Code No: K0421/R07 **Set No. 1**

IV B.Tech II Semester Regular Examinations, Apr/May 2013
OPTICAL COMMUNICATIONS
(Electronics & Communication Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain in detail the acceptance angle with reference to ray theory transmission.
   (b) Calculate the number of modes at 820 nm and 1.3 μ m in a graded index fiber having a parabolic index profile (α=2), a 25μm core radius, n_1= 1.48 and n_2 = 1.46. How does this compare to a step index fiber? [8+8]

2. (a) Discuss mode cut off conditions in optical fibers.
   (b) A single mode fiber has a beat length in the range 7cm to 1m. What range of propagation constant difference does this correspond to for an operating wavelength of 1500 nm? [8+8]

3. (a) What is dispersion in an optical fiber? How does it affect communication link compare single and multimode fiber in this regard in detail.
   (b) In a system, a 2 Km fiber was used, the 3 dB pulse widths at the input & output are 0.5 ns and 10 ns respectively. Find the pulse broadening for the fiber and the bandwidth - length product in MHz - Km. [8+8]

4. (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 lasing 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]

5. Write short notes on the following:
   (a) Power coupling from a vertical Cavity Surface Emitting Laser (VCSEL) diode to a single mode fiber.
   (b) Radiation patterns in axial and vertical planes from surface emitting LED and edge emitting LED. [8+8]

6. (a) With the help of a suitable block diagram explain the functioning of every element of a fiber optic receiver.
   (b) Discuss briefly about various sources of noise in a PIN diode based fiber optic receiver. [8+8]

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7. (a) List and describe all the system considerations for selection of components in the design of a fiber optic link.
   (b) Describe a procedure to carryout the power budget analysis of a fiber optic link. [8+8]

8. Write brief notes on the following :
   (a) Attenuation measurements for optical fibers.
   (b) Wavelength division multiplexing for optical communication system. [8+8]

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Code No: K0421/R07 **Set No. 2**

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OPTICAL COMMUNICATIONS
(Electronics & Communication Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Draw the block diagram of an optical transmission link and explain the function of each element.
   (b) Discuss the applications of optical fiber system. [8+8]
2. (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 V_s attenuation for different ranges of the signal. [8+8]
3. (a) What is pulse broadening? Analyze pulse broadening in a graded index wave guide.
   (b) A certain optical fiber has attenuation of 3.5 dB/ Km at 850 nm. If 0.5 mw of optical fiber is initially launched in to the fiber, what is the power level in mw after 4Km? [8+8]
4. (a) Write short notes on "Fiber Splices".
   (b) A planar LED is fabricated from GAS which has a refractive index of 3.6.
      i. Calculate the optical power emitted in to air as a percentage of internal optical power for the device when the transmission factor at the crystal air interface is 0.68.
      ii. When the optical power generated internally is 50% of the electrical power supplied, determine the external power efficiency. [8+8]
5. Write short notes on the following:
   (a) Radiation patterns of a Lambertian source with necessary equations.
   (b) Radiation from a monochromatic source and power coupling into a fiber.[8+8]
6. (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 InGaAs 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.

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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 InGaAs	= 0.73 eV at 300K

7. (a) Describe a method to carryout rise time budget analysis for a fiber optic link
   (b) Explain the procedure to determine the maximum allowable RZ and NRZ data rates from rise time budget analysis.
   (c) Explain the effect of mode mixing factor, q, on modal dispersion induced rise time. [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: K0421/R07 **Set No. 3**

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OPTICAL COMMUNICATIONS
(Electronics & Communication Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Compute the V-number and no. of modes supported by a fiber with $n_1 = 1.55$, $n_2 = 1.50$; core radius is 25 μm and operating wavelength is 1300 nm.
   (b) Compare single mode and multimode fibers. [8+8]
2. (a) Give an account of cut off wavelength for single mode and multi mode fibers and discuss its dependence on fiber length.
   (b) When the mean optical power launched into an 8 Km length of fiber is 120 μw, the mean optical power at the fiber output is 3 μw. Calculate the over all signal attenuation in decibels and over all signal attenuation for a 10 Km length of same kind of fiber. [8+8]
3. Explain the pulse dispersion with suitable diagrams in detail. [16]
4. (a) Two multimode step index fibers have NAs of 0.2 and 0.4 respectively and both have the same core refractive index which is 1.48. Estimate the insertion loss at a joint in each fiber caused by a 5^0 angular misalignment of the fiber core axes. It may be assumed that the medium between the fibers in air.
   (b) Explain the intrinsic coupling losses at fiber joint due to mismatch of core diameter, NA and refractive index profile difference. [8+8]
5. Write short notes on the following:
   (a) Radiation patterns of a Lambertian source with necessary equations.
   (b) Radiation from a monochromatic source and power coupling into a fiber. [8+8]
6. (a) Reason out if the two parameters, 'quantum efficiency' and 'responsivity' signify the same properties of a detector diode.
   (b) A PIN diode is characterized by a quantum efficiency of 72% at a wavelength of 900 nm. Calculate:
      i. Responsivity of the PIN diode at 900 nm.
      ii. Received optical power if the mean photo current is 10 mA at 900 nm.
      iii. Number of received photons for 1 mA mean photo generated current.
   [8+8]
7. (a) Explain various factors contributing to overall optical system rise time.

(b) Calculate the system rise time for a 6 Km fiber optic link of following specifications. [10+6]

Rise time of the LED and its drive electronics	= 14ns
Material dispersion related rise time degradation	= 21ns
Bandwidth of the optical receiver	= 25MHz
Bandwidth-distance product of the fiber	=400 MHz-Km
Mode mixing factor, q	= 0.7

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: K0421/R07 **Set No. 4**

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OPTICAL COMMUNICATIONS
(Electronics & 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 wave equation for a step index fiber.
   (b) Calculate the critical angle, maximum entrance angle and NA for a step index fiber having a core index of 1.60 and a cladding index of 1.49. Derive the expressions used. [8+8]

2. (a) Explain the mechanisms losses in resulting in optical fibers.
   (b) An optical signal, after propagating through a fiber has lost 80% of its power in a length of 600m of fiber. Calculate the loss in dB/Km of this fiber. [8+8]

3. Define and distinguish between the different types of signal distortion in optical fibers. [16]

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

5. (a) With the help of neat diagrams describe lens coupling mechanisms to improve coupling efficiency from a fiber optic source.
   (b) Differentiate between Lambertian and monochromatic optical sources in terms of power coupling into a single mode fiber.
   (c) What is equilibrium numerical aperture? Explain the significance of equilibrium numerical aperture on source to fiber power coupling. [6+5+5]

6. 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]

7. (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]

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8. (a) How can the maximum achievable transmission distance with a set of active and passive components in an optical link be calculated? Explain with the help of necessary transmission curves.

   (b) Describe eye patterns analysis for assessing the performance of a digital fiber optic link. Is it possible to estimate BER also from eye patterns? [8+8]

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