Explanation: When a ray travels from one medium to another, the ray incident from a light source is called as incident ray. In passing through, the speed varies. The ratio of the speed of incident and the refracted ray in different medium is called refractive index.

9. When a ray of light enters one medium from another medium, which quality will not change? a) Direction b) Frequency c) Speed d) Wavelength View Answer

Answer: b Explanation: The electric and the magnetic field have to remain continuous at the refractive index boundary. If the frequency is changed, the light at the boundary would change its phase and the fields won’t match. In order to match the field, frequency won’t change

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Single-Mode Fibers”.

1. An optical fiber has core-index of 1.480 and a cladding index of 1.478. What should be the core size for single mode operation at 1310nm? a) 7.31μm b) 8.71μm c) 5.26μm d) 6.50μm View Answer

Answer: d Explanation: Normalized frequency V<=2.405 is the value at which the lowest order Bessel function J=0. Core size(radius) .

2. An optical fiber has a core radius 2μm and a numerical aperture of 0.1. Will this fiber operate at single mode at 600 nm? a) Yes b) No View Answer

Answer: a Explanation: V= 2πa.NA/λ. Calculating this equation, we get the value of V. V is the normalised frequency and should be below 2.405 in order to operate the fiber at single mode. Here, V=2.094, is less than 2.405. Thus, this optical fiber exhibit single mode operation.

3. What is needed to predict the performance characteristics of single mode fibers? a) The intermodal delay effect b) Geometric distribution of light in a propagating mode c) Fractional power flow in the cladding of fiber d) Normalized frequency View Answer

Answer: b Explanation: A mode field diameter (MFD) is a fundamental parameter of single mode fibers. It tells us about the geometric distribution of light. MFD is analogous to core diameter in multimode fibers, except in single mode fibers not all the light that propagates is carried in the core.

4. Which equation is used to calculate MFD? a) Maxwell’s equations b) Peterman equations c) Allen Cahn equations d) Boltzmann’s equations View Answer

Answer: b Explanation: Mode field diameter is an important parameter for single mode fibers because it is used to predict fiber properties such as splice loss, bending loss. The standard technique is to first measure the far-field intensity distribution and then calculating mode field diameter using Peterman equations.

5. A single mode fiber has mode field diameter 10.2μm and V=2.20. What is the core diameter of this fiber? a) 11.1μm b) 13.2μm c) 7.6μm d) 10.1μm View Answer

Answer: d Explanation: For a single mode fiber, MFD=2w0. Here, core radius Solving this equation, we get a=5.05μm. Core-diameter=2a=10.1μm.

6. The difference between the modes’ refractive indices is called as \_\_\_\_\_\_\_\_\_\_\_ a) Polarization b) Cutoff c) Fiber birefringence d) Fiber splicing View Answer

Answer: c Explanation: There are two propagation modes in single mode fibers. These two modes are similar but their polarization planes are orthogonal. In actual fibers, there are imperfections such as variations in refractive index profiles. These modes propagate with different phase velocities and their difference is given by Bf =ny – nx. Here, ny and nx are refractive indices of two modes.

7. A single mode fiber has a beat length of 4cm at 1200nm. What is birefringence? a) 2\*10-5 b) 1.2\*10-5 c) 3\*10-5 d) 2 View Answer

Answer: c Explanation: Bf=ny– nx = λ/Lp. Here, λ=wavelength and Lp = beat length. Solving this equation, we will get the answer.

8. How many propagation modes are present in single mode fibers? a) One b) Two c) Three d) Five View Answer

Answer: b Explanation: For a given optical fiber, the number of modes depends on the dimensions of the cable and the variations of the indices of refraction of both core and cladding across the cross section. Thus, for a single mode fiber, there are two independent, degenerate propagation modes with their polarization planes orthogonal.

9. Numerical aperture is constant in case of step index fiber. a) True b) False View Answer

Answer: a Explanation: Numerical aperture is a measure of acceptance angle of a fiber. It also gives the light gathering capacity of the fiber. For a single mode fiber, core is of constant refractive index. There is no variation with respect to core. Thus, Numerical aperture is constant for single mode fibers.

10. Plastic fibers are less widely used than glass fibers. a) True b) False View Answer

Answer: a Explanation: The majority of the fibers are made up of glass consisting of silica. Plastic fibers are used for short distance transmissions unlike glass fibers which can also be used for long haul applications. Also, plastic fibers have higher attenuation than glass fibers.

This set of Optical Communications Interview Questions and Answers focuses on “Electromagnetic Mode Theory for Optical Propagation”.

1. Which equations are best suited for the study of electromagnetic wave propagation? a) Maxwell’s equations b) Allen-Cahn equations c) Avrami equations d) Boltzmann’s equations View Answer

Answer: a Explanation: Electromagnetic mode theory finds its basis in electromagnetic waves. Electromagnetic waves are always represented in terms of electric field E, magnetic field H, electric flux density D and magnetic flux density B. These set of equations are provided by Maxwell’s equations.

2. When λ is the optical wavelength in vacuum, k is given by k=2Π/λ. What does k stand for in the above equation? a) Phase propagation constant b) Dielectric constant c) Boltzmann’s constant d) Free-space constant View Answer

Answer: a Explanation: In the above equation, k = 2Π/λ, also termed as wave equation, k gives us the direction of propagation and also the rate of change of phase with distance. Hence it is termed as phase propagation constant.

3. Constructive interference occur when total phase change after two successive reflections at upper and lower interfaces is equal to? (Where m is integer) a) 2Πm b) Πm c) Πm/4 d) Πm/6 View Answer

Answer: a Explanation: The component of phase waves which is in x direction is reflected at the interference between the higher and lower refractive index media. It is assumed that such an interference forms a lowest order standing wave, where electric field is maximum at the center of the guide, decaying towards zero.

4. When light is described as an electromagnetic wave, it consists of a periodically varying electric E and magnetic field H which are oriented at an angle? a) 90 degree to each other b) Less than 90 degree c) Greater than 90 degree d) 180 degree apart View Answer

Answer: a Explanation: In case of electromagnetic wave which occur only in presence of both electric and magnetic field, a particular change in magnetic field will result in a proportional change in electric field and vice versa. These changes result in formation of electromagnetic waves and for electromagnetic waves to occur both fields should be perpendicular to each other in direction of wave travelling.

5. A monochromatic wave propagates along a waveguide in z direction. These points of constant phase travel in constant phase travel at a phase velocity Vp is given by? a) Vp=ω/β b) Vp=ω/c c) Vp=C/N d) Vp=mass/acceleration View Answer

Answer: a Explanation: Velocity is a function of displacement. Phase velocity Vp is a measure of angular velocity.

6. Which is the most important velocity in the study of transmission characteristics of optical fiber? a) Phase velocity b) Group velocity c) Normalized velocity

d) Average velocity View Answer

Answer: b Explanation: Group velocity is much important in relation to transmission characteristics of optical fiber. This is because the optical wave propagates in groups or form of packets of light.

7. What is refraction? a) Bending of light waves b) Reflection of light waves c) Diffusion of light waves d) Refraction of light waves View Answer

Answer: a Explanation: Unlike reflection, refraction involves penetration of a light wave from one medium to another. While penetrating, as it passes through another medium it gets deviated at some angle.

8. The phenomenon which occurs when an incident wave strikes an interface at an angle greater than the critical angle with respect to the normal to the surface is called as \_\_\_\_\_\_\_\_\_\_\_\_ a) Refraction b) Partial internal reflection c) Total internal reflection d) Limiting case of refraction View Answer

Answer: c Explanation: Total internal reflection takes place when the light wave is in the more dense medium and approaching towards the less dense medium. Also, the angle of incidence is greater than the critical angle. Critical angle is an angle beyond which no propagation takes place in an optical fiber.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Cylindrical Fiber”.

1. A multimode step index fiber has a normalized frequency of 72. Estimate the number of guided modes. a) 2846 b) 2592 c) 2432 d) 2136 View Answer

Answer: b Explanation: A step-index fiber has a constant refractive index core. The number of guided

modes in a step-index fiber are given by M = (V\*V)/2. Here M denotes the number of modes and V denotes normalized frequency.

2. A graded-index fiber has a core with parabolic refractive index profile of diameter of 30μm, NA=0.2, λ=1μm. Estimate the normalised frequency. a) 19.32 b) 18.84 c) 16.28 d) 17.12 View Answer

Answer: b Explanation: Normalized frequency for a graded index fiber is given by V = 2Πa(NA)/λ. Substituting and calculating the values, we get option 18.84. Here, V denotes normalized frequency and NA = numerical aperture.

3. A step-index fiber has core refractive index 1.46 and radius 4.5μm. Find the cutoff wavelength to exhibit single mode operation. Use relative index difference as 0.25%. a) 1.326μm b) 0.124μm c) 1.214μm d) 0.123μm View Answer

Answer: c Explanation: The cutoff wavelength is the wavelength beyond which no single mode operation takes place. On solving λc = 2Πan1 2Δ−−−√/V, we get option c. Here, V=2.405, n1 = refractive index of core, a=radius of core.

4. A single-mode step-index fiber or multimode step-index fiber allows propagation of only one transverse electromagnetic wave. a) True b) False View Answer

Answer: a Explanation: Single mode step index fiber is also called as mono-mode step index fiber. As the name suggests, only one mode is transmitted and hence it has the distinct advantage of low intermodal dispersion.

5. One of the given statements is true for intermodal dispersion. Choose the right one. a) Low in single mode and considerable in multimode fiber b) Low in both single mode and multimode fiber c) High in both single mode and multimode fiber d) High in single mode and low in multimode fiber View Answer

Answer: a Explanation: Single mode propagates only one wave or only one mode is transmitted. Therefore, intermodal dispersion is low in single mode. In multimode fibers, higher dispersion may occur due to varying group velocities of propagating modes.

6. For lower bandwidth applications \_\_\_\_\_\_\_\_\_\_\_\_\_\_ a) Single mode fiber is advantageous b) Photonic crystal fibers are advantageous c) Coaxial cables are advantageous d) Multimode fiber is advantageous View Answer

Answer: d Explanation: In multimode fibers, intermodal dispersion occurs. The group velocities often differ which gradually restricts maximum bandwidth attainability in multimode fibers.

7. Most of the optical power is carried out in core region than in cladding. a) True b) False View Answer

Answer: a Explanation: In an ideal multimode fiber, there is no mode coupling. The optical power launched into a particular mode remains in that mode itself. The majority of these modes are mostly confined to fiber core only.

8. Meridional rays in graded index fibers follow \_\_\_\_\_\_\_\_\_\_\_\_ a) Straight path along the axis b) Curved path along the axis c) Path where rays changes angles at core-cladding interface d) Helical path View Answer

Answer: b Explanation: Meridional rays pass through axis of the core. Due to the varying refractive index at the core, the path of rays is in curved form.

9. What is the unit of normalized frequency? a) Hertz b) Meter/sec c) Coulombs d) It is a dimensionless quantity View Answer

Answer: d Explanation: Normalized frequency of optical fiber is the frequency which exists at cut-off

condition. There is no propagation and attenuation above cut-off. It is directly proportional to numerical aperture which is a dimensionless quantity; hence itself is a dimensionless quantity.

10. Skew rays follow a \_\_\_\_\_\_\_\_\_\_\_ a) Hyperbolic path along the axis b) Parabolic path along the axis c) Helical path d) Path where rays changes angles at core-cladding interface View Answer

Answer: c Explanation: The ray which does not pass through the fiber axis is termed as skew ray. Unlike Meridional rays, skew rays are more in number which makes them follow a round path called as helical path.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Photonic Crystal Fibers & Attenuation”.

1. Photonic crystal fibers also called as \_\_\_\_\_\_\_\_\_\_\_ a) Conventional fibers b) Dotted fibers c) Stripped fibers d) Holey fibers View Answer

Answer: d Explanation: Photonic crystal fibers contain a fine array of air holes running longitudinally down the fiber cladding. The microstructure within the fiber is highly periodic.

2. Conventional optical fibers has more transmission losses than photonic crystal fibers. a) True b) False View Answer

Answer: a Explanation: Conventional optical fibers have several hundreds of losses in transmission. Photonic crystal fibers have resulted in reduction in overall transmission losses.

3. Losses in photonic crystal fibers are reduced to a level of \_\_\_\_\_\_\_\_\_\_\_ a) 0.1dB/km b) 0.2dB/km c) 0.3dB/km d) 0.4dB/km View Answer

Answer: c Explanation: Conventional fibers have losses of several hundred decibels per km. The invention of photonic crystal tubes has reduced the losses by hundreds of decibels.

4. The high index contrast enables the PCF core to be reduced from around 8 μmin conventional fiber to \_\_\_\_\_\_\_\_\_\_\_ a) Less than 1μm b) More than 5μm c) More than 3μm d) More than 2μm View Answer

Answer: a Explanation: PCF’s have a wider range of optical properties in comparison with standard fibers. The lesser the core, more is the intensity of light in the core and enhances the non-linear effects.

5. The periodic arrangement of cladding air holes in photonic band gap fibers provides for the formation of a photonic band gap in the \_\_\_\_\_\_\_\_\_\_\_ a) H-plane of fiber b) E-plane of fiber c) E-H-plane of fiber d) Transverse plane of fiber View Answer

Answer: d Explanation: Photonic band gap fibers are a class of micro structured fiber in which periodic arrangement of air holes is required. As a PBG fiber exhibits a 2-dimensional band gap, than the wavelengths within this band gap cannot propagate perpendicular to the fiber axis.

6. In index-guided photonic crystal fiber structure, the dark areas are air holes. What does white areas suggests? a) Air b) Silica c) Water d) Plasma View Answer

Answer: d Explanation: Index-guided photonic crystal fibers have greater index contrast because the cladding contains air-holes having refractive index 1. Both index guided and conventional fibers arises from the manner in which guided mode interacts with the cladding region.

7. Which is the unit of measurement of attenuation in optical fibers? a) km b) dB c) dB/km

d) Coulomb’s View Answer

Answer: c Explanation: Attenuation is also referred to as transmission loss. Channel attenuation helped to determine the maximum transmission distance prior to signal restoration. Attenuation is usually expressed in logarithmic unit of decibel. It is given by αdBL = 10 log10Pi / Po Where αdB = signal attenuation per unit length Pi & Po = Input and output power.

8. The optical fiber incurs a loss in signal power as light travels down the fiber which is called as \_\_\_\_\_\_\_\_\_\_\_ a) Scattering b) Attenuation c) Absorption d) Refraction View Answer

Answer: b Explanation: When the light is passed through the fiber, it travels a large amount of distance before it starts fading. It needs restoration in the path. This loss or fading is called as Attenuation.

9. If the input power 100μW is launched into 6 km of fiber, the mean optical power at the fiber output is 2μW. What is the overall signal attenuation through the fiber assuming there are no connectors or splices? a) 15.23dB b) 16.98dB c) 17.12dB d) 16.62dB View Answer

Answer: b Explanation: Signal attenuation is usually expressed in decibels. It is given by Signal attenuation=10 log10Pi / Po Where, Pi & Po = Input and output power.

10. A device that reduces the intensity of light in optical fiber communications is \_\_\_\_\_\_\_\_\_\_\_ a) compressor b) Optical attenuator c) Barometer d) Reducer View Answer

Answer: b Explanation: A compressor compresses the signal before transmission. It does not affect the

intensity of light. Optical attenuator is a device that affects the intensity of light and incurs a loss in transmission.

11. A decibel may be defined as the ratio of input and output optical power for a particular optical wavelength. a) True b) False View Answer

Answer: a Explanation: Signal attenuation refers to the loss in transmission and it needs a logarithmic unit to express. Decibel is mainly used for comparing two power levels. It has the advantage that the operations of multiplication and division reduce to addition and subtraction.

12. When the input and output power in an optical fiber is 120μW & 3μW respectively and the length of the fiber is 8 km. What is the signal attenuation per km for the fiber? a) 3dB/km b) 2dB/km c) 1dB/km d) 4dB/km View Answer

Answer: b Explanation: Signal attenuation per unit length is given by αdBL = 10 log10Pi / Po αdBL = 16 dB αdB = 16 dB/L = 2dB/km.

**2. Questions on Transmission Characteristics Of Optical Fibers**

**The section contains questions on material absorption and fiber bend loss, linear and nonlinear scattering losses, chromatic and intermodal dispersion, fiber dispersion, polarization and nonlinear effects.**

This set of Optical Communications Questions and Answers for Freshers focuses on “Material Absorption & Fiber Bend Losses In Silicon Glass Fibers”.

1. Which of the following statements best explain the concept of material absorption? a) A loss mechanism related to the material composition and fabrication of fiber b) A transmission loss for optical fibers c) Results in attenuation of transmitted light d) Causes of transfer of optical power View Answer

Answer: a Explanation: Material absorption is a loss mechanism that results in dissipation of transmitted

optical power as heat in a waveguide. It can be caused by impurities or interaction with other components of the core.

2. How many mechanisms are there which causes absorption? a) One b) Three c) Two d) Four View Answer

Answer: b Explanation: Absorption is a loss mechanism. It may be intrinsic, extrinsic and also caused by atomic defects.

3. Absorption losses due to atomic defects mainly include \_\_\_\_\_\_\_\_\_\_\_ a) Radiation b) Missing molecules, oxygen defects in glass c) Impurities in fiber material d) Interaction with other components of core View Answer

Answer: b Explanation: Atomic defects are imperfections in the atomic structure of fiber material. Atomic structure includes nucleus, molecules, protons etc. Atomic defects thus contribute towards loss of molecules, oxygen, etc.

4. The effects of intrinsic absorption can be minimized by \_\_\_\_\_\_\_\_\_\_\_ a) Ionization b) Radiation c) Suitable choice of core and cladding components d) Melting View Answer

Answer: c Explanation: Intrinsic absorption is caused by interaction of light with one or more components of the glass i.e. core. Thus, if the compositions of core and cladding are chosen suitably, this effect can be minimized.

5. Which of the following is not a metallic impurity found in glass in extrinsic absorption? a) Fe2+ b) Fe3+ c) Cu d) Si View Answer

Answer: d Explanation: In the optical fibers, prepared by melting techniques, extrinsic absorption can be observed. It is caused from transition metal element impurities. In all these options, Si is a constituent of glass and it cannot be considered as an impurity to glass itself.

6. Optical fibers suffer radiation losses at bends or curves on their paths. a) True b) False View Answer

Answer: a Explanation: Optical fibers suffer radiation losses due to the energy in the bend or curves exceeding the velocity of light in the cladding. Hence, guiding mechanism is inhibited, which in turn causes light energy to be radiated from the fiber.

7. In the given equation, state what αr suggests? a) Radius of curvature b) Refractive index difference c) Radiation attenuation coefficients d) Constant of proportionality View Answer

Answer: c Explanation: Above equation represents the fiber loss. This loss is seen at bends and curves as the fibers suffer radiation losses at curves. These radiation losses are represented by a radiation attenuation coefficient (αr).

8. A multimode fiber has refractive indices n1 = 1.15, n2 = 1.11 and an operating wavelength of 0.7μm. Find the radius of curvature? a) 8.60μm b) 9.30μm c) 9.1μm d) 10.2μm View Answer

Answer: b Explanation: The radius of curvature of the fiber bend of a multimode fiber is given by Where, Rc = radius of curvature n1, n2 = refractive indices λ = wavelength.

9. A single mode fiber has refractive indices n1=1.50, n2 = 2.23, core diameter of 8μm, wavelength = 1.5μm cutoff wavelength = 1.214μm. Find the radius of curvature? a) 12 mm b) 20 mm

c) 34 mm d) 36 mm View Answer

Answer: c Explanation: The radius of curvature of the fiber bend of a single mode fiber is given by- Where R = radius of curvature, n1, n2 = refractive indices, λc = cutoff wavelength, λ = operating wavelength.

10. How the potential macro bending losses can be reduced in case of multimode fiber? a) By designing fibers with large relative refractive index differences b) By maintaining direction of propagation c) By reducing the bend d) By operating at larger wavelengths View Answer

Answer: a Explanation: In the case of multimode fibers, radius of curvature is directly proportional to core refractive index and operating wavelength. In order to reduce the macro bending losses, the operative wavelength must be small and fibers must have large relative refractive index difference. Losses are inversely proportional to refractive index differences.

11. Sharp bends or micro bends causes significant losses in fiber. a) True b) False View Answer

Answer: a Explanation: Sharp bends usually have a radius of curvature almost near to the critical radius. The fibers with the radius near to the critical radius cause significant losses and hence they are avoided.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Linear & Non-Linear Scattering Losses”.

1. Rayleigh scattering and Mie scattering are the types of \_\_\_\_\_\_\_\_\_\_\_\_\_ a) Linear scattering losses b) Non-linear scattering losses c) Fiber bends losses d) Splicing losses View Answer

Answer: a Explanation: Rayleigh scattering and Mie scattering both result from non-ideal physical properties of the fiber. These losses may be impossible to eradicate. Linear scattering mechanisms cause the transfer of optical power contained within one propagating mode to be transferred linearly into a different mode.

2. Dominant intrinsic loss mechanism in low absorption window between ultraviolet and infrared absorption tails is \_\_\_\_\_\_\_\_\_\_\_ a) Mie scattering b) Rayleigh scattering c) Stimulated Raman scattering d) Stimulated Brillouin scattering View Answer

3. Rayleigh scattering can be reduced by operating at smallest possible wavelengths. a) True b) False View Answer

Answer: b Explanation: Rayleigh scattering results from inhomogeneity of a random nature occurring on a small level compared with the wavelength of light. The Rayleigh scattering is inversely proportional to the wavelength. Thus, as wavelength scattering reduces.

4. The scattering resulting from fiber imperfections like core-cladding RI differences, diameter fluctuations, strains, and bubbles is? a) Rayleigh scattering b) Mie scattering c) Stimulated Brillouin scattering d) Stimulated Raman scattering View Answer

Answer: b Explanation: Linear scattering also occurs at inhomogeneity which are comparable in size with the guided wavelength. These results from non-perfect cylindrical structures of the waveguide and hence caused by fiber imperfections.

5. Mie scattering has in-homogeneities mainly in \_\_\_\_\_\_\_\_\_\_\_ a) Forward direction b) Backward direction c) All direction d) Core-cladding interface View Answer

Answer: a Explanation: In Mie scattering, the scattering in-homogeneities size is greater thanλ/10. Also, the

scattered intensity has an angular dependence which is very large. The in-homogeneities are mainly in the direction of guided wavelength i.e. in forward direction.

6. The in-homogeneities in Mie scattering can be reduced by coating of a fiber. a) True b) False View Answer

Answer: a Explanation: Mie scattering is a type of linear scattering loss. It results from fluctuations in diameter, differences in core-cladding refractive index, and differences along the fiber length. Therefore, such in-homogeneities can be reduced by controlled extrusion and coating of the fiber.

7. Raman and Brillouin scattering are usually observed at \_\_\_\_\_\_\_\_\_\_\_ a) Low optical power densities b) Medium optical power densities c) High optical power densities d) Threshold power densities View Answer

Answer: c Explanation: Raman and Brillouin scattering mechanism are non-linear. They provide optical gain but with a shift in frequency, thus contributing to attenuation for light transmission at a particular wavelength. They can be seen at high optical power densities.

8. The phonon is a quantum of an elastic wave in a crystal lattice. a) True b) False View Answer

Answer: a Explanation: A phonon is an elastic arrangement of atoms or molecules in condensed matter. This matter maybe solids or liquids. A phonon is a discrete unit of vibrational mechanical energy given by hf joules; Where h = Planck’s constant f = frequency.

9. A single-mode optical fiber has an attenuation of 0.3dB/km when operating at wavelength of 1.1μm. The fiber core diameter is 4μm and bandwidth is 500 MHz. Find threshold optical power for stimulated Brillouin scattering. a) 11.20 mw b) 12.77 mw c) 13.08 mw d) 12.12 mw View Answer

Answer: b Explanation: The threshold optical power stimulated Brillouin scattering is given by- PB = 4.4\*10-3d2λ2αdBv Where, PB = threshold optical power d = diameter of core λ = wavelength αdB = attenuation.

10. 0.4 dB/km, 1.4μm, 6μm, 550MHz. Find threshold optical power for stimulated Raman scattering. a) 1.98 W b) 1.20 W c) 1.18 W d) 0.96 W View Answer

Answer: c Explanation: The threshold optical power stimulated Raman scattering is given by- PR = 5.9\*10-2d2λαdB Where, PR = optical power for Raman scattering d = diameter of core λ = wavelength αdB = attenuation.

11. Stimulated Brillouin scattering is mainly a \_\_\_\_\_\_\_\_\_\_\_ a) Forward process b) Backward process c) Upward process d) Downward process View Answer

Answer: b Explanation: The incident photon in Stimulated Brillouin scattering reduces a phonon of acoustic frequency as well as scattered photon. This produces an optical frequency shift which varies with the scattering angle. This frequency shift is max. in backward direction reducing to zero in forward direction making Stimulated Brillouin scattering a backward process.

12. High frequency optical phonon is generated in stimulated Raman scattering. a) False b) True View Answer

Answer: b Explanation: An acoustic proton is generated in Stimulated Brillouin scattering. Raman scattering may have an optical power threshold higher than Stimulated Brillouin scattering.

13. Stimulated Raman scattering occur in \_\_\_\_\_\_\_\_\_\_\_ a) Forward direction b) Backward direction c) Upward direction d) Forward and backward direction View Answer

Answer: d Explanation: Stimulated Raman scattering is similar to Stimulated Brillouin scattering except that a high frequency phonon is generated in Stimulated Raman scattering. Stimulated Raman scattering can occur in forward and backward direction as it has optical power threshold higher than Stimulated Brillouin scattering.

14. Stimulated Raman scattering may have an optical power threshold of may be three orders of magnitude \_\_\_\_\_\_\_\_\_\_\_ a) Lower than Brillouin threshold b) Higher than Brillouin threshold c) Same as Brillouin threshold d) Higher than Rayleigh threshold View Answer

Answer: b Explanation: Stimulated Raman scattering involves generation of high- frequency phonon. Stimulated Brillouin scattering on the other hand, involves the generation of an acoustic phonon in a scattering process.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Dispersion – Chromatic Dispersion “.

1. What is dispersion in optical fiber communication? a) Compression of light pulses b) Broadening of transmitted light pulses along the channel c) Overlapping of light pulses on compression d) Absorption of light pulses View Answer

Answer: b Explanation: Dispersion of transmitted optical signal causes distortion of analog as well as digital transmission. When the optical signal travels along the channel, the dispersion mechanism causes broadening of light pulses and thus in turn overlaps with their neighboring pulses.

2. What does ISI stand for in optical fiber communication? a) Invisible size interference b) Infrared size interference c) Inter-symbol interference

d) Inter-shape interference View Answer

Answer: c Explanation: Dispersion causes the light pulses to broaden and overlap with other light pulses. This overlapping creates an interference which is termed as inter-symbol interference.

3. For no overlapping of light pulses down on an optical fiber link, the digital bit rate BT must be \_\_\_\_\_\_\_\_\_\_\_ a) Less than the reciprocal of broadened pulse duration b) More than the reciprocal of broadened pulse duration c) Same as that of than the reciprocal of broadened pulse duration d) Negligible View Answer

Answer: a Explanation: The digital bit rate and pulse duration are always inversely proportional to each other. BT < = 12 Γ Where BT = bit rate 2Γ = duration of pulse.

4. The maximum bit rate that may be obtained on an optical fiber link is 1/3Γ. a) True b) False View Answer

Answer: b Explanation: The digital bit rate is function of signal attenuation on a link and signal to noise ratio. For the restriction of interference, the bit rate should be always equal to or less than 1/2Γ.

5. 3dB optical bandwidth is always \_\_\_\_\_\_\_\_\_\_\_ the 3dB electrical bandwidth. a) Smaller than b) Larger than c) Negligible than d) Equal to View Answer

Answer: b Explanation: Optical bandwidth is half of the maximum data rate. For non-return:0 (NRZ), bandwidth is same as bit rate. The bandwidth B for metallic conductors is defined by electrical 3dB points. Optical communication uses electrical circuitry where signal power has dropped to half its value due to modulated portion of modulated signal.

6. A multimode graded index fiber exhibits a total pulse broadening of 0.15μsover a distance of 16 km. Estimate the maximum possible bandwidth, assuming no intersymbol interference.

a) 4.6 MHz b) 3.9 MHz c) 3.3 MHz d) 4.2 MHz View Answer

Answer: c Explanation: The maximum possible bandwidth is equivalent to the maximum possible bitrate. The maximum bit rate assuming no inter-symbol interference is given by BT = 12 Γ Where BT = bandwidth.

7. What is pulse dispersion per unit length if for a graded index fiber, 0.1μs pulse broadening is seen over a distance of 13 km? a) 6.12ns/km b) 7.69ns/km c) 10.29ns/km d) 8.23ns/km View Answer

Answer: b Explanation: The dispersion mechanism causes broadening of light pulses. The pulse dispersion per unit length is obtained by dividing total dispersion of total length of fiber. Dispersion = 0.1\*10-6/13 = 7.69 ns/km.

8. Chromatic dispersion is also called as intermodal dispersion. a) True b) False View Answer

Answer: b Explanation: Intermodal delay is a result of each mode having a different group velocity at a single frequency. The intermodal delay helps us to know about the information carrying capacity of the fiber.

9. Chromatic dispersion is also called as intermodal dispersion. a) True b) False View Answer

Answer: b Explanation: Intermodal delay, the name only suggests, includes many modes. On the other hand chromatic dispersion is pulse spreading that takes place within a single mode. Chromatic dispersion is also called as intermodal dispersion.

10. The optical source used in a fiber is an injection laser with a relative spectral width σλ/λ of 0.0011 at a wavelength of 0.70μm. Estimate the RMS spectral width. a) 1.2 nm b) 1.3 nm c) 0.77 nm d) 0.98 nm View Answer

Answer: c Explanation: The relative spectral width σλ/λ= 0.01 is given. The rms spectral width can be calculated as follows: σλ/λ = 0.0011 σλ = 0.0011λ = 0.0011\*0.70\*10-6 = 0.77 nm.

11. In waveguide dispersion, refractive index is independent of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ a) Bit rate b) Index difference c) Velocity of medium d) Wavelength View Answer

Answer: d Explanation: In material dispersion, refractive index is a function of optical wavelength. It varies as a function of wavelength. In wavelength dispersion, group delay is expressed in terms of normalized propagation constant instead of wavelength.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Intermodal Dispersion”.

1. Intermodal dispersion occurring in a large amount in multimode step index fiber results in \_\_\_\_\_\_\_\_\_\_\_\_ a) Propagation of the fiber b) Propagating through the fiber c) Pulse broadening at output d) Attenuation of waves View Answer

Answer: c Explanation: Pulse broadening due to intermodal dispersion is caused due to difference in propagation delay between different modes in the multimode fiber. As different modes travel with different group velocities, the pulse width at output depends on transmission time of all modes. This creates difference in overall dispersion which results in pulse broadening.

2. After Total Internal Reflection the Meridional ray \_\_\_\_\_\_\_\_\_\_ a) Makes an angle equal to acceptance angle with the axial ray b) Makes an angle equal to critical angle with the axial ray c) Travels parallel equal to critical angle with the axial ray d) Makes an angle equal to critical angle with the axial ray View Answer

Answer: d Explanation: The Meridional ray travels along the axis of the fiber. When the ray is incident, makes an angle equal to acceptance angle and thus it propagates through the fiber. As the propagating ray gets refracted from the boundary, it makes an angle (i.e. critical angle) with the normal.

3. Consider a single mode fiber having core refractive index n1= 1.5. The fiber length is 12m. Find the time taken by the axial ray to travel along the fiber. a) 1.00μsec b) 0.06μsec c) 0.90μsec d) 0.30μsec View Answer

Answer: b Explanation: The time taken by the axial ray to travel along the fiber gives the minimum delay time Tmin = Ln1/c Where L = length of the fiber n1 = Refractive index of core c = velocity of light in vacuum.

4. A 4 km optical link consists of multimode step index fiber with core refractive index of 1.3 and a relative refractive index difference of 1%. Find the delay difference between the slowest and fastest modes at the fiber output. a) 0.173 μsec b) 0.152 μsec c) 0.96 μsec d) 0.121 μsec View Answer

Answer: a Explanation: The delay difference is given by δTs = Ln1/c Where δTs = delay difference n1 = core refractive index Δ = Relative refractive index difference c = velocity of light in vacuum.

5. A multimode step-index fiber has a core refractive index of 1.5 and relative refractive index difference of 1%. The length of the optical link is 6 km. Estimate the RMS pulse broadening due to intermodal dispersion on the link. a) 92.6 ns b) 86.7 ns c) 69.3 ns d) 68.32 ns View Answer

Answer: b Explanation: The RMS pulse broadening due to intermodal dispersion is obtained by the equation is given below: σs = Ln1Δ/2√3c Where σs = RMS pulse broadening L = length of optical link C = velocity of light in vacuum n1 = core refractive index.

6. The differential attenuation of modes reduces intermodal pulse broadening on a multimode optical link. a) True b) False View Answer

Answer: a Explanation: Intermodal dispersion may be reduced by propagation mechanisms. The differential attenuation of various modes is due to the greater field penetration of the higher order modes into the cladding of waveguide. These slower modes exhibit larger losses at any core-cladding irregularities.

7. The index profile of a core of multimode graded index fiber is given by? a) N (r) = n1 [1 – 2Δ(r2/a)2]1/2; r<a b) N (r) = n1 [3 – 2Δ(r2/a)2]1/2; r<a c) N (r) = n1 [5 – 2Δ(r2/a)2]1/2; r>a d) N (r) = n1 [1 – 2Δ(r2/a)2]1/2; r<a View Answer

Answer: d Explanation: In multimode graded index fibers, many rays can propagate simultaneously. The Meridional rays follow sinusoidal trajectories of different path length which results from index grading.

8. Intermodal dispersion in multimode fibers is minimized with the use of step-index fibers. a) True b) False View Answer

Answer: b Explanation: As multimode graded index fibers show substantial bandwidth improvement over multimode step index fibers. So, inter-modal dispersion in multimode fiber is minimized with the use of multimode graded index fibers.

9. Estimate RMS pulse broadening per km due to intermodal dispersion for multimode step index fiber where length of fiber is 4 km and pulse broadening per km is 80.6 ns. a) 18.23ns/km b) 20.15ns/km c) 26.93ns/km d) 10.23ns/km View Answer

Answer: b Explanation: The RMS pulse broadening per km due to intermodal dispersion for multimode step index fiber is given by (σs(1 km)/L = 80.6/4 = 20.15 Where L = length of fiber σs = pulse broadening.

10. Practical pulse broadening value for graded index fiber lies in the range of \_\_\_\_\_\_\_\_\_\_ a) 0.9 to 1.2 ns/km b) 0.2 to 1 ns/km c) 0.23 to 5 ns/km d) 0.45 to 8 ns/km View Answer

Answer: b Explanation: As all optical fiber sources have a finite spectral width, the profile shape must be altered to compensate for this dispersion mechanism. The minimum overall dispersion for graded index fiber is also limited by other intermodal dispersion mechanism. Thus pulse broadening values lie within range of 0.2 to 1 ns/km.

11. The modal noise occurs when uncorrected source frequency is? a) δf>>1/δT b) δf=1/δT c) δf<<1/δT d) Negligible View Answer

Answer: a Explanation: Modal noise is dependent on change in frequency. Frequency is inversely proportional to time. The patterns are formed by interference of modes from a coherent source when coherence time of source is greater than intermodal dispersion time δT within fiber.

12. Disturbance along the fiber such as vibrations, discontinuities, connectors, splices, source/detectors coupling result in \_\_\_\_\_\_\_\_\_\_ a) Modal noise b) Inter-symbol interference c) Infrared interference d) Pulse broadening View Answer

Answer: a Explanation: Disturbance along the fiber cause fluctuations in specific pattern. These speckle patterns have characteristics time longer than resolution time of detector and is known as modal noise.

13. The modal noise can be reduced by \_\_\_\_\_\_\_\_\_\_ a) Decreasing width of signal longitudinal mode b) Increasing coherence time c) Decreasing number of longitudinal modes d) Using fiber with large numerical aperture View Answer

Answer: d Explanation: Disturbances along fiber cause fluctuations in speckle patterns. Fibers with large numerical apertures support the transmission of large number of modes giving greater number of speckle, thereby reducing modal noise.

14. Digital transmission is more likely to be affected by modal noise. a) True b) False View Answer

Answer: b Explanation: Analog transmission is more affected by modal noise due to higher optical power levels which is required at receiver when quantum noise effects are considered. So it is important to look into design considerations.

This set of Optical Communications Interview Questions and Answers for freshers focuses on “Overall Fiber Dispersion & Modified Single Mode Fibers”.

1. A multimode step index fiber has source of RMS spectral width of 60nm and dispersion parameter for fiber is 150psnm-1km-1. Estimate rms pulse broadening due to material dispersion. a) 12.5ns km-1 b) 9.6ns km-1 c) 9.0ns km-1 d) 10.2ns km-1 View Answer

Answer: c Explanation: The RMS pulse broadening per km due to material dispersion is given by σm(1 km) = σλLM = 60\*1\* 150pskm-1 = 9.0nskm-1 Where σλ = rms spectral width L = length of fiber M = dispersion parameter.

2. A multimode fiber has RMS pulse broadening per km of 12ns/km and 28ns/km due to material dispersion and intermodal dispersion resp. Find the total RMS pulse broadening. a) 30.46ns/km b) 31.23ns/km c) 28.12ns/km d) 26.10ns/km View Answer

Answer: a Explanation: The overall dispersion in multimode fibers comprises both chromatic and intermodal terms. The total RMS pulse broadening σT is given by Where σm = RMS pulse broadening due to material dispersion σi = RMS pulse broadening due to intermodal dispersion.

3. Γg = dβ / C\*dk. What is β in the given equation? a) Attenuation constant b) Propagation constant c) Boltzmann’s constant d) Free-space View Answer

Answer: b Explanation: Above given equation is an equation of transit time or a group delay(Γg) for a light pulse. This light pulse is propagating along a unit length of a single mode fiber.

4. Most of the power in an optical fiber is transmitted in fiber cladding. a) True b) False View Answer

Answer: b Explanation: Most of the power in optical fiber is transmitted in fiber core. This is because in multimode fibers, majority of modes propagating in the core area are far from cutoff. Hence more power is transmitted.

5. A single mode fiber has a zero dispersion wavelength of 1.21μm and a dispersion slope of 0.08 psnm-2km-1. What is the total first order dispersion at wavelength 1.26μm. a) -2.8psnm-1 km-1 b) -3.76psnm-1 km-1 c) -1.2psnm-1 km-1 d) 2.4psnm-1 km-1 View Answer

Answer: b Explanation: The total first order dispersion for fiber at two wavelength is obtained by DT(1260 nm) = λS0/4 [1-(λ0/λ)4] = (1260\*0.08\*10-12)/4 \* (1-[1550/1260]4) = -3.76psnm-1km-1 Where λ0 = zero dispersion wavelength λ = wavelength S0 = dispersion slope DT = total first order dispersion.

6. The dispersion due to material, waveguide and profile are -2.8nm-1km-1, 20.1nm-1km-1 and 23.2nm-1km-1respectively. Find the total first order dispersion? a) 36.2psnm-1 km-1 b) 38.12psnm-1 km-1 c) 40.5psnm-1 km-1 d) 20.9psnm-1 km-1 View Answer

Answer: c Explanation: The total dispersion is given by DT = DM + DW + DP(psnm-1km-1) Where DW = waveguide dispersion DM = Material dispersion DP = profile dispersion.

7. Dispersion-shifted single mode fibers are created by \_\_\_\_\_\_\_\_\_\_ a) Increasing fiber core diameter and decreasing fractional index difference b) Decreasing fiber core diameter and decreasing fractional index difference c) Decreasing fiber core diameter and increasing fractional index difference d) Increasing fiber core diameter and increasing fractional index difference View Answer

Answer: c Explanation: It is possible to modify the dispersion characteristics of single mode fibers by tailoring of some fiber parameters. These fiber parameters include core diameter and relative index difference.

8. An alternative modification of the dispersion characteristics of single mode fibers involves achievement of low dispersion gap over the low-loss wavelength region between \_\_\_\_\_\_\_\_\_\_ a) 0.2 and 0.9μm b) 0.1 and 0.2μm c) 1.3 and 1.6μm d) 2 and 3μm View Answer

Answer: c Explanation: Dispersion characteristics can be altered by changing fiber parameters and wavelength. The achievement of low dispersion gap over the region 1.3 and 1.6μm modifies the dispersion characteristics of single mode fibers.

9. The fibers which relax the spectral requirements for optical sources and allow flexible wavelength division multiplying are known as \_\_\_\_\_\_\_\_\_\_ a) Dispersion-flattened single mode fiber b) Dispersion-enhanced single mode fiber c) Dispersion-compressed single mode fiber d) Dispersion-standardized single mode fiber View Answer

Answer: a Explanation: The dispersion-flattened single mode fibers (DFFS) are obtained by fabricating multilayer index profiles with increased waveguide dispersion. This is tailored to provide overall dispersion say 2psnm-1km-1 over the wavelength range 1.3 to 1.6μm.

10. For suitable power confinement of fundamental mode, the normalized frequency v should be maintained in the range 1.5 to 2.4μm and the fractional index difference must be linearly increased as a square function while the core diameter is linearly reduced to keep v constant. This confinement is achieved by? a) Increasing level of silica doping in fiber core b) Increasing level of germanium doping in fiber core c) Decreasing level of silica germanium in fiber core d) Decreasing level of silica doping in fiber core View Answer

Answer: b Explanation: The tailoring of fiber parameters provides suitable power confinement. These parameters may be diameter, index-difference, frequency etc. The doping level of germanium contributes to the tailoring of fiber parameters; which in turn provides suitable power confinement.

11. Any amount of stress occurring at the core-cladding interface would be reduced by grading the material composition. a) True

b) False View Answer

Answer: a Explanation: A problem arises with that of simple step index approach to dispersion shifting is high. The fibers produced exhibit high dopant-dependent losses at operating wavelengths. These losses are caused by induced-stress in the region of core-cladding interface. This can be reduced by grading the material composition of the fiber.

12. The variant of non-zero-dispersion-shifted fiber is called as \_\_\_\_\_\_\_\_\_\_ a) Dispersion flattened fiber b) Zero-dispersion fiber c) Positive-dispersion fiber d) Negative-dispersion fiber View Answer

Answer: d Explanation: The dispersion profile for non-zero dispersion shifted fiber is referred to as bandwidth non-zero-dispersion-shifted fiber. It was introduced to provide wavelength division multiplexed applications to be extended into the s-band. The variant of non-zero-dispersion-shifted fiber can also be referred to as dispersion compensating fiber.

13. Non-zero-dispersion-shifted fiber was introduced in the year 2000. a) True b) False View Answer

Answer: b Explanation: Non-zero-dispersion-shifted fiber was introduced in mid-1990s to provide wavelength division multiplexing applications. In the year 2000, the dispersion profile for non-zero-dispersion-shifted fiber was introduced.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Polarization”.

1. For many applications that involve optical fiber transmission, an intensity modulation optical source is not required. a) True b) False View Answer

Answer: b Explanation: In many optical fibers transmission, the cylindrical fibers used generally do not maintain polarization state of light input source not more than a few meters. So for this reason, optical sources intensity modulation is required.

2. The optical source used for detection of optical signal is \_\_\_\_\_\_\_\_\_\_\_\_ a) IR sensors b) Photodiodes c) Zener diodes d) Transistors View Answer

Answer: b Explanation: Optical signal is generally detected by photodiodes because photodiode is generally insensitive to optical polarization or phase of light with the fiber.

3. An optical fiber behaves as a birefringence medium due to differences in \_\_\_\_\_\_\_\_\_\_\_ a) Effective R-I and core geometry b) Core-cladding symmetry c) Transmission/propagation time of waves d) Refractive indices of glass and silica View Answer

Answer: a Explanation: In an optical fiber with ideal optically circulatory symmetric core, both polarization modes propagate with same velocities. These fibers have variations in internal and external stress; fiber bending and so exhibit some birefringence.

4. The beat length in a single mode optical fiber is 8 cm when light from a laser with a peak wavelength 0.6μm is launched into it. Estimate the modal birefringence. a) 1×10-5 b) 3.5×10-5 c) 2×10-5 d) 4×10-5 View Answer

Answer: a Explanation: Modal birefringence can be obtained by- BF = λ/LB = 0.8×10-6/0.08 = 1×10-5 Where λ = peak wavelength LB = beat length.

5. Beat length of a single mode optical fiber is 0.6cm. Calculate the difference between propagation constants for the orthogonal modes. a) 69.8 b) 99.86 c) 73.2 d) 104.66 View Answer

Answer: d Explanation: The difference between the propagation constant for two orthogonal modes can be obtained by: βx – βy = 2Π/LB = 2×3.14/0.06 = 104.66 Where βx & βy are propagation constants for slow & fast modes resp. LB = beat length.

6. A polarization maintaining fiber operates at a wavelength 1.2μm and have a modal birefringence of 1.8\*10-3. Calculate the period of perturbation. a) 0.7 seconds b) 0.6 seconds c) 0.23 seconds d) 0.5 seconds View Answer

Answer: b Explanation: The period of perturbation is given by- T = λ/BF Where λ is operating wavelength, BF = Birefringence, T = period of perturbation.

7. When two components are equally excited at the fiber input, then for polarization maintaining fibers δΓg should be around \_\_\_\_\_\_\_\_\_\_\_ a) 1.5ns/km b) 1 ns/km c) 1.2ns/km d) 2ns/km View Answer

Answer: b Explanation: The differential group delay δΓg is related to polarization mode dispersion (PMD) of fiber. This linear relationship to fiber length however applies only to short fiber-lengths in which birefringence are uniform.

8. Polarization modal noise can \_\_\_\_\_\_\_\_\_ the performance of communication system. a) Degrade b) Improve c) Reduce d) Attenuate View Answer

Answer: a Explanation: Polarization modal noise is generally of larger amplitude than modal noise. It is obtained within multimode fibers and so it degrades the performance of the communication system and prevents transmission of analog signals.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Non-Linear Effects”.

1. The nonlinear effects in optical fibers are large. a) True b) False View Answer

Answer: b Explanation: The nonlinear effect arises from the interactions between light waves and the material transmitting them and thus affects the optical signals. The nonlinear effects are usually small in optical fibers. They have power levels of up to few milliWatts.

2. How many categories of nonlinear effects are seen in optical fibers? a) One b) Two c) Three d) Four View Answer

Answer: b Explanation: The nonlinear effects are separated on the basis of their characteristics. There are two such categories; one is scattering effect and the other is Kerr effect.

3. Which of the following is not related to Kerr effects? a) Self-phase modulation b) Cross-phase modulation c) Four-wave mixing d) Stimulated Raman Scattering View Answer

Answer: d Explanation: Stimulated Raman Scattering is related to scattering. The other effects include modulation and mixing which are parts of Kerr effect.

4. Linear scattering effects are \_\_\_\_\_\_\_ in nature. a) Elastic b) Non-Elastic c) Mechanical d) Electrical View Answer

Answer: a Explanation: Linear scattering effects are elastic because the scattered wave frequency is equal to incident wave frequency. Nonlinear scattering effects are purely inelastic.

5. Which thing is more dominant in making a fiber function as a bidirectional optical amplifier? a) Core material b) Pump source c) Cladding material d) Diameter of fiber View Answer

Answer: b Explanation: Brillouin gain is always greater than Raman gain. It exists for light propagation in opposite direction to the pump source. Also Brillouin frequency shifts and gain bandwidth are much smaller than Raman. Raman amplification occurs for light propagating in either direction. Thus, pump source is more important in making a fiber function as bidirectional optical amplifier.

6. \_\_\_\_\_\_\_\_\_ semiconductor laser sources generally have broader bandwidths. a) Injection b) Pulsed c) Solid-state d) Silicon hybrid View Answer

Answer: b Explanation: Pulsed semiconductor lasers have broader bandwidths. Therefore, these sources prove to be inefficient pump sources. They prove inefficient especially for narrow gain spectrum.

7. Nonlinear effects which are defined by the intensity – dependent refractive index of the fiber are called as \_\_\_\_\_\_\_\_ a) Scattering effects b) Kerr effects c) Raman effects d) Tomlinson effects View Answer

Answer: b Explanation: Kerr effects are nonlinear effects. Nonlinear effects are divided into scattering and Kerr effects. Scattering effects include scattering of phonon whereas Kerr effects include intensity refractive index parameters.

8. Self-phase modulation causes modifications to the pulse spectrum. a) True b) False View Answer

Answer: a Explanation: Kerr effect results in different transmission phase for the peak of the pulse

compared with leading and trailing edges. Self-phase modulation can broaden the frequency spectrum of the pulse as the time varying phase creates a time varying frequency.

9. Self-phase modulation can be used for \_\_\_\_\_\_\_\_\_\_\_\_\_ a) Enhancing the core diameter b) Wavelength shifting c) Decreasing the attenuation d) Reducing the losses in the fiber View Answer

Answer: b Explanation: Self phase modulation is related to phase change. It imposes a positive frequency sweep on the pulse which in turn enables wavelength or frequency shifting.

10. The beating between light at different frequencies or wavelengths in multichannel fiber transmission causes \_\_\_\_\_\_\_\_ a) Attenuation b) Amplitude modulation of channels c) Phase modulation of channels d) Loss in transmission View Answer

Answer: c Explanation: Phase modulation is related to frequency and wavelength shifting. In multichannel fiber transmission, phase modulation causes generation of modulation sidebands at new frequencies. This phenomenon is called as four-wave mixing.

11. What is different in case of cross-phase modulation from self-phase modulation? a) Overlapping but same pulses b) Overlapping but distinguishable pulses c) Non-overlapping and same pulses d) Non-overlapping but distinguishable pulses View Answer

Answer: b Explanation: In cross phase modulation, variation in intensity of one pulse width modulates the refractive index of the fiber which causes phase modulation of the overlapping phases. In self-phase modulation, this phase modulation broadens the pulse spectrum.

12. When three wave components co-propagate at angular frequency w1, w2, w3, then a new wave is generated at frequency w4, which is given by? a) w4 = w1 – w2 – w3 b) w4 = w1 + w2 + w3 c) w4 = w1 + w2 – w3 d) w4 = w1 – w2 + w3 View Answer

Answer: c Explanation: This type of frequency mixing is called as four-wave mixing. This frequency combination is problematic for multichannel optical communication as they become phase matched if the channel wavelengths are near to zero dispersion wavelengths.

13. \_\_\_\_\_\_\_\_\_\_\_\_\_ results from a case of nonlinear dispersion compensation in which the nonlinear dispersion compensation in which the nonlinear chirp caused by self-phase modulation balances, postpones, the temporal broadening induced by group velocity delay. a) Four wave mixing b) Phase modulation c) Soliton propagation d) Raman scattering View Answer

Answer: c Explanation: Soliton propagation is a nonlinear dispersion phenomenon. It limits the propagation distance that can be achieved when acting independently. It balances broadening of light pulse.

**3. Questions & Answers on Optical Fibers And Cables**

The section contains questions and answers on vapour and liquid phase techniques, optical fibers and its cables, fiber transmission characteristics and cable design.

This set of Optical Communications Questions and Answers for Experienced people focuses on “Preparation of Optical Fibers – Liquid Phase Techniques”.

1. What is a fundamental necessity in the fabrication of fibers for light transmission? a) Same refractive index for both core and cladding b) Pump source c) Material composition of fiber d) Variation of refractive index inside the optical fiber View Answer

Answer: d Explanation: For fabrication of fibers, two different transparent materials to light over a wavelength range of 0.8 to 1.7μm are required. Fiber should exhibit low attenuation, absorption and scattering losses. The variation of refractive indices in a fiber is a necessity for fiber fabrication.

2. Which materials are unsuitable for the fabrication of graded index fiber? a) Glass-like-materials b) Mono-crystalline structures

c) Amorphous material d) Silica based material View Answer

Answer: b Explanation: In case of graded index fiber, it is essential that the refractive index of the material is varied by suitable doping with another compatible material. These two materials should have mutual solubility over a wide range of concentration. This is achieved only in glass-like-materials.

3. How many different categories are available for the methods of preparing optical glasses? a) 1 b) 2 c) 3 d) 4 View Answer

Answer: b Explanation: The methods of preparing optical glasses are divided into two categories. One is the conventional glass refining technique and other is vapor-phase-deposition method.

4. What is the first stage in liquid-phase-technique? a) Preparation of ultra-pure material powders b) Melting of materials c) Decomposition d) Crystallization View Answer

Answer: a Explanation: In liquid-phase-technique melting, the first stage includes the preparation of ultra-pure material powders. These are usually oxides or carbonates which decomposes during glass melting.

5. Which processes are involved in the purification stage in liquid-phase-technique? a) Filtration, Co-precipitation, Re-crystallization b) Decomposition, Filtration, Drying c) Doping, Drying, Decomposition d) Filtration, Drying, Doping View Answer

Answer: a Explanation: The compounds such as oxides and carbonates are formed during the glass melting. The purification accounts for a large proportion of material cost. These compounds are commercially available. The purification involves filtration, co-precipitation, re-crystallization and drying.

6. At what temperature range, does the melting of multi components glass systems takes place? a) 100-300 degree Celsius b) 600-800 degree Celsius c) 900-1300 degree Celsius d) 1500-1800 degree Celsius View Answer

Answer: c Explanation: The glass materials in the powdered form and have relatively low melting point. Thus, the glass materials are melted at relatively low temperatures in the range of 900-1300 degrees Celsius.

7. Fiber drawing using preform was useful for the production of graded index fibers. a) True b) False View Answer

Answer: b Explanation: A technique for producing fine optical fiber waveguides is to make a preform using the rod in the tube process. This technique was useful for the production of step-index fibers with large core diameters. In this technique, achievement of low attenuation is not critical as there is a danger of including bubbles at the core-cladding interface.

8. The minute perturbations and impurities in the fiber drawing process using preform technique can result in very high losses of \_\_\_\_\_\_\_\_\_\_\_\_\_ a) Between 500 and 1000 dB/km b) Between 100 and 300 dB/km c) Between 1200 and 1600 dB/km d) More than 2000 dB/km View Answer

Answer: a Explanation: The minute perturbations and impurities in the fiber include formations of bubbles and involvement of particulate matter. The losses due to such impurities can be between 500 and 1000 dB/km.

9. The liquid-phase melting technique is used for the production of fibers \_\_\_\_\_\_\_\_\_\_\_ a) With a core diameter of 50μm b) With a core diameter less than 100μm c) With a core diameter more than 200μm d) With a core diameter of 100μm View Answer

Answer: c Explanation: The multicomponent glass fibers prepared continuously by liquid-phase melting technique have losses in the range of 5 and 20 dB/km at a wavelength of 0.85μm. This method is

thus used for preparation of fibers with a large core diameter. Also this technique is used for the continuous production of fibers.

10. Graded index fibers produced by liquid-phase melting techniques are less dispersive than step-index fibers. a) True b) False View Answer

Answer: a Explanation: Liquid-phase melting technique does not offer optimum parabolic profile fibers. This parabolic profile yields minimum pulse dispersion. Graded index fibers prepared using liquid-phase melting techniques are less dispersive but do not have the bandwidth-length products of optimum profile fibers.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Vapor – Phase Deposition Techniques”.

1. Which of the following is not a technique for fabrication of glass fibers? a) Vapor phase oxidation method b) Direct melt method c) Lave ring method d) Chemical vapor deposition technique View Answer

Answer: c Explanation: Lave ring method refers to the deposition of a crystalline layer on a substrate. All the other methods, except lave ring method, refer to optical fiber fabrication.

2. \_\_\_\_\_\_\_\_\_\_\_\_\_ technique is method of preparing extremely pure optical glasses. a) Liquid phase (melting) b) Radio frequency induction c) Optical attenuation d) Vapor Phase Deposition (VPD) View Answer

Answer: d Explanation: Vapor Phase Deposition techniques are used to prepare silica-rich glasses. These glasses exhibit highest transparency and optimal optical properties.

3. Which of the following materials is not used as a starting material in vapor-phase deposition technique? a) SiCl4 b) GeCl4 c) O2

d) B2O3 View Answer

Answer: d Explanation: In vapor-phase deposition technique, starting materials are volatile organic compounds. These materials are distilled to reduce the concentration of transition metal impurities. B2O3 is used as a dopant.

4. P2O5 is used as a \_\_\_\_\_\_\_\_\_\_\_\_\_ a) Dopant b) Starting material c) Cladding glass d) Core glass View Answer

Answer: a Explanation: P2O5 is a non silica material. Dopants are formed from non silica materials so that refractive index modification is achieved. Other dopants include Ti O2, Ge O2, etc.

5. How many types of vapor-phase deposition techniques are present? a) One b) Two c) Three d) Four View Answer

Answer: b Explanation: Vapor-phase deposition techniques are divided into two types. The two types are flame hydrolysis and chemical vapor deposition (CVD). Further, these two types are subdivided into two more sections.

6. \_\_\_\_\_\_\_\_\_\_\_ uses flame hydrolysis stems from work on soot processes which were used to prepare the fiber with losses below 20 dB/km. a) Outside vapor phase oxidation b) Chemical vapor deposition c) Liquid phase melting d) Crystallization View Answer

Answer: a Explanation: Outside vapor phase oxidation is a type of vapor flame hydrolysis. It was originally developed by Hyde. In this process, the glass composition is deposited from a ‘soot’ generated by hydrolyzing the halide vapors in an oxygen-hydrogen flame.

7. Complete the given reaction.

SiCl4 + 2H2O → SiO2 + \_\_\_\_\_\_

a) 2HCl b) 4HCl c) 2Cl2 d) 4Cl2 View Answer

Answer: b Explanation: SiCl4 is a starting material used in vapour-phase deposition technique. Dopants are added to the starting material in presence of heat to give glass compound. In the above reaction SiO2 (solid compound) along with 4HCl(gas) is obtained.

8. In modified chemical vapor deposition, vapor phase reactant such as \_\_\_\_\_\_\_\_\_ pass through a hot zone. a) Halide and oxygen b) Halide and hydrogen c) Halide and silica d) Hydroxides and oxygen View Answer

Answer: a Explanation: Halide and oxygen are passed through the hot zone during chemical vapor deposition. Glass particles formed during this travel are deposited on the walls of silica tube which are moved back and forth allowing the particles to deposit layer by layer.

9. \_\_\_\_\_\_\_\_\_ is the stimulation of oxide formation by means of non-isothermal plasma maintained at low pressure in a microwave cavity surrounding the tube. a) Outside Vapor Phase Oxidation (OVPO) b) Vapor Axial Deposition (VAD) c) Modified Chemical Vapor Deposition (MCVD) d) Plasma-activated Chemical Vapor Deposition (PCVD) View Answer

Answer: d Explanation: PCVD method was first developed by Cuppers and Koenig’s. It involves a plasma-induced chemical vapor deposition inside a silica tube. It is different from MCVD process as it involves stimulation of oxide formation by means of non-isothermal plasma.

10. Only graded index fibers are made with the help of vapor-phase deposition techniques. a) True b) False View Answer

Answer: b Explanation: Vapor phase deposition techniques are used for preparation of both step-index and graded index fibers. These techniques provide fibers with low attenuation losses. Also, it gives similar performance for the fabrication of both single mode and multimode fibers.

11. Modified Chemical Vapor Deposition (MCVD) process is also called as an inside vapor phase oxidation (IVPD) technique. a) True b) False View Answer

Answer: a Explanation: MCVD process was developed by Bell Telephone Laboratories and Southampton University, UK. It is called as inside vapor phase oxidation (IVPO) as it takes place inside the silica tube at the temperatures between 1400 and 1600 degrees Celsius.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Optical Fibers”.

1. Multimode step index fiber has \_\_\_\_\_\_\_\_\_\_\_ a) Large core diameter & large numerical aperture b) Large core diameter and small numerical aperture c) Small core diameter and large numerical aperture d) Small core diameter & small numerical aperture View Answer

Answer: a Explanation: Multimode step-index fiber has large core diameter and large numerical aperture. These parameters provides efficient coupling to inherent light sources such as LED’s.

2. A typically structured glass multimode step index fiber shows as variation of attenuation in range of \_\_\_\_\_\_\_\_\_\_\_ a) 1.2 to 90 dB km-1 at wavelength 0.69μm b) 3.2 to 30 dB km-1 at wavelength 0.59μm c) 2.6 to 50 dB km-1 at wavelength 0.85μm d) 1.6 to 60 dB km-1 at wavelength 0.90μm View Answer

Answer: c Explanation: A multimode step index fibers show an attenuation variation in range of 2.6 to 50dBkm-1. The wide variation in attenuation is due to the large differences both within and between the two overall preparation methods i.e. melting and deposition.

3. Multimode step index fiber has a large core diameter of range is \_\_\_\_\_\_\_\_\_\_\_ a) 100 to 300 μm b) 100 to 300 nm c) 200 to 500 μm d) 200 to 500 nm View Answer

Answer: a Explanation: A multimode step index fiber has a core diameter range of 100 to 300μm. This is to facilitate efficient coupling to inherent light sources.

4. Multimode step index fibers have a bandwidth of \_\_\_\_\_\_\_\_\_\_\_ a) 2 to 30 MHz km b) 6 to 50 MHz km c) 10 to 40 MHz km d) 8 to 40 MHz km View Answer

5. Multimode graded index fibers are manufactured from materials with \_\_\_\_\_\_\_\_\_\_\_ a) Lower purity b) Higher purity than multimode step index fibers. c) No impurity d) Impurity as same as multimode step index fibers. View Answer

Answer: b Explanation: Multimode graded index fibers have higher purity than multimode step index fiber. To reduce fiber losses, these fibers have more impurity.

6. The performance characteristics of multimode graded index fibers are \_\_\_\_\_\_\_\_\_\_\_ a) Better than multimode step index fibers b) Same as multimode step index fibers c) Lesser than multimode step index fibers d) Negligible View Answer

Answer: a Explanation: Multimode graded index fibers use a constant grading factor. Performance characteristics of multimode graded index fibers are better than those of multimode step index fibers due to index graded and lower attenuation.

7. Multimode graded index fibers have overall buffer jackets same as multimode step index fibers but have core diameters \_\_\_\_\_\_\_\_\_\_\_ a) Larger than multimode step index fibers b) Smaller than multimode step index fibers c) Same as that of multimode step index fibers d) Smaller than single mode step index fibers View Answer

8. Multimode graded index fibers with wavelength of 0.85μm have numerical aperture of 0.29 have core/cladding diameter of \_\_\_\_\_\_\_\_\_\_\_ a) 62.5 μm/125 μm b) 100 μm/140 μm

c) 85 μm/125 μm d) 50 μm/125μm View Answer

Answer: b Explanation: Multimode graded index fibers with numerical aperture 0.29 having a core/cladding diameter of 100μm/140μm. They provide high coupling frequency LED’s at a wavelength of 0.85 μm and have low cost. They are also used for short distance application.

9. Multimode graded index fibers use incoherent source only. a) True b) False View Answer

Answer: b Explanation: Multimode graded index fibers are used for short haul and medium to high bandwidth applications. Small haul applications require LEDs and low accuracy lasers. Thus either incoherent or incoherent sources like LED’s or injection laser diode are used.

10. In single mode fibers, which is the most beneficial index profile? a) Step index b) Graded index c) Step and graded index d) Coaxial cable View Answer

Answer: b Explanation: In single mode fibers, graded index profile is more beneficial as compared to step index. This is because graded index profile provides dispersion-modified-single mode fibers.

11. The fibers mostly not used nowadays for optical fiber communication system are \_\_\_\_\_\_\_\_\_\_\_ a) Single mode fibers b) Multimode step fibers c) Coaxial cables d) Multimode graded index fibers View Answer

Answer: a Explanation: Single mode fibers are used to produce polarization maintaining fibers which make them expensive. Also the alternative to them are multimode fibers which are complex but accurate. So, single-mode fibers are not generally utilized in optical fiber communication.

12. Single mode fibers allow single mode propagation; the cladding diameter must be at least \_\_\_\_\_\_\_\_\_\_\_ a) Twice the core diameter

b) Thrice the core diameter c) Five times the core diameter d) Ten times the core diameter View Answer

Answer: d Explanation: The cladding diameter in single mode fiber must be ten times the core diameter. Larger ratios contribute to accurate propagation of light. These dimension ratios must be there so as to avoid losses from the vanishing fields.

13. A fiber which is referred as non-dispersive shifted fiber is? a) Coaxial cables b) Standard single mode fibers c) Standard multimode fibers d) Non zero dispersion shifted fibers View Answer

Answer: b Explanation: A standard single mode fiber having step index profile is known as non-dispersion shifted fiber. As these fibers have a zero dispersion wavelength of 1.31μm and so are preferred for single-wavelength transmission in O-band.

14. Standard single mode fibers (SSMF) are utilized mainly for operation in \_\_\_\_\_\_\_\_\_\_\_ a) C-band b) L-band c) O-band d) C-band and L-band View Answer

Answer: c Explanation: SSMFs are utilized for operation in O-band only. It shows high dispersion in the range of 16 to 20ps/nm/km in C-band and L-band. So SSMFs are used in O-band.

15. Fiber mostly suited in single-wavelength transmission in O-band is? a) Low-water-peak non dispersion-shifted fibers b) Standard single mode fibers c) Low minimized fibers d) Non-zero-dispersion-shifted fibers View Answer

Answer: b Explanation: Standard single mode fibers with a step index profile are called non dispersion shifted fiber and it is particularly used for single wavelength transmission in O-band and as if has a zero-dispersion wavelength at 1.31μm.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on ” Optical Fiber Cables”.

1. When optical fibers are to be installed in a working environment, the most important parameter to be considered is? a) Transmission property of the fiber b) Mechanical property of the fiber c) Core cladding ratio of the fiber d) Numerical aperture of the fiber View Answer

Answer: b Explanation: Nowadays, optical fibers are used alternatively to electric transmission lines. They are installed safely and maintained in all environments including underground areas. This requires mechanical strengthening of fibers in order to ensure proper transmission.

2. It is not important to cover these optical fibers required for transmission. a) True b) False View Answer

Answer: b Explanation: Unprotected optical fibers have number of losses regarding its strength and durability. Bare glass fibers are brittle and have small cross-section area that makes them highly susceptible to damages while handling and maintenance. Thus, to improve tensile strength, optical fibers should be covered by surrounding them with number of protective layers.

3. Optical fibers for communication use are mostly fabricated from \_\_\_\_\_\_\_\_\_\_\_ a) Plastic b) Silica or multicomponent glass c) Ceramics d) Copper View Answer

Answer: b Explanation: Silica or a compound of glass are brittle and have almost perfect elasticity until reaching their breaking point. Strength of these materials is high. Thus, optical fibers are fabricated from these materials.

4. An Si-O bond with a Young’s modulus of 9\*1010Nm-1 have an elliptical crack of depth 7nm. The surface energy is 2.29 J. Estimate fracture stress for silica fiber. a) 4.32\*109Nm-1 b) 6.32\*109Nm-1 c) 5.2\*109Nm-1 d) 3\*109Nm-1 View Answer

Answer: a Explanation: For an elliptical crack, the fracture stress is given by- Sf = (2Eγp/πC)1/2 Where Sf = fracture stress γp = surface energy C = depth of crack.

5. Calculate percentage strain at break for a Si-O bond with a fracture strength of 3.52\*1010Nm-1 and Young’s modulus of 9 \*109Nm-1. a) 3.1 % b) 2.8 % c) 4.5 % d) 3.9 % View Answer

Answer: d Explanation: Young’s modulus is given by- E = Stress/Strain To calculate strain from the above formula, we have to divide stress by Young’s modulus. Therefore, Strain = Stress/E.

6. Stress corrosion must be considered while designing and testing optical fiber cables. a) True b) False View Answer

Answer: a Explanation: Stress corrosion means growth of flaws due to stress and water. This occurs as a result of molecular bonds at the tip of crack being attacked by water. Hence, it is important to have a protection against water to avoid stress corrosion.

7. Which statistics are used for calculations of strengths of optical fibers? a) Edwin statistics b) Newton statistics c) Wei-bull statistics d) Gamma statistics View Answer

Answer: c Explanation: Calculations of strengths are conducted using Wei-bull statistics in case of optical fibers. It describes the strength behavior of a system that is dependent on the weakest link of the system. The Wei-bull statistics gives the probability of failure of the optical fiber at a given strength.

8. What does n denotes in the equation given below, if vc is the crack velocity; A is the constant for the fiber material and KI is the strength intensity factor?

vc = AKIn

a) Refractive index b) Stress corrosion susceptibility c) Strain d) Young’s modulus View Answer

Answer: b Explanation: The above equation allows estimation of the time to failure of a fiber under stress corrosion conditions. The constant n is called as stress corrosion susceptibility. It is typically in the range of 15 to 50 for a glass.

This set of Optical Communications Interview Questions and Answers for Experienced people focuses on “Stability of the Fiber Transmission Characteristics”.

1. \_\_\_\_\_\_\_\_\_\_\_\_ results from small lateral forces exerted on the fiber during the cabling process. a) Attenuation b) Micro-bending c) Dispersion d) Stimulated Emission View Answer

Answer: b Explanation: Optical fibers must be designed so that the transmission characteristics of the fiber are maintained after the cabling process. The main problem which occurs in the cabling process is the meandering of the axis of the fiber core on a microscopic scale within the cable form. This phenomenon is called as micro-bending.

2. Microscopic meandering of the fiber core axis that is micro-bending is caused due to \_\_\_\_\_\_\_\_\_\_\_ a) Environmental effects b) Rough edges of the fiber c) Large diameter of core d) Polarization View Answer

Answer: a Explanation: Micro-bending can be generated at any stage during manufacturing process, cable installation process or during service. This is mainly due to environmental effects, mainly varying temperatures causing differential expansion or contraction.

3. How many forms of modal power distribution are considered? a) One b) Two c) Three

d) Four View Answer

Answer: b Explanation: Two forms of modal power distribution are considered. The first form is seen when a fiber is excited by a diffuse Lambertian source, and is called as fully filled mode distribution. The second form occurs when, due to mode coupling and attenuation, the distribution of optical power becomes invariant with the distance of propagation along the fiber, and is called as steady-state mode distribution.

4. What does micro-bending losses depend on \_\_\_\_\_\_\_\_\_\_\_\_\_ a) Core material b) Refractive index c) Diameter d) Mode and wavelength View Answer

Answer: d Explanation: Micro-bending losses cause differential expansion or contraction. These losses are mode dependent. The number of modes is a function inverse to the wavelength of the transmitted light and thus micro-bending losses are wavelength dependent.

5. The fiber should be\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to avoid deterioration of the optical transmission characteristics resulting from mode-coupling-induced micro-bending. a) Free from irregular external pressure b) Coupled with plastic c) Large in diameter d) Smooth and in a steady state View Answer

Answer: a Explanation: Micro-bending losses results from environmental effects such as temperature variation. The irregular external pressure deteriorates the quality of transmission through the fiber. Thus, controlled coating and cabling of the fiber is essential in order to reduce the cabled fiber attenuation.

6. The diffusion of hydrogen into optical fiber affects the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ a) Transmission of optical light in the fiber b) Spectral attenuation characteristics of the fiber c) Core of the fiber d) Cladding of the fiber View Answer

Answer: b Explanation: The hydrogen absorption by an optical fiber increases optical fiber losses. It forms

absorption peaks where the hydrogen diffuses into interstitial spaces in the glass. At high temperatures, these losses can increase and reduced if the hydrogen source is removed.

7. \_\_\_\_\_\_\_\_\_\_ can induce a considerable amount of attenuation in optical fibers. a) Micro-bending b) Dispersion c) Diffusion of hydrogen d) Radiation Exposure View Answer

Answer: d Explanation: The optical transmission characteristics of the fiber cables can be degraded by exposure to nuclear radiation. The nature of this attenuation depends upon fiber structures, optical intensity, wavelength, etc. The radiation-induced attenuation comprises both permanent and temporary components which makes the exposure irreversible and reversible respectively.

8. The radiation-induced attenuation can be reduced through photo-bleaching. a) True b) False View Answer

Answer: a Explanation: Photo-bleaching can be exploited to study the diffusion of molecules. It is used to remove the radiation exposure by quenching auto-fluorescence. It helps to increase signal-to-noise ratio of the fiber and thus reduces attenuation.

9. The losses due to hydrogen absorption and reaction with fiber deposits can be temporary. a) True b) False View Answer

Answer: b Explanation: Hydrogen absorption occurs in two mechanisms. First phenomenon affects silica-based glass fibers whereas the second one occurs when hydrogen reacts with the fiber deposits to give P-OH, Ge-OH absorption. These losses are permanent.

10. The losses caused due to hydrogen absorption mechanisms are in the range of \_\_\_\_\_\_\_\_\_\_\_ a) 20 dB/km to 25 dB/km b) 10 dB/km to 15 dB/km c) 25 dB/km to 50 dB/km d) 0 dB/km to 5 dB/km View Answer

Answer: c Explanation: The diffusion of hydrogen into optical fiber leads to an increase in optical fiber

losses, causing damage to spectral loss characteristics. This phenomenon gets vibrant at higher temperatures. The losses caused due to such absorption are greater than 25 dB/km.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Cable Design”.

1. The cable must be designed such that the strain on the fiber in the cable does not exceed \_\_\_\_\_\_\_\_\_\_ a) 0.002% b) 0.01% c) 0.2% d) 0.160% View Answer

Answer: c Explanation: The constraints included in cable design are stability, protection, strength and jointing of the fibers. The fiber cable does not get affected if the strain exerted on it is below 0.2%. Although, it is suggested that the permanent strain on the fiber should be less than 0.1%.

2. How many categories exists in case of cable design? a) Two b) Three c) One d) Four View Answer

Answer: b Explanation: Cable design is separated into three categories. They are fiber buffering, cable structural and strength and cable sheath and water barrier. After successfully going through these tests, an optical cable is designed.

3. How many types of buffer jackets are used in fiber buffering? a) Three b) One c) Two d) Four View Answer

Answer: a Explanation: The buffer jacket is designed to protect the fiber from micro-bending losses. There are three types of buffer jackets used in fiber buffering. They are tight buffer jackets, loose tube buffer jackets and filled loose tube buffer jacket.

4. Loose tube buffer jackets exhibits a low resistance to movement of the fiber. a) True

b) False View Answer

Answer: a Explanation: Loose tube buffering is achieved by using a hard, smooth, flexible material in the form of extruded tube. The buffer tube is smooth from inside. Thus, it exhibits a low resistance to movement of the fiber. Also, it can be easily stripped for jointing or fiber termination.

5. An inclusion of one or more structural members in an optical fiber so as to serve as a cable core foundation around which the buffer fibers may be wrapped is called \_\_\_\_\_\_\_\_\_\_\_\_\_ a) Attenuation b) Splicing c) Buffering d) Stranding View Answer

Answer: d Explanation: Optical fiber is made structurally stronger by adding one or more strength members. The core fiber is trapped with buffered fibers or they are slotted in the core foundation. This approach is called as stranding.

6. Which of the following is not a strength member used in optical cable? a) Steel wire b) Germanium c) Aramid yarns d) Glass elements View Answer

Answer: b Explanation: Strength members or tensile members are added to the fiber to make it stronger and durable. These members include solid steel wire, dielectric aramid yarns (Kevlar), glass elements etc. Germanium is not a structural or strength member.

7. When the stranding approach consists of individual elements (e.g. single-fiber or multi fiber loose tube buffer) than the cable is termed as \_\_\_\_\_\_\_\_\_\_\_\_\_ a) Optical unit cable b) Coaxial cable c) Layer cable d) Bare glass cable View Answer

Answer: c Explanation: The stranding approach consists of a fiber core foundation around which the buffered fibers are wrapped. The cable elements are stranded in one, two or several layers around the central structural member. When the stranding is composed of individual elements, then the

cable is termed as layer cable. If the cable core consists of stranding elements each of which comprises a unit of stranding elements, then it is termed as optical unit cable.

8. The primary function of the structural member is load bearing. a) True b) False View Answer

Answer: b Explanation: The primary function of the structural member is not load bearing. It’s function is to provide suitable accommodation for the fiber ribbons within the cables. These fiber ribbons lie in the helical grooves or slots formed in the surface of the structural members.

9. What is the Young’s modulus of Kevlar, an aromatic polyester? a) 9 ×1010Nm-2 b) 10 ×1010Nm-2 c) 12 ×1010Nm-2 d) 13 ×1010Nm-2 View Answer

Answer: d Explanation: Kevlar is used as a strength member in an optical fiber. The Young’s modulus of Kevlar is very high which gives it strength to weight ratio advantage four times that of steel. Kevlar is coated with extruded plastic to provide a smooth surface which in turn prevents micro-bending losses.

10. The cable is normally covered with an outer plastic sheath to reduce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a) Abrasion b) Armor c) Friction d) Dispersion View Answer

Answer: a Explanation: Abrasion is the process of scraping or wearing something away. If the cable is not coated with plastic sheath, it gives rise to effects such as abrasion and crushing. The most common plastic sheath material used in covering a cable is polyethylene (PE).

**4. Questions on Optical Fiber Connections : Joints, Couplers and Isolators**

The section contains questions on fiber alignment and splices, fiber and beam connectors, fiber couplers, optical isolators and circulators.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on “Fiber Alignment and Joint Loss”.

1. A measure of amount of optical fiber emitted from source that can be coupled into a fiber is termed as \_\_\_\_\_\_\_\_\_\_\_\_\_\_ a) Radiance b) Angular power distribution c) Coupling efficiency d) Power-launching View Answer

Answer: c Explanation: Coupling efficiency depends upon the type of fiber attached to the source which should consider the parameters such as numerical aperture, core size, R.I. profile, radiance, core-cladding index difference. All these parameters relate to the performance of the fibers determined by power coupled into the fiber to power emitted by the source. This is called coupling efficiency ηwhich is given by η = PF/Ps Where PF = power coupled into the fiber Ps = power emitted by the source.

2. The ratio r = (n1 – n)/(n1 – n) indicates \_\_\_\_\_\_\_\_\_\_\_\_ a) Fresnel reflection b) Reflection coefficient c) Refraction coefficient d) Angular power distribution coefficient View Answer

Answer: b Explanation: The ratio, r = (n1-n)/(n1-n) is known as Reflection coefficient. It relates the amplitude of the reflected ray to the amplitude of the incident wave.

3. A GaAs optical source having a refractive index of 3.2 is coupled to a silica fiber having a refractive index of 1.42. Determine Fresnel reflection at interface in terms of percentage. a) 13.4% b) 17.4% c) 17.6% d) 14.8% View Answer

Answer: d Explanation: If the fiber end and the source are in close physical contact, the reflection is given by r = ((n1-n)/(n1-n))2 Multiplying r by 100, we get the value of r in terms of percentage.

4. A particular GaAs fiber has a Fresnel reflection magnitude of 17.6% i.e. 0.176. Find the power loss between the source and the fiber? a) 0.86 dB

b) 0.78 dB c) 0.84 dB d) 0.83 dB View Answer

Answer: c Explanation: The optical losses in decibels at the joint is given by Loss = -10log10(1-r) Where L = loss due to Fresnel reflection R = magnitude of Fresnel reflection.

5. Two joined step index fibers are perfectly aligned. What is the coupling loss of numerical aperture are NAR= 0.26 for emitting fiber? a) -0.828 dB b) -0.010 dB c) -0.32 dB d) 0.32 dB View Answer

Answer: b Explanation: Coupling loss for two joined step index fibers is given by LF(NA) = -10 log (NAR/NAE)2 Where LF = coupling loss NAR = Numerical aperture of receiving fiber NAE = Numerical aperture of emitting fiber.

6. Two joined graded index fibers that are perfectly aligned have refractive indices αR = 1.93 for receiving fiber αE = 2.15 for emitting fiber. Calculate the coupling loss. a) 0.23 dB b) 0.16 dB c) 0.82 dB d) 0.76 dB View Answer

Answer: a Explanation: Coupling loss for two joined and perfectly aligned graded index fiber is given by LF(α) = -10log10αR(αE+2)/αE(αR+2) Where LF(α) = Coupling loss αR = refractive index of receiving fiber αE = refractive index of emitting fiber.

7. How many types of misalignments occur when joining compatible fiber? a) One b) Two c) Five

d) Three View Answer

Answer: d Explanation: There are three layers of fiber misalignments and they are: Longitudinal, lateral and angular misalignments.

8. Losses caused by factors such as core-cladding diameter, numerical aperture, relative refractive index differences, different refractive index profiles, fiber faults are known as \_\_\_\_\_\_\_\_\_\_\_\_ a) Intrinsic joint losses b) Extrinsic losses c) Insertion losses d) Coupling losses View Answer

Answer: a Explanation: There are inherent connection problems while joining fibers. These connection problem cause different losses in the fibers and are called as Intrinsic joint losses.

9. A step index fiber has a coupling efficiency of 0.906 with uniform illumination of all propagation modes. Find the insertion loss due to lateral misalignment? a) 0.95 dB b) 0.40 dB c) 0.42 dB d) 0.62 dB View Answer

Answer: c Explanation: The insertion loss due to lateral misalignment is given by Loss10t = -10log10t η10t Where, Loss10t = insertion loss due to lateral misalignment η10t = Coupling efficiency.

10. A graded index fiber has a parabolic refractive index profile (α=2) and core diameter of 42μm. Estimate an insertion loss due to a 2 μm lateral misalignment when there is index matching and assuming there is uniform illumination of all guided modes only. a) 0.180 b) 0.106 c) 0.280 d) 0.080 View Answer

Answer: d Explanation: The misalignment loss (assuming there is uniform illumination of all guided modes) is given by

Lt = 0.85(y/a)

Where y = lateral misalignment

a = core radius.

11. Determine coupling efficiency if the misalignment loss in a graded index fiber is 0.102.

a) 0.136

b) 0.898

c) 0.982

d) 0.684

View Answer

Answer: b

Explanation: If the misalignment loss is known, the coupling efficiency is defined by

η = 1-Lt

Where η = coupling efficiency

Lt = misalignment loss.

12. In a single mode fiber, the losses due to lateral offset and angular misalignment are given by

0.20 dB and 0.46 dB respectively. Find the total insertion loss.

a) 0.66 dB

b) 0.26 dB

c) 0.38 dB

d) 0.40 dB

View Answer

Answer: a

Explanation: The total insertion loss in a single mode fiber is given by

TT = TL + Ta

Where, TT = total insertion loss

TL = lateral offset loss

Ta = Angular misalignment loss.

13. The intrinsic loss through a multimode fiber joint is independent of direction of propagation.

a) True

b) False

View Answer

Answer: b

Explanation: Intrinsic loss is defined as the summation of lateral offset loss and angular

misalignment loss. In case of multimode fibers, the intrinsic loss is dependent on the refractive

index gradient. The intrinsic loss through a single mode fiber joint is independent of direction of

propagation.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on

“Fiber Splices”.

1. A permanent joint formed between two different optical fibers in the field is known as a

\_\_\_\_\_\_\_\_\_\_\_\_

a) Fiber splice

b) Fiber connector

c) Fiber attenuator

d) Fiber dispersion

View Answer

Answer: a

Explanation: The jointing of two individual fibers is called as fiber splicing. It is used to

establish long-haul optical fiber links by joining two small length fibers.

2. How many types of fiber splices are available?

a) One

b) Two

c) Three

d) Four

View Answer

Answer: b

Explanation: Splices are divided into two types depending upon the splicing technique used.

These are fusion splicing (welding) and mechanical splicing.

3. The insertion losses of the fiber splices are much less than the Fresnel reflection loss at a

butted fiber joint.

a) True

b) False

View Answer

Answer: a

Explanation: The Fresnel reflection loss is usually more because there is no large step change in

refractive index with the fusion splice as it forms a continuous fiber connection. Also, some

method of index matching tends to be utilized with mechanical splices.

4. What is the main requirement with the fibers that are intended for splicing?

a) Smooth and oval end faces

b) Smooth and square end faces

c) Rough edge faces

d) Large core diameter

View Answer

Answer: b

Explanation: A curved mandrel is used which cleaves the fiber to achieve end preparation. The

edges must be smooth and have square face at the end for splicing purpose.

5. In score and break process, which of the following is not used as a cutting tool?

a) Diamond

b) Sapphire

c) Tungsten carbide

d) Copper

View Answer

Answer: d

Explanation: The score and break process is also called as scribe and break. It involves the

scribing of the fiber surface under tension with a cutting tool. Copper is not used as a cutting

tool.

6. The heating of the two prepared fiber ends to their fusing point with the application of

required axial pressure between the two optical fibers is called as \_\_\_\_\_\_\_\_\_\_\_\_

a) Mechanical splicing

b) Fusion splicing

c) Melting

d) Diffusion

View Answer

7. Which of the following is not used as a flame heating source in fusion splicing?

a) Microprocessor torches

b) Ox hydric burners

c) Electric arc

d) Gas burner

View Answer

Answer: d

Explanation: Micro-plasma torches uses argon and hydrogen and alcohol vapor. The most widely

used heating source is an electric arc. Thus, gas burner is not used in fusion splicing.

8. The rounding of the fiber ends with a low energy discharge before pressing the fibers together

and fusing with a stronger arc is called as \_\_\_\_\_\_\_\_\_\_\_\_

a) Pre-fusion

b) Diffusion

c) Crystallization

d) Alignment

View Answer

Answer: a

Explanation: Pre-fusion involves rounding of fiber ends. It removes the requirement for fiber end

preparation which has a distinct advantage in the field environment. It is utilized with multimode

fibers giving average splice losses of 0.09dB.

9. \_\_\_\_\_\_\_\_\_\_\_\_\_ is caused by surface tension effects between the two fiber ends during fusing.

a) Pre-fusion

b) Diffusion

c) Self-alignment

d) Splicing

View Answer

Answer: c

Explanation: The two fiber ends are close but not aligned before fusion. During fusion, the

surface tension affects the fiber ends to get aligned. After fusion, they are aligned in such a way

that a transmission medium can get a good continuity.

10. Average insertion losses as low as \_\_\_\_\_\_\_\_\_ have been obtained with multimode graded

index and single-mode fibers using ceramic capillaries.

a) 0.1 dB

b) 0.5 dB

c) 0.02 dB

d) 0.3 dB

View Answer

Answer: a

Explanation: Mechanical techniques for splicing involve the use of an accurately produced rigid

tube in which fiber ends are permanently bonded. It utilizes a ceramic capillary in which an

epoxy resin is injected through a transverse bore to provide mechanical sealing and index

matching. This technique which uses ceramic capillaries provides insertion losses as low as

0.1dB.

11. \_\_\_\_\_\_\_\_\_\_\_\_\_ are formed by sandwiching the butted fiber ends between a V-groove glass

substrate and a flat glass retainer plate.

a) Springroove splices

b) V-groove splices

c) Elastic splices

d) Fusion splices

View Answer

Answer: b

Explanation: In V-groove splices, a V-groove glass substrate is used with a flat glass plate. The

name V-groove suggests that the fiber ends are spliced in a V-shape.

These splices provide losses as low as 0.01dB.

12. Mean splice insertion losses of 0.05 dB are obtained using multimode graded index fibers

with the Springroove splice.

a) True

b) False

View Answer

Answer: a

Explanation: Springroove utilizes a bracket containing two cylindrical pins which act as

alignment guide for two fiber ends. An elastic element is used to press the fibers into a groove.

The assembly is secured with a drop of epoxy resin. It provides a loss of 0.05 dB and has found a

practical use in Italy.

13. Alignment accuracy of the order \_\_\_\_\_\_\_\_\_\_\_ is obtained using the three glass rod

alignment sleeve.

a) 0.23 μm

b) 0.15 μm

c) 0.05 μm

d) 0.01 μm

View Answer

Answer: c

Explanation: Alignment accuracies as high as 0.05 μmare necessary to obtain low losses. The

mode-field diameter for single-mode fiber is in the range 8 to 10μm. The three glass rod

alignment provides higher accuracies than rotary splice sleeve.

14. In case of multiple fusion, splice losses using an electric arc fusion device with multimode

graded index fiber range from \_\_\_\_\_\_\_\_\_\_\_\_

a) 0.01 to 0.04 dB

b) 0.19 to 0.25 dB

c) 0.12 to 0.15 dB

d) 0.04 to 0.12 dB

View Answer

Answer: d

Explanation: In multiple fusions, an electric arc fusing device allows splicing of 12 fibers

simultaneously. It takes a tool time of 6 minutes, which requires only 30 seconds per splice. The

splice losses for single mode fiber are of 0.04 dB as maximum whereas for graded index fibers,

losses are up to 0.12dB.

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on

“Fiber Connectors”.

1. Demountable fiber connectors are more difficult to achieve than optical fiber splices.

a) True

b) False

View Answer

Answer: a

Explanation: Fiber connectors must maintain tolerance requirements similar to splices in order to

couple light efficiently between the fibers. Also, fiber connectors must accomplish this in a

removable fashion. The connector design must allow repeated connection and disconnection

without any problems of fiber alignment.

2. What is the use of an index-matching material in the connector between the two jointed fibers?

a) To decrease the light transmission through the connection

b) To increase the light transmission through the connection

c) To induce losses in the fiber

d) To make a fiber dispersive

View Answer

Answer: b

Explanation: The index-matching material used might be epoxy resin. It increases the light

transmission through the connection while keeping dust and dirt from between the fibers. It also

provides optimum optical coupling.

3. How many categories of fiber connectors exist?

a) One

b) Three

c) Two

d) Four

View Answer

Answer: c

Explanation: Fiber connectors are separated into two broad categories. They are butt-jointed

connectors and expanded beam connectors. Butt-jointed connectors rely upon alignment of the

two fiber ends butted to each other whereas expanded beam connectors uses interposed optics at

the joint.

4. The basic ferrule connector is also called as \_\_\_\_\_\_\_\_\_\_\_\_\_

a) Groove connector

b) Beam connector

c) Multimode connector

d) Concentric sleeve connector

View Answer

Answer: d

Explanation: The basic ferrule connector is the simplest connector. The ferrules are placed in an

alignment sleeve within the connector. The alignment sleeve is concentric which allows the fiber

ends to be butt-jointed.

5. What is the use of watch jewel in cylindrical ferrule connector?

a) To obtain the diameter and tolerance requirements of the ferrule

b) For polishing purposes

c) Cleaving the fiber

d) To disperse a fiber

View Answer

Answer: a

Explanation: Ferrule connectors have a watch jewel in the ferrule end face. It is used instead of

drilling of the metallic ferrule end face which takes time. It is used to obtain close diameter and

tolerance requirements of the ferrule end face whole easily.

6. The concentricity errors between the fiber core and the outside diameter of the jeweled ferrule

are in the range of \_\_\_\_\_\_\_\_\_\_\_ with multimode step-index fibers.

a) 1 to 3μm

b) 2 to 6μm

c) 7 to 10μm

d) 12 to 20μm

View Answer

Answer: b

Explanation: The fiber alignment accuracy of the basic ferrule connector is dependent on the

ferrule hole into which the fiber is inserted. The concentricity errors in the range of 2 to 6μm

gives insertion losses in the range 1 to 2dB with multimode step index fibers.

7. The typical average losses for multimode graded index fiber and single mode fiber with the

precision ceramic ferrule connector are \_\_\_\_\_\_\_\_\_\_\_\_\_ respectively.

a) 0.3 and 0.5 dB

b) 0.2 and 0.3 dB

c) 0.1 and 0.2 dB

d) 0.4 and 0.7 dB

View Answer

Answer: b

Explanation: Unlike metal and plastic components, the ceramic ferrule material is harder than the

optical fiber. Thus, it is unaffected by grinding and polishing process. This factor enables to

provide the low-loss connectors which have low losses as low as 0.2 and 0.3 dB in case of

optical fibers.

8. Bi-conical ferrule connectors are less advantageous than cylindrical ferrule connectors.

a) FalseStat

b) True

View Answer

Answer: a

Explanation: Cylindrical and bi-conical ferrule connectors are assembled in housings to form a

multi-fiber configuration. The force needed to insert multiple cylindrical ferrules can be large

when multiple ferrules are involved. The multiple bi-conical ferrule connectors are more

advantageous as they require less insertion force.

9. In connectors, the fiber ends are separated by some gap. This gap ranges from \_\_\_\_\_\_\_\_\_\_\_\_

a) 0.040 to 0.045 mm

b) 0.025 to 0.10 mm

c) 0.12 to 0.16 mm

d) 0.030 to 0.2mm

View Answer

Answer: b

Explanation: In connectors, gaps are introduced to prevent them from rubbing against each other

and becoming damaged during connector fixing/engagement. The gap ranges from 0.025 to 0.10

mm so as to reduce the losses below 8dB for a particular diameter fiber say 50μm

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on

“Expanded Beam Connectors”.

1. What is the use of interposed optics in expanded beam connectors?

a) To achieve lateral alignment less critical than a butt-joined fiber connector

b) To make a fiber loss free

c) To make a fiber dispersive

d) For index-matching

View Answer

Answer: a

Explanation: Expanded beam connector utilize interposed optics at the joint in order to expand the

beam from transmitting fiber end before reducing it to a size compatible with the receiving fiber end. It

helps to achieve lateral alignment less critical than a butt-jointed connector. Also, the longitudinal

separation is critical in expanded beam connectors.

2. The expanded beam connectors use \_\_\_\_\_\_\_\_\_\_\_\_ for beam expansion and reduction.

a) Square micro-lens

b) Oval micro-lens

c) Spherical micro-lens

d) Rectangular micro-lens

View Answer

Answer: c

Explanation: Expanded beam connectors use the principle of transmission of digital data to the receiver.

It uses spherical micro-lens to first expand the beam from the transmitting end and reduces the beam at

the receiving end.

3. Lens-coupled expanded beam connectors exhibit average losses of \_\_\_\_\_\_\_\_\_ in case of

single mode and graded index fibers.

a) 0.3 dB

b) 0.7 dB

c) 0.2 dB

d) 1.5 dB

View Answer

Answer: b

Explanation: Lens-coupled expanded beam connectors use spherical micro-lenses. The average losses

are in the range of 1dB. With the antireflection coating on the lenses, the losses are reduced to 0.7 dB in

case of single mode fibers.

4. Sapphire ball lens expanded beam design is successful than spherical lens coupled design.

a) True

b) False

View Answer

Answer: a

Explanation: Spherical lens coupled design exhibits losses in the range 0.7 dB to 1dB. Sapphire ball lens

expanded beam design achieved successful single mode fiber connection with losses as low as 0.4dB.

5. The fiber is positioned at the \_\_\_\_\_\_\_\_ of the lens in order to obtain a collimated beam and to

minimize lens-to-lens longitudinal misalignment effects.

a) Aperture

b) Focal length

c) Curve

d) Exterior circumference

View Answer

Answer: b

Explanation: The expanded beam connector also uses a molded spherical lens. A lens alignment sleeve is

used to minimize the effects of angular misalignment. The fiber is positioned at the focal length of the

lens to achieve losses as low as 0.7dB.

6. \_\_\_\_\_\_\_\_\_\_\_ exhibits a parabolic refractive index profile with a maximum at the axis similar

to graded index fiber.

a) Lens coupled design

b) Sapphire ball lens

c) Spherical micro-lens

d) GRIN-rod lens

View Answer

Answer: d

Explanation: GRIN-rod lens geometry has a parabolic refractive index profile. It facilitates efficient beam

expansion and collimation within expanded beam connectors. It finds its applications in fiber couplers

and source-to-fiber coupling.

7. The GRIN-rod lens can produce a collimated output beam with a divergent angle αof between

\_\_\_\_\_\_\_\_\_\_\_\_\_ from a light source situated on, or near to, the opposite lens face.

a) 1 to 5 degrees

b) 9 to 16 degrees

c) 4 to 8 degrees

d) 25 to 50 degrees

View Answer

Answer: a

Explanation: GRIN-rod lens comprises of a cylindrical glass rod typically 0.2 to 2 mm in diameter. It

exhibits a parabolic refractive index profile. It facilitates efficient beam expansion and collimation with

an angle in the range 1 to 5 degrees.

8. In the given equation, if r is the radial distance, n is the refractive index; what does z stands

for?

dr2/dz2 = (1/n) (d n/dr)

a) Focal length

b) Distance along the optical axis

c) Axial angle

d) Diameter

View Answer

Answer: b

Explanation: The above equation is known as paraxial ray equation which governs the ray propagation

through the GRIN-rod lens. GRIN-rod lens geometry is parabolic in nature. Thus z is the distance along

the optical axis of a parabolic profile.

9. The majority of the GRIN-rod lenses have diameters in the range of \_\_\_\_\_\_\_\_\_\_\_\_

a) 2 to 2.5 mm

b) 3 to 4 mm

c) 0.1 to 0.4 mm

d) 0.5 to 2 mm

View Answer

Answer: d

Explanation: The GRIN-rod lenses performance directly depends on the radial distance. The diameters in

the range of 0.5 to 2 mm may be employed with either single mode or multimode fibers. They are

available with numerical apertures of 0.37, 0.46 and 0.6.

10. Which of the following factors does not cause divergence of the collimated beam from a

GRIN-rod lens?

a) Lens cut length

b) Size of fiber core

c) Refractive index profile

d) Chromatic aberration

View Answer

Answer: c

Explanation: Various factors contribute to the divergence of the collimated beam from a GRIN-rod lens.

Error in lens cut length, finite size of the fiber core and chromatic aberration are the factors that cause

divergence.

11. GRIN-rod lens connectors have loss characteristics that are independent of the modal power

distribution in the fiber.

a) True

b) False

View Answer

Answer: a

Explanation: GRIN-rod lens geometry is analogous to butt-jointed multimode fiber

connectors. The loss characteristics of butt-jointed connectors are dependent on modal power

distribution in the fiber

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on

“Fiber Couplers”.

1. When considering source-to-fiber coupling efficiencies, the \_\_\_\_\_\_\_\_ is an important

parameter than total output power.

a) Numerical aperture

b) Radiance of an optical source

c) Coupling efficiency

d) Angular power distribution

View Answer

Answer: b

Explanation: Radiance is the optical power radiated into a unit solid angle per unit emitt ing

surface area. Since this optical power is dependent on radiance, radiance is much important

factor than optical power.

2. It is a device that distributes light from a main fiber into one or more branch fibers.

a) Optical fiber coupler

b) Optical fiber splice

c) Optical fiber connector

d) Optical isolator

View Answer

Answer: a

Explanation: Nowadays, requirements to divide combined optical signals for applications are

increasing. Optical fiber coupler is one such device that is used for dividing and combining

optical signals. It is generally used in LANs, computer networks etc.

3. Optical fiber couplers are also called as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

a) Isolators

b) Circulators

c) Directional couplers

d) Attenuators

View Answer

Answer: c

Explanation: Optical fiber couplers are passive devices. The power transfer in couplers takes

place either through the fiber core cross-section by butt jointing the fibers or by using some form

of imaging optics between the fibers. It distributes light from one fiber to many fibers and hence

it is also called as a directional coupler.

4. How many types of multiport optical fiber couplers are available at present?

a) Two

b) One

c) Four

d) Three

View Answer

Answer: d

Explanation: Multiport optical fiber couplers are subdivided into three types. These are three and

four port couplers, star couplers and wavelength division multiplexing (WDM) couplers. These

couplers distribute light among the branch fibers with no scattering loss.

5. The optical power coupled from one fiber to another is limited by \_\_\_\_\_\_\_\_\_\_\_\_

a) Numerical apertures of fibers

b) Varying refractive index of fibers

c) Angular power distribution at source

d) Number of modes propagating in each fiber

View Answer

Answer: d

Explanation: When two fibers are coupled to each other, the optical power is limited by number

of modes propagating in each fiber. For example, when a fiber propagating with 500 modes is

connected to a fiber that propagates only 400 modes, then at maximum, only 80% of power is

coupled into the other fiber.

6. \_\_\_\_\_\_\_\_ couplers combine the different wavelength optical signal onto the fiber or separate

the different wavelength optical signal output from the fiber.

a) 3-port

b) 2\*2-star

c) WDM

d) Directional

View Answer

Answer: c

Explanation: WDM coupler is abbreviated as wavelength division multiplexing coupler. It is a

category of multiport optical fiber couplers. It is designed to permit a number of different peak

wavelength optical signals to be transmitted in parallel on a single fiber.

7. How many fabrication techniques are used for 3 port fiber couplers?

a) One

b) Two

c) Three

d) Four

View Answer

Answer: b

Explanation: There are two fabrication techniques available for three port couplers. First is a

lateral offset method which relies on the overlapping of the fiber end faces and the other is the

semi-transparent mirror method. Using these techniques, three port couplers with both

multimode and single-mode fibers can be fabricated.

8. Which is the most common method for manufacturing couplers?

a) Wavelength division multiplexing

b) Lateral offset method

c) Semitransparent mirror method

d) Fused bi-conical taper (FBT) technique

View Answer

Answer: d

Explanation: The FBT technique is basic and simple. In this technique, the fibers are generally

twisted together and then spot fused under tension such that the fused section is elongated to

form a bi-conical taper structure. A three port coupler can be obtained by removing one of the

input fibers.

9. Couplers insertion loss is same as that of excess loss.

a) True

b) False

View Answer

Answer: b

Explanation: Excess loss is defined as the ratio of input power to output power. The insertion

loss is defined as the loss obtained for a particular port-to-port optical path. Thus, the insertion

loss and excess loss are different in nature.

10. A four-port multimode fiber FBT coupler has 50 μW optical power launched into port 1. The

measured output power at ports 2,3 and 4 are 0.003, 23.0 and 24.5 μW respectively. Determine

the excess loss.

a) 0.22 dB

b) 0.33 dB

c) 0.45 dB

d) 0.12 dB

View Answer

Answer: a

Explanation: Excess loss is a ratio of power input to power output of the fiber and it is given by

Excess loss = 10log10 P1/(P3+P4)

WhereP1, P3, P4 = output power at ports 1,3 and 4 resp.

11. A four-port FBT coupler has 60μW optical power launched into port one. The output powers

at ports 2, 3, 4 are 0.0025, 18, and 22 μW respectively. Find the split ratio?

a) 42%

b) 46%

c) 52%

d) 45%

View Answer

Answer: d

Explanation: Split ratio indicates the percentage division of optical power between the outputs

ports. It is given by

Split ratio = [P3/(P3+P4)]\*100%

Where P3 and P4 are output powers at ports 3 and 4 respectively.

12. How many manufacturing methods are used for producing multimode fiber star couplers?

a) Two

b) One

c) Three

d) Five

View Answer

Answer: a

Explanation: The manufacturing methods of star couplers are mixer-rod technique and FBT

technique. In the mixer-rod method, a thin platelet of glass is employed, which mixes light from

one fiber, dividing it among the outgoing fibers. FBT method involves twisting, heating and

pulling of fiber.

13. Calculate the splitting loss if a 30×30 port multimode fiber star coupler has 1 mW of optical

power launched into an input port.

a) 13 dB

b) 15 dB

c) 14.77 dB

d) 16.02 dB

View Answer

Answer: c

Explanation: The splitting loss is related to the number of output ports N of a coupler. It is given

by-

Splitting loss (Star coupler) = 10log10N (dB).

14. A \_\_\_\_\_\_\_\_\_\_\_\_\_ coupler comprises a number of cascaded stages, each incorporating three

or four-port FBT couplers to obtain a multiport output.

a) Star

b) Ladder

c) WDM

d) Three-port

View Answer

Answer: a

Explanation: A star coupler can be realized by constructing a ladder coupler. It consists of many

cascaded stages. If a three-port coupler is used, then a ladder coupler does not form symmetrical

star coupler. It is a useful device to achieve a multiport output with low insertion loss.

15. A number of three-port single-mode fiber couplers are used in the fabrication of a ladder

coupler with 16 output ports. The three-port couplers each have an excess loss of 0.2 dB along

with a splice loss of 0.1 dB at the interconnection of each stage. Determine the excess loss.

a) 1.9 dB

b) 1.4 dB

c) 0.9 dB

d) 1.1 dB

View Answer

Answer: d

Explanation: The number of stages M within the ladder design is given by 2M=16. Hence M=4.

Thus, excess loss is given by-

Excess loss = (M×loss in each 3-port coupler) + (Number of splices×Loss in each stage)

Where number of splices = 3 (as the value of M is equal to 4)

This set of Optical Communications Multiple Choice Questions & Answers (MCQs) focuses on

“Optical Isolators and Circulators”.

1. An FBG is developed within a fiber core having a refractive index of 1.30. Find the grating

period for it to reflect an optical signal with a wavelength of 1.33μm.

a) 0.51 μm

b) 0.58 μm

c) 0.61 μm

d) 0.49 μm

View Answer

Answer: a

Explanation: The grating period is denoted by Λ. It is given by-

Λ = λB/ 2n

Where λB = wavelength

n = refractive index.

2. It is a passive device which allows the flow of optical signal power in only one direction and

preventing reflections in the backward direction.

a) Fiber slice

b) Optical fiber connector

c) Optical isolator

d) Optical coupler

View Answer

Answer: c

Explanation: Ideally, an optical isolator transmits the signal power in the desired forward

direction. Material imperfections in the isolator medium generate backward reflections. Optical

isolators can be implemented by using FBG.

3. Which feature of an optical isolator makes it attractive to use with optical amplifier?

a) Low loss

b) Wavelength blocking

c) Low refractive index

d) Attenuation

View Answer

Answer: b

Explanation: Optical isolators are made using FBGs. Since FBGs are wavelength dependent, the

optical isolators can be designed to allow or block the optical signal at particular wavelength.

The wavelength blocking feature makes the optical isolator a very attractive device for use with

optical amplifier in order to protect them from backward reflections.

4. Magneto-optic devices can be used to function as isolators.

a) True

b) False

View Answer

Answer: a

Explanation: Magneto-optic devices use the principle of Faraday rotation. It relates the TM mode

characteristics and polarization state of an optical signal with its direction of propagation. The

rotation of polarization plane is proportional to the intensity of component of magnetic field in

the direction of optical signal. Therefore, it is possible to block and divert an optical signal using

magnetic properties which is a function of an isolator.

5. How many implementation methods are available for optical isolators?

a) One

b) Four

c) Two

d) Three

View Answer

Answer: d

Explanation: Optical isolators can be implemented using three techniques. These are as follows:

-By using FBGs

-By using magnetic oxide materials

-By using semiconductor optical amplifiers (SOAs).

6. A device which is made of isolators and follows a closed loop path is called as a

\_\_\_\_\_\_\_\_\_\_\_\_

a) Circulator

b) Gyrator

c) Attenuator

d) Connector

View Answer

Answer: a

Explanation: Isolator can be connected together to form multiport devices. A circulator is formed

from isolators connected together to form a closed circular path. In circulator, the signal

continues to travel in closed loop and does not get discarded unlike isolator.

7. The commercially available circulators exhibit insertion losses around \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

a) 2 dB

b) 0.7 dB

c) 0.2 dB

d) 1 dB

View Answer

Answer: d

Explanation: A number of isolators can be used to implement a circulator. However, as the

number of ports increases, the device complexity increases. Hence, three-or four-port circulators

are used for optical interconnection with insertion losses around 1 dB and high isolation in the

range of 40-50dB.

8. A combination of a FBG and optical isolators can be used to produce non-blocking optical

wavelength division add/draw multiplexers.

a) True

b) False

View Answer

Answer: b

Explanation: Optical wavelength divisions add/draw multiplexers can be produced by a

combination of a FBG and a circulator. Non-blocking NXM optical wavelengths divisions

add/draw multiplexer is produced where N and M denotes the number of wavelength channels

and add/drop channels.

\_\_