Code No: 07A7EC14 **R07** **Set No. 2**

IV B.Tech I Semester Examinations,November 2010
OPTICAL COMMUNICATIONS
Electronics And Communication Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Explain in detail about the ultra violet absorption, infrared absorption and Ion-resonance absorption losses in pure and dopped SiO_2 at various wavelengths.
   (b) What are the three important mechanisms that are responsible for absorption losses in signal through an optical fiber? Explain in brief the curve for wavelength verses attenuation for different ranges of the signal. [8+8]

2. (a) Describe how rise time budget analysis of a fiber optic link is done.
   (b) Compute modal and material dispersion induced rise time degradation for the 5Km fiber optic link specified below. [8+8]

Spectral width of the optical source at 850nm wavelength	= 42nm
Material dispersion factor in 800-900 nm region 0.09ns/nm-Km	= 0.09ns/nm-Km
Mode mixing factor over 5km fiber length	= 0.6
Bandwidth-distance product of the fiber	=450 MHz-Km

3. (a) Explain how mode filling during launching of optical power into a fiber effects attenuation in a Fiber.
   (b) Discuss the merits and drawbacks of cut back method of measurement of attenuation.
   (c) Optical power output of a 2.8Km fiber is 10mW at 850nm wavelength. The optical power measured when the fiber is cut off to 20m is 128mW. Compute the attenuation (dB/Km) in the optical fiber at 850nm wavelength. Mention the conditions for attenuation measurement. [4+4+8]

4. (a) Derive an expression for multiple time difference ($\Delta t/z$) in the multi path dispersion of the optical fiber.
   (b) Mention the principal requirements of a good connector design. [8+8]

5. (a) What is LASER diode? Compare its performance with that of LED.
   (b) A practical surface emitting LED has 50 μm diameter emitting area and operates at peak modulation current of 100 mA. What is the bandwidth of Ga Al As LED having a 2.0 μm active area thickness.
   Assume $B_r = 10^{-10}$ cm^3/s and
   $\delta = 10^4$ cm/ sec. [8+8]

6. (a) Define equilibrium numerical aperture.

(b) An LED with circular emission region of diameter 200 μm and an axial radiance of 100 W / cm^2- Sr at 100mA drive current is coupled into a step index fiber of 50μm radius and of 0.22 numerical aperture. Compute the power coupled into this step index fiber. Compute the % difference in coupled power if the radius of the fiber is halved.

(c) Calculate the power coupled from the source specified above into a parabolic index graded-index fiber of 50μm diameter with n_1=1.485 and $\Delta = 0.01$. [3+8+5]

7. (a) Explain numerical aperture with reference to ray theory transmission.

(b) A multi mode step index fiber has a relative refractive index difference of 1% and a core refractive index of 1.5. The number of modes operating at a wavelength of 1.3μm is 1100. Estimate the diameter of the fiber core. [8+8]

8. (a) Define 'sensitivity', 'Bit Error Rate in the received data' and 'quantum limit' of a fiber optic receiver.

(b) In a fiber optic link transmitting digital data at 200 kbps, the signal and noise voltages measured at the output of the receiver decoder are 1.0 volts and 0.2 volts respectively. If the probability of error in the received data is given as 0.01, compute:

i. The average time for error occurrence if probability of ones and zeroes in the data stream is same.

ii. Signal-to-Noise Ratio of the receiver in dB. [6+10]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A7EC14 **R07** **Set No. 4**

IV B.Tech I Semester Examinations,November 2010
OPTICAL COMMUNICATIONS
Electronics And Communication Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Describe important specifications of a semiconductor photo diode to be suitable for fiber optic communications.
   (b) Compute the range of quantum efficiency of an In Ga As PIN diode in the wavelength range between 1200 nm and 1600 nm if the responsivity of the diode is specified to be more than 0.6 A/W in the required wavelength region. Use the necessary physical constants listed. [8+8]

Speed of light in vacuum	$=3 \times 10^8$ m/s
Electron charge	$=1.602 \times 10^{-19}$ C
Planck's constant	$=6.6256 \times 10^{-34}$ J-S
Boltzman's constant	$=1.38 \times 10^{-23}$ J/K
Band gap energy of Gas	= 1.15 eV at 300K.

2. (a) Draw the block schematic of a general communication system and explain the functions of each block.
   (b) Discuss briefly about the leaky modes and mode coupling losses in the fiber optic communication. [8+8]

3. Describe the following briefly:
   (a) Transmission distance versus bit rate diagram.
   (b) Attenuation measurement using cutback method. [8+8]

4. (a) List the estimates and conclusions possible from transmission distance versus bit rate plot for a given wavelength-LED-PIN diode combination.
   (b) Discuss the difference between a dispersion limited and an attenuation limited fiber optic link.
   (c) Explore the possibility to include system margin in rise-time budget analysis also. [6+6+4]

5. (a) Distinguish between connection losses (Intrinsic losses) and extrinsic losses.
   (b) A single mode fiber connector is used with a 6 μm core diameter silica (refractive index 1.46) step index fiber which has a normalized frequency of 2.2 and NA of 0.9. The connector has a lateral offset of 0.7 μm and an angular misalignment of 0.8^0. Estimate the total insertion loss of the connector assuming that the joint is index matched and that there is no longitudinal misalignment. [8+8]

6. (a) Write expression for power coupled into a step index fiber from an LED source.

(b) An LED with circular emission region of diameter 100μm and an axial radiance of 100 W / cm^2- Sr at 100mA drive current is coupled into a step index fiber of 50 μm diameter and of 0.22 numerical aperture. Compute the power coupled into this step index fiber. Compute the %difference in coupled power if the radius of the fiber is:

i. Halved.

ii. Doubled. [4+12]

7. (a) A laser diode has maximum average output of 1mw (0 dBm). The laser is to be amplitude modulated with a signal x(t) has a DC component of 0.5 and a periodic component of $\pm$ 2.6. If the current input to optical output relationship is
$p(t) = \frac{i(t)}{25}$, find the values of I_O and m if the modulating current is.
$i(t) = I_0[1 + mx(t)]$

(b) Obtain the expression for the 3 dB modulation bandwidth of LED and discuss the importance of radiative recombination lifetime. [8+8]

8. (a) Explain what is meant by:

i. Modal bire fringence

ii. The beat length in a single mode fiber

(b) A multi mode graded index fiber has a refractive index at the core axis of 1.46 with cladding refractive index of 1.45. The critical radius of curvature which allows large bending losses to occur as 84 μm, when the fiber is transmitting light of a particular wavelength. Determine the wavelength of the transmitted light. [8+8]

$\star\star\star\star\star$

Code No: 07A7EC14 **R07** **Set No. 1**

IV B.Tech I Semester Examinations,November 2010
OPTICAL COMMUNICATIONS
Electronics And Communication Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) What is absorption in optical fiber? Explain in detail the three types of mechanisms of absorption in an optical fiber.
   (b) Write notes on "Scattering losses in fiber". [8+8]
2. What is internal quantum efficiency of LED and derive the expression for the life time reduction caused by interfacial recombination. [16]
3. Describe any TWO of the following:
   (a) Receiver sensitivity and Signal-to-Noise Ratio in a digital fiber optic link.
   (b) Operation and Performance of an analog fiber optic receiver
   (c) Threshold detection for equi-probable zeroes and ones in data stream in a FO receiver. [8+8]
4. (a) Derive an expression for coupled power from an LED into a relatively smaller step index fiber with equal numerical aperture.
   (b) A Ga As source of 200 μm diameter active area and refractive index of 3.6 radiating into 30^0 solid angle couples power into an all silica optical fiber of 50 μm diameter and 0.22 numerical aperture. Estimate the loss in power coupling due to all types of mismatch between the devices. Express the loss computed in dB also. [8+8]
5. (a) Determine the expressions for the power flow through core and cladding of a step index fiber.
   (b) Calculate the required Δ if a fiber with 8 μm core and 125 μm cladding is to be a single mode at 1300 nm. The core refractive index is 1.5. [8+8]
6. (a) What is meant by steady-state modal equilibrium ?
   (b) Calculate the system rise time of a 6 Km fiber optic link with the following specifications:

Rise time of the LED and its drive electronics	= 12ns
Material dispersion related rise time degradation	= 24ns
Bandwidth of the optical receiver	= 20MHz
Bandwidth-distance product of the fiber	= 400 MHz-Km
Mode mixing factor, q over 6 Km fiber	= 1.0

   (c) Verify whether NRZ bit stream of 16 Mbps data rate can be transmitted over the fiber optic link specified above. [16]

7. Discuss the magnitude of different dispersions in various fibers and also explain how does this dispersion vary with a different operating wavelengths for the fiber in detail. [16]

8. (a) List the conditions under which cut-back method of measurement of fiber attenuation yields more accurate values.

   (b) Suggest a non-destructive method for measurement of fiber attenuation. Mention the principle behind this method.

   (c) Output of a PIN detector preamplifier of an optical receiver for 1.6Km fiber is 2.26 Volts at 820nm wavelength. The output of PIN preamplifier increases to 9.06 Volts when this fiber is cutback to 4m length at the same wavelength. Compute the total attenuation and attenuation per unit length (dB/Km) of the cut-off fiber. [5+5+6]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A7EC14 **R07** **Set No. 3**

IV B.Tech I Semester Examinations,November 2010
OPTICAL COMMUNICATIONS
Electronics And Communication Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Optical power of 5 mw coupled in to an optical fiber reduces to 3.8 mw after propagation through a distance of 10 km. Determine the attenuation coefficient α of this fiber in dB/ Km. Determine the power to be coupled in to this fiber if 100 μw of power is to be available at a distance of 85 Km.
   (b) Derive the relation between the effective refractive index and the normalized propagation constant. [8+8]

2. (a) Explain the procedure to establish a decision level for threshold detection in a fiber optic receiver with 50% probability of occurrence of 'ones' and 'zeroes'.
   (b) What is dark current? Explain the significance of dark current on signal to-Noise ratio of a fiber optic receiver. [10+6]

3. (a) Explain step index fiber structure in detail.
   (b) The core of an optical fiber is made of glass of refractive index 1.55 and in clad with another glass of refractive index 1.0. Determine:
      i. Numerical Aperture
      ii. Acceptance angle
      iii. Critical angle. [8+8]

4. (a) Describe the possible system specifications for selection of all the components of a fiber optic link operating in 850nm wavelength window.
   (b) Describe briefly various multiplexing techniques suitable in fiber optic links.
   (c) What are the types of dispersion contributing significantly to overall system rise time in case of single mode fibers?List them. [6+5+5]

5. (a) Describe all the factors giving rise to losses while coupling optical power between any two devices of a fiber optic link.
   (b) What is a pig-tailed device? List out the advantages and disadvantages of pig-tailing either as fiber optic source or as fiber optic detector.
   (c) Write expressions for power coupling from an LED into a step index fiber for larger and smaller active area relative to the area of the fiber. [5+5+6]

6. (a) Discuss about the total dispersion and maximum transmission rate of the optical fiber.

(b) Calculate the wave guide dispersion in units of ps/km for a 9/125 single mode fiber with $n_1 = 1.48$; D = 0.22% operating at 1.3μm, core diameter = 9 μm and cladding diameter = 125 μm. [8+8]

7. (a) A Ga Al As laser diode has a 600 μm cavity length has an effective absorption coefficient of 15cm^{-1}. For coated facts, the reflectiveness are 0.30 at each end. What is the optical gain at the laser threshold.

(b) If one end of the laser is coated with a dielectric reflector so that its reflectivity is now 80%. What is the optical gain at the lasing threshold?

(c) If the internal quantum efficiency is 0.6, what is external quantum efficiency in case (a) and (b). [16]

8. (a) List separately, the assumptions made for measurement of dispersion in optical fibers in time and frequency domains.

(b) How is the 3-dB electrical bandwidth of an optical fiber measured? Explain with the help of suitable test set-up.

(c) If the output response of an optical fiber is Gaussian in shape, estimate the 3dB electrical bandwidth of the fiber for an RMS output pulse width of 0.5 ns. [4+8+4]

⋆ ⋆ ⋆ ⋆ ⋆