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

IV B.Tech I Semester Examinations,May 2011
OPTICAL COMMUNICATIONS
Electronics And Communication Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Briefly describe micro bending and scattering losses in optical fibers.
   (b) Discuss different absorption losses in SiO_2 fiber at 850 nm, 1300 nm and 1550 nm. [8+8]

2. (a) Describe lensing mechanisms to improve coupling efficiency between a source and a fiber.
   (b) Derive an expression for power coupled from a Lambertian surface emitting LED into a smaller step-index fiber. [8+8]

3. (a) Draw the structures of fabry perot LASER diode and distributed feed back (DFB) LASER diodes. Compare them in thier priniciples and performances.
   (b) Discuss how modulation capability of LASER diode be determined. [8+8]

4. (a) Explain about the light guidance in a optical fiber with figures and explain the total internal reflection and numerical aperture with diagrams and equations.
   (b) Calculate the maximum entrance angle, critical angle and numerical aperture of a step index fiber having $n_1 = 1.48$ and $n_2 = 1.46$. Assume that the fiber is immersed in a solution whose refractive index is 1.4. [8+8]

5. (a) Derive an expression for the pulse dispersion in a parabolic index medium and in a planar step index wave guide.
   (b) For a fiber, material dispersion parameter is 58.8 ps/ nm/ km. The relative spectral width δ_λ/λ of the source is 0.0012 at the wavelength of 850 nm. Calculate the RMS pulse broadening per km. [8+8]

6. (a) Describe Photo carrier generation and internal multiplication processes in an Avalanche Photo Detector.
   (b) The quantum efficiency of a silicon APD at 900 nm wavelength is 80%. The final current out of this APD is 16 μA for an incident optical power of 0.45 μW on the diode. Compute the Avalanche multiplication factor of the APD. 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.

7. (a) what is multiplexing? Describe various possible multiplexing techniques in communication links along with respective merits and de-merits.

(b) Identify a set of Fiber optic components suitable for a long haul, high data rate fiber optic transmission links.

(c) Discuss the possible replacement of selected components if the transmission distance has to be doubled the system margin should be increased to 10dB from 5dB. [8+4+4]

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]

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

IV B.Tech I Semester Examinations,May 2011
OPTICAL COMMUNICATIONS
Electronics And Communication Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Discuss the dependence of equilibrium numerical aperture on power coupling from a source into a fiber.
   (b) Estimate the losses encountered while coupling power from a source to a fiber due to mismatch in their numerical apertures and surface areas. [6+10]

2. (a) Explain the bending losses in an optical fiber.
   (b) What is micro bending and how can it be reduced?
   (c) Explain with diagram, how the micro bending is minimized and avoided by a compressible jacket. [5+5+6]

3. Explain the following:
   (a) Semiconductor injection laser diode resonating modes.
   (b) LED structures and characteristics. [8+8]

4. (a) Analyse the conditions for a fiber optic link to be categorized as dispersion limited.
   (b) A 90 Mbps NRZ Data transmission system uses a GaAlAs laser diode having 2nm spectral width. The transmission distance is 7 Km over a graded -index fiber having 800 MHz-Km bandwidth-distance product. Calculate the system rise time if there is no mode mixing in the 7Km length of the fiber such that mode mixing factor, q = 1. The rise times of source with its drive circuitry and detector along with associated receiver electronics are 12ns and 15ns respectively. Material dispersion factor, Dmat is given as 0.08ns/nm-Km. [8+8]

5. (a) Estimate the optimum voltage for logic level decision by threshold detection. State the assumptions made in estimation.
   (b) Compute the BER and SNR in dB of a fiber optic receiver at a data rate of 2.048 Mbps. The average time for error occurrence, signal voltage and noise voltages are specified as 8 minutes, 1.20 volts and 0.08 volts respectively.[8+8]

6. (a) Distinguish between leaky modes and guided modes in optical fiber transmission.
   (b) For a multimode step index optical fiber of glass core of refractive index 1.5 and quartz cladding of refractive index 1.46, determine:
      i. Critical angle

ii. Acceptance angle
iii. Numerical aperture
Derive the relations used. [8+8]

7. (a) Explain the necessity of line coding in optical communication systems?
(b) Assume suitable clock signal for representation of coded data waveforms for the bit stream 1011011101 in:
i. NRZ
ii. RZ
iii. AMI
iv. Bi-phase Manchester type of line codes.
(c) List the merits and demerits of the following line codes:
i. RZ
ii. NRZ
iii. AMI
iv. Bi-Phase Manchester. [4+8+4]

8. (a) Write notes on "dispersion shifted fiber and dispersion compensating fiber".
(b) Explain in detail about the refractive index profile dispersion and dispersion Vs bandwidth of an optical fiber. [8+8]

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

IV B.Tech I Semester Examinations,May 2011
OPTICAL COMMUNICATIONS
Electronics And Communication Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Describe the radiative losses in fibers resulting in absorption.
   (b) Explain the mechanisms of dispersion of signals in optical fibers. [8+8]

2. Describe briefly:
   (a) Power coupling from a Surface emitting LED into a fiber with area and numerical aperture mismatch.
   (b) Equilibrium Numerical Aperture and power coupling from an LED. [8+8]

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) A single mode fiber has a normalized frequency V = 2.40, a core refractive index n_1= 1.47, a cladding refractive index n_2 = 1.465 and a core diameter 2 a = 9 mm. Find:
      i. The insertion losses of a fiber joint having a lateral offset of 1 μm.
      ii. The loss at a joint having a angular misalignment of 1^0 at a 1300 nm wavelength.
   (b) Explain about losses in end separator, connecting different fibers when joining two fibers. [8+8]

5. (a) List the estimates and conclusions that can be made from a transmission distance versus bit rate plot for a given wavelength, LED, PIN diode combination.
   (b) Describe the procedure to introduce wavelength division multiplexing and demultiplexing in full duplex fiber optic links. [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. [8+8]

7. (a) Define responsivity of an APD. List out the drawbacks of a Germanium APD for use in digital fiber optic links.

   (b) An APD with a multiplication factor of 20 operates at a wavelength of 1550 nm. Calculate the quantum efficiency and the output photo current from the device if the responsivity due to primary photo detection is 0.6 A/W when 10^{11} photons per second are incident on the device. 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.

8. (a) A given fiber has dispersion parameter D = 20 ps $nm^{-1}Km^{-1}$ and length L = 10 Km, laser with spectral half width $\delta\lambda$ = 1nm is used as light source and an input signal (bit) duration Δt_1 = 1ns is introduced at the entrance end of the fiber. Calculate:

   i. The percentage of output bit duration and
   ii. The bandwidth length product of that fiber.

   (b) What is mode coupling? Give the effect of mode coupling on dispersion in graded index fibers. [8+8]

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

IV B.Tech I Semester Examinations,May 2011
OPTICAL COMMUNICATIONS
Electronics And Communication Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Derive the equation for the radiative life time of an LED for computation of internal quantum efficiency.
   (b) Define following terms for a LED.
      i. Internal quantum efficiency
      ii. Bulk recombination time
      iii. Modulation capability. [8+8]

2. (a) Sketch the radiation patterns from a surface emitting LED in both axial and perpendicular planes with reference to active emitting region. Support the sketches with corresponding mathematical expressions.
   (b) Derive an expression for power coupling from a large surface emitting LED into a smaller step-index fiber. [8+8]

3. (a) Explain the function of each block with a help of neat block diagram of a digital optical fiber communication system.
   (b) Compare the fiber structure and NA in step index and graded index fibers. [8+8]

4. Derive expressions for inter modal and intra modal dispersion in step index fibers. [16]

5. (a) Derive an expression for Signal-to-Noise Ratio at the output of a PIN diode based analog receiver.
   (b) Write modified expression for SNR at the output of an APD based analog receiver.
   (c) What are the differences in specifications, selection of components, performance merit parameters of digital and analog fiber optic receivers? [8+4+4]

6. (a) Is it possible to establish Bi-directional wavelength division multiplexed optical communication link? Justify your answer with relevant equations, diagrams numerical values and description.
   (b) How is the maximum achievable data rate estimated from dispersion measurements for RZ and NRZ formats of data?
   (c) List out the differences between time domain and frequency domain approaches in measurements of inter modal dispersion. [5+6+5]

7. (a) The photo-elastic coefficient and the refractive index for silica are 0.286 and 1.46 respectively. Silica has an isothermal compressibility of $7\times\ 10^{-11}$ m^2 N^{-1} and an estimated fictive temperature of 1400k. Determine the theoretical attenuation in dB/ Km due to fundamental Rayleigh scattering in silica at optical wavelengths of 0.85 and 1.55 μm. Boltzmen constant is 1.381×10^{-23} J K^{-1}.

   (b) Distinguish between macro bending and micro bending losses in brief. [8+8]

8. (a) Discuss all the criteria to select the set of components sufficing design of a fiber optic link.

   (b) Describe the types of dispersion predominant in single mode and multimode fiber optic links.

   (c) Estimate the effect of such dispersion on system rise-time for above types of fibers. [6+5+5]

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