Optical communications

Unit-1:

1. a). What are the various elements in an optical communication system and explain about each element in brief.?
   b). A Silica optical fiber has a core refractive index of 1.50 and a cladding refractive index of 1.47 .Determine,
2. a)The critical angle at the core cladding interface
   b) The numerical aperture for the fiber.

   c) The acceptance angle in air for the fiber.

3. a)Explain the following
   i) Cut off wave length ii) Mode field diameter?
   b). Calculate the maximum number of equated modes through the graded index fiber having NA = 0.21 index profile =1.85 and radius of core =25um of the operating wavelength of 13um.
4. a). What are the advantages of optical fibers over conventional transmission lines?
   b). A Single mode step index fiber has a core diameter 7 um and core refractive index 1.49. Estimate the shortest wavelength of light which allows single mode operation when the refractive index difference for the fiber is 1%
5. a). Compare the step index fiber and graded index fibers with a neat diagram.
   b). Calculate the number of modes at 1550 nm and 1300 nm in a graded index optical fiber having a parabolic index profile , a 20 um core radius , n1=1.48 and n2= 1.46

Unit-2:

1. a). Write down the different types of fiber materials ? Explain about Halide glass material of fiber ?
   b). Explain about Birefringence and Polarization mode Dispersion.
2. a). With the help of relevant expressions and graphical analysis explain material dispersion and waveguide dispersion
   b). A Single mode step index fiber gives a total pulse broadening of 95 ns over a 5km length. Estimate the bandwidth length product for fiber when a non-return to zero digital code (NRZ) is used
3. a). Write short notes on plastic optical fibers.
   b). A Step index multimode fiber with a numerical aperture of 0.20 supports approximately 1000 modes at 850 nm wavelength (i) What is the diameter of core ? (ii) How many modes does the fiber support at 1320nm and 1550nm.

4. a)Explain in detail the signal attenuation or transmission loss in the optical fiber with necessary equations and prove that this is a function of wavelength using graphical analysis.
   b). A single mode fiber operating at the wavelength of 1.4um is found to have a total material dispersion of 2.81 ns, and a total waveguide dispersion of 0.495 ns. Determine the received pulse width and approximate bit-rate of the fiber if the transmitted pulse has a width of 0.5 ns.

Unit-3:

1. a). Write short notes on V-groove splices
   b). Explain about straight sleeve connectors
2. a).Write a short note on connector return loss.
   b). A Single mode fiber is operating at 850 nm of step index fiber with n1= 1.480 and n2=1.465 . Find the core radius of a fiber
3. a). Write short notes on “Fiber Splices”.
   b). Determine the cutoff wavelength for a step index fiber to exhibit single mode operation when the core refractive index and the radius are 1.46 and 1.45 um respectively with the refractive index difference being 0.25 %
4. a). What are the types of connectors ? Explain in detail ?.
   b) An Optical fiber in air has an N.A of 0.3. Compare the acceptance angle for meridional rays with that for skew rays which change direction by 90 degrees at each reflections.

Unit-4:

1. a). Draw the schematic of an edge emitting LED and explain the reasons for such construction.
   b). Calculate the wavelength of emission from GaAS whose bandgap is 1.44ev
2. a)Explain the principle of operation of an Avalanche photo diode.
   b). A PIN Photodiode on average generates one electron hole pair per incident photons at a wavelength of 0.8um.Assuming all the electrons are collected, Calculate
   (i) The quantum efficiency of the device
   (ii) Its maximum possible bandgap energy.
   (iii) The mean Output Photo current when the received optical power is 10^{-7} W
3. a). Explain the principle of operation of PIN photodiode with a neat diagram.
   b). A PIN Photodiode on average generates one electron hole pair per incident photons at a wavelength of 0.8um.Assuming all the electrons are collected, Calculate
   (i) The quantum efficiency of the device
   (ii) Its maximum possible bandgap energy
   (iii) The mean Output Photo current when the received optical power is 10^{-7} W
4. a). Discuss the Optical source characteristics.

b). If the quantum efficiency at 1.3um wavelength of light is 0.65 and the number of photons incident at this wavelength is $5x10^5$,what is the no of electron-hole pairs generated

Unit-5:

1. a). Comparisons of photo detectors.
   b) An LED with a circular emitting area of radius 20mm has a Lambertain emission pattern with a 100W/(cm^2.sr)axial radiance at a 100 ma drive current .How much optical power can be coupled in to a step index fiber having a 100 mm core diameter and NA = 0.22? How much optical power can be coupled from this source in to a 50 mm core diameter graded index fiber having α=2.0 , n1=1.48 and Δ=0.01?
2. a). Derive an expression for power coupled from a Lambertian surface emitting LED into a smaller step-index fiber.
   b) An LED with a circular emitting area of radius 20mm has a Lambertain emission pattern with a 100W/(cm^2.sr)axial radiance at a 100 ma drive current .How much optical power can be coupled in to a step index fiber having a 100 mm core diameter and NA = 0.22? How much optical power can be coupled from this source in to a 50 mm core diameter graded index fiber having α=2.0 , n1=1.48 and Δ=0.01?
3. a). With help of neat diagrams describe lens coupling mechanisms to improve coupling efficiency from a fiber optic source.
   b) The average optical power launched in to a 10km length of fiber is 100uw and the average output power is 25uw.Calculate (i) The signal attenuation in dB through the fiber.It is assumed that there are no connectors or splices.(ii) Signal attenuation per km of the fiber (iii) Overall signal attenuation for the 11km optical link using the same fiber with 3 splices each having an attenuation of 0.8dB (iv) Numerical value of the ratio between input and output power
4. a). Derive an expression for power coupled from a Lambertian surface emitting LED into a smaller step-index fiber.
   b) A GaAs optical source with a refractive index of 3.6 is coupled to a silica fiber that has a refractive index of 1.48.If the fiber end and the source are in close physical contact, then find the Fresenel reflection at the interface and power loss in dB ?

Unit-6:

1. a). Describe with a diagram to explain the operation of an unidirectional WDM system.
   b) List the conditions under which cut-back method of measurement of fiber attenuation yields more accurate values
2. a). Suggest a non-destructive method(insertion loss method) for measurement of fiber attenuation .Mention the principle behind this method.
   b).Discuss about the Point to Point Fiber Optic Link and its characteristics with an example.

3. a). Write short notes on “Rise time budget Analysis”.
   b). Assume
   LED together with its drive circuit rise time= 15ns
   LED spectral width=40nm
   Material dispersion rise time=21ns
   Length of the fiber=6km
   Modal dispersion induced fiber rise time=3.9ns
   Receiver rise time=14ns
   Bit rate=20Mbps
   BER=
   Verify the system meet the desired performance or not?
4. a). Write short notes on “Power budget Analysis”.
   b). **Example:** Assume data rate =20Mb/s, Bit error rate=10^{-9} ,Detector is a silicon pin photodiode operating at 850nm.,Input signal is -42dBm, GaAlAs LED which can couple 50uW power into fiber flylead, Connector loss=1dB ,Attenuation αf=3.5 db/km, Link power margin=6dB.