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

IV B.Tech II Semester Supplementary Examinations, July/Aug 2012
OPTICAL COMMUNICATIONS
(Electronics & Communication Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Compare the advantages and disadvantages of guided optical communication links with that of co-axial and microwave systems.
   (b) Calculate the number of modes at 820 nm in a graded index fiber having parabolic index profile, a 25 μm core-radius, $n_1 = 1.48$ and $n_2 = 1.46$. How does it compare to a step index fiber? [8+8]

2. (a) Explain birefringence in single mode step index fibers.
   (b) Consider an optical fiber with $n_1 = 1.465$, $n_2 = 1.46$ and $a = 4$ μm. Determine the wavelength at which all modes except the HE_{11} mode are cut off. [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) A step index fiber has a core refractive index of 1.5 and a core diameter of 50 μm. The fiber is jointed with a lateral misalignment between the core axes of 5 μm. Estimate the insertion loss at the joint due to the lateral misalignment assuming uniform distribution of power between all guided modes when:
      i. There is a small air gap at the joint
      ii. The joint is considered index matched.
   (b) Write short notes on V-groove splices. [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. (a) Establish a relation between responsivity and quantum efficiency of a photo detector starting from definition of these two parameters.
   (b) Determine the quantum efficiency and responsivity of a PIN photodiode operating at 850 nm wavelength if 6.2×10^{12} photons incident at 850 nm generate 1.2×10^{12} electrons from the device.

(c) Discuss the factors on which the response time of a photo detector depends. [8+8]

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. Describe any TWO of the following:
   (a) Estimates made from Eye pattern analysis.
   (b) Necessity of line coding in optical communication.
   (c) Uni-directional and Bi-directional WDM for optical links. [8+8]

⋆ ⋆ ⋆ ⋆ ⋆

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

IV B.Tech II Semester Supplementary Examinations, July/Aug 2012
OPTICAL COMMUNICATIONS
(Electronics & Communication Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Compare optical fiber systems and conventional copper cable systems.
   (b) Calculate the critical angle, NA of step index fiber having $n_1 = 1.50$ core-cladding difference $\Delta = 1\%$. What is the maximum entrance angle θ_{omax} for the fiber if the outer medium is air with n =1. [8+8]

2. (a) Write short notes on Plastic Optical Fibers".
   (b) Find the radius of curvature R at which the number of modes decreases by 50 percent in a graded index fiber take $\alpha = 2$, $n_2 = 1.5$, $\Delta = 0.01$, a = 25 μm, λ = 1.3 μm. [8+8]

3. (a) Derive an expression for the material dispersion on the optimum profile for the pulse dispersion in graded index optical fibers.
   (b) For the fiber, it is given that at $\lambda = 850$ nm, $\lambda^2 \left(\frac{d^2 n_1}{d\lambda^2}\right) = 0.015$ the RMS spectral width of the light source is 20 nm at this wavelength.
   Determine:
      i. Material dispersion parameter
      ii. RMS pulse broadening / Km due to material dispersion. [8+8]

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

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 a fiber optic source or a 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) Define responsivity and quantum efficiency in relation to a fiber optic receiver. Discuss if these parameters are dependent on the preamplifier and post amplifier circuitry of the receiver.

(b) Compute the wavelength at which the numerical values of quantum efficiency and responsivity of a photodiode operating at 820 nm wavelength become equal.
Use the necessary physical constants listed.

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

(c) Describe the factors on which the speed of response of a photo diode depends. [6+5+5]

7. Describe about the following briefly:

(a) Component choice for design of a fiber optic link.

(b) Power Budget analysis of a fiber optic link with an example. [8+8]

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: K0421 **R07** **Set No. 3**

IV B.Tech II Semester Supplementary Examinations, July/Aug 2012
OPTICAL COMMUNICATIONS
(Electronics & Communication Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (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]

2. (a) A single mode step index fiber with a core refractive index of 1.49 has a critical bending radius of 10.4 mm when illuminated with light at a wavelength of 1.3 μm. If the cut off wavelength for the fiber is 1.15 μm, calculate the relative refractive index difference.
   (b) Compare stimulated Brillouin and stimulated Raman scattering in optical fiber. [8+8]

3. (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 the optical fiber. [8+8]

4. (a) Draw the schematic of an edge emitting LED and explain the reasons for such construction.
   (b) Discuss the major requirements of an optical fiber emitter. [8+8]

5. (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]

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) 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) Describe the principle and necessity of WDM technique in optical communication systems.
   (b) With the help of suitable diagrams, explain how uni-directional and bi-directional WDM optical communication links operate.
   (c) Is it possible to multiplex number of closely spaced wavelengths within the same wavelength window of optical communication? [5+6+5]

⋆ ⋆ ⋆ ⋆ ⋆

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

IV B.Tech II Semester Supplementary Examinations, July/Aug 2012
OPTICAL COMMUNICATIONS
(Electronics & Communication Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) A step index multimode fiber with a numerical aperture of 0.2 supports 1000 modes at 850 nm, what is the diameter of the core? How many modes of the fiber support at 1320 nm. What percent of optical power flows in the cladding.
   (b) Discuss the significance of numerical aperture in optical fibers. Derive a relation for NA in case of 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) Derive an expression for the material dispersion on the optimum profile for the pulse dispersion in graded index optical fibers.
   (b) For the fiber, it is given that at $\lambda = 850$ nm, $\lambda^2 \left(\frac{d^2 n_1}{d\lambda^2}\right) = 0.015$ the RMS spectral width of the light source is 20 nm at this wavelength.
   Determine:
      i. Material dispersion parameter
      ii. RMS pulse broadening / Km due to material dispersion. [8+8]

4. (a) An optical fiber has a core refractive index of 1.5. Two lengths of the fiber with smooth and perpendicular (to the core axes) end faces are butted together. Assuming the fiber axes are perfectly aligned, calculate the optical loss in decibels at the joint (due to fresnel reflection) when there is a small air gap between the fiber end faces.
   (b) Write short notes on "Fusion splices". [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. (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]

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

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) Describe the principle and necessity of WDM technique in optical communication systems.
   (b) With the help of suitable diagrams, explain how uni-directional and bi-directional WDM optical communication links operate.
   (c) Is it possible to multiplex number of closely spaced wavelengths within the same wavelength window of optical communication? [5+6+5]

⋆ ⋆ ⋆ ⋆ ⋆