Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 71745

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Seventh Semester

Electronics and Communication Engineering

EC 6702 — OPTICAL COMMUNICATION AND NETWORKS

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the advantages of optical fiber?

2. A multimode silica fiber has a core refractive index $n_1 = 1.48$ and cladding refractive index $n_2 = 1.46$. Find the numerical aperture of fiber.

3. What is intra modal dispersion?

4. Define group delay.

5. What is minimum detectable optical power?

6. Compare the optical sources : LASER AND LED.

7. What are the methods employed for measuring attenuation in optical fiber.

8. Define bit error rate.

9. What is an optical layer?

10. What are the key parameters required for analysing the optical link?

PART B — (5 × 16 = 80 marks)

11. (a) (i) A step index multimode fiber with a numerical aperture of 0.2 support approximately 1000 modes at an 850 nm wavelength. What is the diameter of its core? How many modes does the fiber supports at 850 nm and 1550 nm? (8)

(ii) Draw the block diagram of optical fiber transmission link and explain. (8)

Or

(b) (i) Find the core radius necessary for single mode operation at 1320nm of a step index fiber with n_1 =1.48 and n_2 = 1.478. Determine the numerical aperture and acceptance angle of this fiber. (7)

(ii) Derive the wave equations for a crylindrical fiber. (9)

12. (a) What are the causes of signal attenuation in optical fiber? Explain about it detail. (16)

Or

(b) Derive an expression for pulse broadening in graded index fiber. (16)

13. (a) Discuss about surface emitting LED and edge emitting LEG with neat sketch. (16)

Or

(b) Explain about different types of lensing schemes used in improving the efficiency of light emitting diode. (16)

14. (a) Discuss in detail about the methods used for measuring intermodal dispersion and chromatic dispersion. (16)

Or

(b) Explain about the operation of an optical receiver and source of error during transmission. Draw the configuration of receiver. (16)

15. (a) (i) An engineer has the following components available :

* GaAlAs laser diode, operating at 850 nm, fiber coupled power 0 dBm
* Ten sections of cable each of which is 500 m long, has 4 dB/km attenuation, has connectors at both ends
* 2 dB/connector connector loss
* A PIN photodiode receiver, –45 dBm sensitivity
* An avalanche photodiode receiver, –56 dBm sensitivity

The engineer wishes to construct a 5-km link operating at 20 Mb/s. Analyze which receiver should be used if a 6-dB Operating margin is required.

(ii) Discuss about the principle of optical code division multiple access. (8)

Or

(b) (i) An optical fiber system is to be designed to operate over an 8 km length without repeaters. The rise times of the chosen components are : (8)

(1) Source (LED) 8 ns

(2) Fiber: intermodal 5 ns km-1

(3) (pulse broadening) intramodal 1 ns km-1

(4) Detector (*p-i-n* photodiode) 6 ns

From system rise time considerations estimate the maximum bit rate that may be achieved on the link when using an NRZ format.

(ii) Discuss about the protection mechanism in UPSR and BLSR ring architecture with neat sketch. (8)

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Question Paper Code : 40972

08/05/18

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Seventh Semester
Electronics and Communication Engineering
EC 6702 – OPTICAL COMMUNICATION AND NETWORKS
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Sketch the cross sectional view of the transverse electric field vectors for the four lowest order modes in a step index fiber.
2. State the reasons to opt for optical fiber communication.
3. What is elastic and inelastic scattering ? Give examples.
4. Define polarization mode dispersion and write the expression for it.
5. Illustrate the factors that determine the response time of the photodiode.
6. An LED has radiative and non-radiative recombination times of 30 ns and 100 ns respectively. Determine the internal quantum efficiency.
7. List the error sources associated with fiber optic receiver section.
8. Define quantum limit.
9. Mention the drawbacks of broadcast and select networks for wide area network applications.
10. Write a short note on soliton.

PART – B **(5×16=80 Marks)**

11. a) i) A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and a cladding refractive index of 1.47. Determine : **(8)**
    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.

    ii) Discuss briefly about the structure of graded index fiber. **(8)**

(OR)

b) i) A graded index fiber with a parabolic refractive index profile core has a refractive index at the core axis of 1.5 and a relative index difference of 1%. Estimate the maximum possible core diameter which allows single-mode operation at a wavelength of 1.3 μm. (8)

ii) With the neat block diagram, explain the fundamental blocks of optical fiber communication. (8)

12. a) i) Explain in detail about the scattering and the bending losses that occur in an optical fiber with relevant diagrams and expressions. (8)

ii) 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. Determine : (8)

a) The overall signal attenuation or loss in decibels through the fiber assuming there are no connectors or splices ;

b) The signal attenuation per kilometer for the fiber

c) The overall signal attenuation for a 10 km optical link using the same fiber with splices at 1 km intervals, each giving an attenuation of 1 dB ;

d) The numerical input/output power ratio in (c).

(OR)

b) i) Discuss material and waveguide dispersion mechanisms with necessary mathematical expressions. (8)

ii) A multimode graded index fiber exhibits total pulse broadening of 0.1 μs over a distance of 15 km. Estimate : (8)

a) The maximum possible bandwidth on the link assuming no inter-symbol interference ;

b) The pulse dispersion per unit length

c) The bandwidth-length product for the fiber.

13. a) i) A planar LED is fabricated from gallium arsenide which has a refractive index of 3.6. (8)

a) Calculate the optical power emitted into air as a percentage of the internal optical power for the device when the transmission factor at the crystal-air interface is 0.68.

b) When the optical power generated internally is 50% of the electric power supplied, determine the external power efficiency.

ii) Illustrate the different lensing schemes available to improve the power coupling efficiency. (8)

(OR)

b) i) Give a brief account on the resonant frequencies of laser diodes. (8)

ii) Explain about the various fiber splicing techniques with necessary diagrams. (8)

14. a) i) Measurements are made using a calorimeter and thermocouple experimental arrangement. Initially a high absorption fiber is utilized to obtain a plot of $(T_\infty - T_f)$ on a logarithmic scale against t. It is found from the plot that the readings of $(T_\infty - T_f)$ after 10 and 100 seconds are 0.525 and 0.021 μV respectively. The test fiber is then inserted in the calorimeter and gives a maximum temperature rise of $4.3 * 10^{-4}$ °C with a constant measured optical power of 98 mW at a wavelength of 0.75 μm, The thermal capacity per kilometer of the silica capillary and fluid is calculated to be $1.64 * 10^4$ J °C^{-1}. Determine the absorption loss in dB km^{-1}, at a wavelength of 0.75 μm, for the fiber under test. (8)

ii) With a typical experimental arrangement, brief the measurement process of diameter of the fiber. (8)

(OR)

b) i) Discuss the different structures of receiver in the optical fiber communication with neat diagram. (8)

ii) A He-Ne laser operating at a wavelength of 0.63 μm was used with a solar cell cube to measure the scattering loss in a multimode fiber sample. With a constant optical output power the reading from the solar cell cube was 6.14 nV. The optical power measurement at the cube without scattering was 153.38 μV. The length of the fiber in the cube was 2.92 cm. Determine the loss due to scattering in dB km^{-1} for the fiber at a wavelength of 0.63 μm. (4)

iii) A trigonometrical measurement is performed in order to determine the numerical of a step index fiber. The screen is positioned 10.0 cm from the fiber end face. When illuminated from a wide-angled visible source the measured output pattern size is 6.2 cm. Calculate the approximate numerical aperture of the fiber. (4)

15. a) i) What is optical power budgeting ? Determine the optical power budget for the below system and hence determine its viability.
Components are chosen for a digital optical fiber link of overall length 7 km and operating at 20 Mbit s^{-1} using an RZ code. It is decided that an LED emitting at 0.85 μm with graded index fiber to a p-i-n photodiode is a suitable choice for the system components, giving no dispersion-equalization penalty. An LED which is capable of launching an average of 100 μW of optical power (including the connector loss) into a graded index fiber of 50 μm core diameter is chosen. The proposed fiber cable has an attenuation of 2.6 dB km^{-1} and requires splicing every kilometer with a loss of 0.5 dB per splice. There is also a connector loss at the receiver of 1.5 dB. The receiver mean incident optical power of –41 dBm in order to give the necessary BER of 10^{-10}, and it is predicted that a safety margin of 6 dB will be required. (8)

ii) Discuss about the concept of routing and wavelength assignment in the wavelength routed networks. (8)

(OR)

b) i) Briefly explain the layers of the SONET. (6)

ii) Describe in detail the non-linear effects on the performance of the network. (10)

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Reg. No. : | | | | | | | | | | | | |

F.N

Question Paper Code : 80353

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Seventh Semester

Electronics and Communication Engineering

EC 6702 — OPTICAL COMMUNICATION AND NETWORKS

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define numerical aperture.
2. What are the conditions for light to be propagation inside a fiber?
3. What are the causes of absorption?
4. What is polarization mode dispersion?
5. What are the mechanisms behind lasing action?
6. Define external quantum efficiency.
7. Define BER.
8. What is cut back method?
9. How do you ensure that the required system performance is met or not?
10. Name two popular architectures of SONET/SDH network.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Compare the structure and characteristics of step index and graded index fiber. (12)

(ii) A graded index fiber with a core with a parabolic refractive index profile ($\alpha = 2$) and diameter of 50 μm. The fiber has numerical aperture of 0.2. Estimate the number of the guided modes propagating in the fiber when the transmitted light has a wavelength 1 μm. (4)

Or

(b) (i) Consider a fiber with $25\,\mu m$ core radius, core index $n1 = 1.48$ and $\Delta = 0.01$. If $\lambda = 1320\,nm$, what value of V and how many modes propagate in the fiber. What percent of optical power flows in the cladding? If the core cladding difference is reduced to $\Delta = 0.003$, how many modes does the fiber support and what fraction of the optical power flows in the cladding? (8)

(ii) Explain the functional blocks of an optical communication link with neat block diagram. (8)

12. (a) Discuss about the design optimization of single mode fiber. (16)

Or

(b) What is waveguide dispersion? Derive an expression for time delay produced due to waveguide dispersion. (16)

13. (a) (i) A double heterojunction LED emitting at a peak wavelength of 1310 nm has radiative and non-radiative recombination time of 45 ns and 95 ns respectively The drive current is 35 mA. Determine internal quantum efficiency and internal power level. If the refractive index of the light source material is n = 3.5, find the power emitted from the device. (6)

(ii) What is fiber splicing? Discuss about fusion splicing and mechanical splicing. (10)

Or

(b) Explain the working principle of laser diode and derive its rate equation. (16)

14. (a) Explain the different methods employed in measuring the attenuation in optical fiber with neat block diagram. (16)

Or

(b) What are the performance measures of a digital receiver? Derive an expression for bit error rate of a digital receiver. (16)

15. (a) (i) Draw the generic configuration of SONET and explain the functions of add drop multiplexer in SONET. (8)

(ii) A 90 Mb/s NRZ data transmission system that sends two DS3 channels uses a GaAlAs laser diode that has a spectral width of 1 nm. The rise time of the laser transmitter output is 2 ns. The transmission distance is 7 km over a graded index fiber that has 800 MHz.km bandwidth-distance product. If the receiver bandwidth is 90 MHz and mode mixing factor q = 0.7, what is the system rise time? What is the rise time if there is no mode mixing? (use 0.07 ns/(nm-km)). (8)

Or

(b) Discuss in detail about the effect of noise on system performance.

Question Paper Code : 50454

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017
Seventh Semester
Electronics and Communication Engineering
EC 6702 : OPTICAL COMMUNICATION AND NETWORKS
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Codes/tables/Charts to be permitted, if any, may be indicated

Answer ALL Questions

PART – A (10×2=20 Marks)

1. Why Partial reflection does not suffice the propagation of light ?
2. A graded index optical fiber has a core with a parabolic index profile which has a diameter of 50 μ m. The fiber has a numerical aperture of 0.2. Calculate the total number of guided modes in the fiber when it is operating at a wavelength of 1 μ m.
3. Define attenuation.
4. A manufacturer's data sheet lists the material dispersion D_{mat} = 110 ps/nm. km at a wavelength of 860 nm. Find the rms pulse broadening per km due to material dispersion if the optical source has a spectral width = 40 nm at b an output wavelength of 860 nm.
5. Write the laser diode rate equations.
6. Give some possible lensing schemes to improve optical source to fiber coupling efficiency.
7. Draw the generic structure of transimpedance amplifier.
8. Define receiver sensitivity.
9. Draw the basic structure of STS –1 SONET frame.
10. Mention any 2 nonlinear effects present in optical fiber.

PART – B **(5×16=80 Marks)**

11. a) Explain phase shift with total internal reflection and evanescent field. **(16)**

(OR)

b) Discuss whether TEM waves exist in an optical fiber. If not what type of mode will propagate in a practical optical fiber ? **(16)**

12. a) In detail, explain linear scattering losses. **(16)**

(OR)

b) A multimode step index fiber has a numerical aperture of 0.3 and a core refractive index of 1.45. The material dispersion for the fiber is 250 ps nm^{-1} km^{-1} which makes material dispersion the totally dominating chromatic dispersion mechanism. Estimate (a) the total rms pulse broadening per km when the fiber is used with an LED source of rms spectral width 50 nm and (b) the corresponding bandwidth – length product of the fiber. **(16)**

13. a) With steps, derive the internal quantum efficiency of LED. **(16)**

(OR)

b) With a neat diagram, explain the structure of LASER diode and its radiation pattern. **(16)**

14. a) Explain the dispersion measurements methods in optical fiber. **(16)**

(OR)

b) Discuss on the numerical aperture measurements of optical fiber. **(16)**

15. a) Explain SONET/SDH Networks. **(16)**

(OR)

b) Write a note on optical switching methods. **(16)**

(i) Assume τ is the average carrier lifetime in the recombination region when the injected carrier pair density is n_{th} near the threshold current density J_{th}. That is, in the steady state we have $\partial n / \partial t = 0$, so that

$$n_{th} = \frac{J_{th}\tau}{qd}$$

If a current pulse of amplitude I_p is applied to an unbiased laser diode, show that the time needed for the onset of stimulated emission is

$$t_d = \tau \ln \frac{I_p}{I_p - I_{th}}$$

Assume the drive current I = JA, where J is the current density and A is the area of the active region. (8)

(ii) If the laser is now pre-biased to a current density $J_B = I_B/A$, so that the initial excess carrier pair density is $n_B = J_B\tau / qd$, then the current density in the active region during a current pulse I_p is $J = J_B + J_p$. Show that in this case

$$t_d = \tau \ln \frac{I_p}{I_p + (I_B - I_{th})}.$$ (7)

Or

(b) With schematic diagram, explain the blocks and their functions of the major elements of an optical fiber transmission link. (15)

23/11/18 FN

Reg. No. : | | | | | | | | | | | | | |

Question Paper Code : 20428

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Seventh Semester

Electronics and Communication Engineering

EC 6702 — OPTICAL COMMUNICATION AND NETWORKS

(Regulations 2013)

(Common to PTEC 6702 – Optical Communication and Networks for B.E. (Part-Time) Sixth Semester – Electronics and Communication Engineering – Regulations 2014)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between meridional rays from skew rays.
2. A manufacturing Engineer wants to make an optical fiber that has a core index of 1.480 and cladding index of 1.478. What should be the core size for single mode operation at 1550 nm?
3. What is polarization Mode Dispersion (PMD)?
4. Distinguish between intramodal and intermodal dispersions.
5. Why is silicon not used to fabricate LED or Laser diode?
6. What is internal quantum efficiency?
7. Define responsivity.
8. State detector response time.
9. Define power penalty.
10. What is EDFA?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Draw a neat diagram and explain the ray theory behind the optical fiber communication with a special mention about the total internal reflection, Acceptance angle and Numerical aperture. (8)

(ii) Consider a multimode fiber that has a core refractive index of 1.480 and a core cladding index difference of 2%. Find the numerical aperture, the acceptance angle and the critical angle of the fiber. (5)

Or

(b) (i) Explain about step index and graded index fiber with their index profile diagrams. (8)

(ii) A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 50 μm. The fiber has a numerical aperture of 0.2. Estimate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1 μm. (5)

12. (a) (i) Prove that, delay difference between axial ray and extreme meridional ray is $\delta T_s = \frac{L\Delta n_1}{C}$. (8)

(ii) A 6 km optical link consists of multimode step index fiber, with a core RI of 1.5 and relative refractive index difference of 1%. Estimate. (5)

(1) Delay difference between the slowest and fastest modes at the fiber output

(2) RMS pulse broadening due to intermodal dispersion on the link.

(3) Maximum bit rate that may be obtained without substantial errors on the link assuming only intermodal dispersion.

Or

(b) (i) Describe the attenuation mechanisms in an optical fiber. (9)

(ii) A continuous 40 km long optical fiber link has a loss of 0.4 dB/km.

(1) What is the minimum optical power level that must be launched into the fiber to maintain an optical power level of 2.0 μW at the receiving end? (2)

(2) What is the required input power if the fiber has a loss of 0.6 dB/km? (2)

13. (a) (i) What are the characteristics required for an optical source? With help of neat diagram, describe the operation of surface emitting LED. (8)

(ii) A double heterojunction InGaAsP LED emitting at a peak wavelength of 1310 nm has radiative and non radiative recombination times of 25 and 90 ns respectively. The drive current is 35 mA.

(1) Find the internal quantum efficiency and the internal power level. (3)

(2) If the refractive index of the light source material is n = 3.5, find the power emitted from the device. (2)

Or

(b) (i) Describe the term External quantum efficiency relating to LASER. (8)

(ii) A GaAs optical source with refractive index of 3.6 is coupled to a silica fiber that has a refractive index of 1.48. What is the power loss between source and the fiber? (5)

14. (a) (i) Explain in detail about the front end optical amplifiers. (7)

(ii) Estimate the terms:- Quantum limit and Probability of Error with respect to a receiver with typical values. (6)

Or

(b) Demonstrate the following in detail :

(i) Fiber refractive index profile measurement. (7)

(ii) Fiber cutoff wavelength measurement (6)

15. (a) Explain SONET layers and its frame structure with diagram. (13)

Or

(b) (i) Define and explain the principle of WDM networks. (7)

(ii) State the nonlinear effects on optical network performance. (6)

PART C — (1 × 15 = 15 marks)

16. (a) When a current pulse is applied to a laser diode, the injected carrier pair density n within the recombination region of width 'd' changes with time according to the relationship.

$$\frac{dn}{dt} = \frac{J}{qd} - \frac{n}{\tau}$$

25/11/19/FN

Reg. No. :

Question Paper Code : 91462

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Seventh Semester

Electronics and Communication Engineering

EC6702 – OPTICAL COMMUNICATION AND NETWORKS

(Regulations 2013)

(Common to : PTEC6702 – Optical Communication and Networks for B.E. (Part-Time) – Sixth Semester – Electronics and Communication Engineering) (Regulations 2014)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Find the value of normalized frequency (V) for a given fiber with $n_1 = 1.455$, $n_2 = 1.448$ and $a = 5\ \mu m$ for wavelength $\lambda_0 = 1550$ nm.
2. Give the spectral bands used for optical fiber communications with its name and designation.
3. A fiber has an attenuation of 0.5 dB/km at 1500 nm. If 0.5 mW of optical power is initially launched into the fiber, estimate the power level after 25 km.
4. A manufacturer's data sheet lists the material dispersion D_{mat} of a GeO_2 doped fiber to be 210 ps/ (nm km) at a wavelength of 860 nm. Find the rms pulse broadening per km due to material dispersion if the optical source is a GaAlAs LED that has as spectral width σ_λ of 40 nm at an output wavelength of 860 nm.
5. 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. What is the reflectivity for normal incidence of a plane wave ?
6. What is meant by population inversion ?
7. State the significance of maintaining the fiber outer diameter constant.
8. What is the significance of intrinsic layer in PIN diodes ?
9. Compare the optical link with that of the satellite link.
10. Define power penalty.

PART – B (5×13=65 Marks)

11. a) Discuss the evolution of fiber optic communication system. (13)

(OR)

b) Describe with the aid of simple ray diagram.
   i) The multi mode step index fiber. (5)
   ii) The single mode step index fiber. (5)
   iii) Compare the advantages and disadvantages of these two types of fiber for their use as an optical channel. (3)

12. a) Discuss about the absorption losses in optical fibers and compare and contrast the intrinsic and extrinsic absorption mechanisms. (13)

(OR)

b) Suggest and validate the techniques employed and the fiber structures utilized to provide
   i) Dispersion shifted single mode fibers. (5)
   ii) Dispersion flattened single mode fibers (4)
   iii) Non zero dispersion shifted single mode fibers. (4)

13. a) i) Describe the various types of fiber connectors. (5)
   ii) Describe various fiber splicing techniques with their diagrams. (8)

(OR)

b) i) Draw and explain the different structures used to achieve carrier and optical confinement in laser diodes. (8)
   ii) Explain the lensing schemes used to improve optical source-to-fiber coupling efficiency. (5)

14. a) Discuss with necessary expressions that different types of noises that affect the performance of a photo detector. (13)

(OR)

b) i) Explain the technique used in frequency – Domain intermodal dispersion measurement. (7)
   ii) Explain the Insertion – Loss method that is used for attenuation measurement. (6)

15. a) i) Analyse the rise time budget for a fiber link. (8)
   ii) Assume that the LED together with drive circuit has a rise time of 15 ns. LED has spectral width of 40 nm. We have a material dispersion related rise time degradation of 21 ns over the 6 km link. The rise time degradation from the receiver is 14 ns. The modal dispersion induced fiber rise time is 3.9 ns. Calculate link rise time. (5)

(OR)

b) i) With suitable example, explain the conditions and constrains in the formulation and finding solution for routing and wavelength assignment problems in an optimal way. (8)
   ii) A transmitter has an output power of 0.1 mW. It is used with a fiber having NA = 0.25, attenuation of 6 dB/km and length 0.5 km. The link contains two connectors of 2 dB average loss. The receiver has a minimum acceptable power (sensitivity) of – 35 dBm. The designer has allowed a 4 dB margin. Calculate the link power budget. (5)

PART – C (1×15=15 Marks)

16. a) i) Briefly indicate with the aid of suitable diagrams the difference between meridional and skew ray paths in step index fibers. Derive an expression for the acceptance angle for a skew ray which changes direction by an angle 2γ at each reflection in a step index fiber in term of the fiber NA and γ. It may be assumed that ray theory holds for the fiber. (10)
   ii) A step index fiber with a suitably large core diameter for ray theory considerations has core and cladding refractive indices of 1.44 and 1.42 respectively. Calculate the acceptance angle in air for skew rays which change direction by 150° at each reflection. (5)

(OR)

b) Describe with the aid of suitable diagrams the mechanism giving the emission of light from a LED. Discuss the effects of this mechanism on the properties of the LED in relation to its use as an optical source for communication. (15)

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21377

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Seventh Semester

Electronics and Communication Engineering

EC 2402/EC 72 — OPTICAL COMMUNICATION AND NETWORKING

(Common to PTEC 2402 – Optical Communication and Networking for B.E. (Part-Time) Sixth Semester – Electronics and Communication Engineering – (Regulation 2009))

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. For n_1 = 1.55 and n_2 = 1.52, calculate the critical angle and Numerical aperture.
2. What is a Linearly polarized mode?
3. What is Rayleigh scattering?
4. What is meant by mechanical splice?
5. Calculate the band gap energy for an LED to emit 850 nm.
6. Define : Detector response time.
7. What are the error sources of receiver?
8. What is known as quantum limit?
9. What is a broadcast and select network?
10. What is a soliton?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive the mode equations for a circular fibre using Maxwell's equations. (8)

(ii) Calculate the Numerical Apertures of a fibre having n_1 = 1.6 and n_2 = 1.49 and another fibre having n_1 = 1.458 and n_2 = 1.405. Which fibre has greater Acceptance angle? (8)

Or

(b) (i) Explain the ray theory of a fibre with a special mention about TIR, Acceptance angle and NA. (8)

(ii) Describe Single mode fibres and their mode – field diameter. What are the propagation modes in them? (8)

12. (a) (i) Derive expressions for material dispersion and waveguide dispersion and explain them. (8)

(ii) Describe the various types of fiber connectors and couplers. (8)

Or

(b) (i) Explain fiber alignment and joint losses. (6)

(ii) Describe various fiber splicing techniques with their diagrams. (10)

13. (a) (i) Draw the structures of SLED and ELED and explain their principle of operation. (8)

(ii) Draw the injection laser diode structure and explain lasing in it. (8)

Or

(b) (i) Draw the structures of PIN and APD photo detectors and explain their operations. (8)

(ii) Derive expressions for the SNR of both PIN and APD by incorporating all noise sources. (8)

14. (a) What are the various types of Preamplifiers available for optical networks? Explain any three of them with their circuit diagrams. (16)

Or

(b) Write detailed notes on the following :

(i) Fibre refractive index profile measurement (8)

(ii) Fibre cut off wavelength measurement (8)

15. (a) (i) Explain the SA/SA protocol and modified SA/SA protocol of Broadcast and select networks. (8)

(ii) What are the non – linear effects on network performance? Explain them briefly. (8)

Or

(b) (i) Explain the layered architecture of SONET/SDH with neat diagram. (8)

(ii) Write a detailed notes on optical CDMA and its applications. (8)

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 31377

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Seventh Semester

Electronics and Communication Engineering

EC 2402/EC 72/10144 EC 702 – OPTICAL COMMUNICATION AND NETWORKING

(Regulation 2008/2010)

(Common to PTEC 2402 – Optical Communication and Networking for B.E. (Part-Time) Sixth Semester – Electronics and Communication Engineering – (Regulation 2009))

Time : Three hours Maximum : 100 marks

Missing data may be suitably assumed.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. The refractive indexes of the core and cladding of a silica fiber are 1.48 and 1.46 respectively. Find the acceptance angle for the fiber.
2. Determine the normalized frequency at 820 nm for a step-index fiber having a 25 μm radius. The refractive indexes of the cladding and the core are 1.45 and 1.47 respectively. How many modes propagate in this fiber at 820 nm?
3. A continuous 12 kms-long optical fiber link has a loss of 1.5 dB/km. What is the minimum optical power that must be launched into the fiber to maintain an optical power level of 0.3 μW at the receiving end?
4. Define dispertion in multimode fibers. What is its effect?
5. Write two differences between a Laser diode and a LED.
6. For a photodiode define quantum efficiency-η and responsivity - R.
7. A digital fiber optic link operating at 1310 nm, requires a maximum BER of 10^{-8}. Calculate the required average photons per pulse.
8. The photo detector output in a cutback-attenuation set up is 3.3 V at the far end of the fiber. After cutting the fiber at the near end, 5m from the far end, photo detector output read was 3.92 V. What is the attenuation of the fiber in dB/Km?

9. Obtain the transmission bit rate of the basic SONET frame in Mbps.

10. Illustrate interchannel cross talk that occurs in a WDM system.

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) With the help of a block diagram explain the different components of a optical fiber link. (12)

(ii) Compare the optical fiber link with a satellite link. (4)

Or

(b) (i) Explain the differences between meridional and skew rays. (4)

(ii) Bring out the differences between phase and Group velocities. (6)

(iii) Deduce an expression for NA of a fiber with the help of a neat figure showing all the details. (6)

12. (a) (i) Discuss the attenuation encountered in optical fiber communication due to :

(1) Bending

(2) Scattering

(3) Absorption. (12)

(ii) Calculate the maximum transmission distance for a fiber link with an attenuation of 0.2 dB/Km if the power launched in 1mw and the receiver sensitivity is 50 μW. Calculate the attenuation for an other link with same parameters and the distance of 26 Kms. (4)

Or

(b) (i) Clearly bringout the differences between intra and inter modal dispersion. (12)

(ii) Find the maximum bit rate for the fiber link of 5 Kms. The numerical aperture is 0.25 and the refractive index is 1.48. (4)

13. (a) (i) Explain the working of n hetero structure LED. (10)

(ii) Define Internal quantum efficiency of a LED. Deduce the expression for the same. (6)

Or

(b) (i) What do you understand by optical-wave-confinement and current confinement in LASER diode? Explain with suitable structures. (10)

(ii) Briefly explain the different noise sources of a photo detector. (6)

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14. (a) (i) Explain any two types of preamplifiers used in a receiver. (12)

(ii) Define the terms – 'Quantum limit' and 'Probability of Error' with respect to a receiver with typical values. (4)

Or

(b) (i) Explain the 'Insertion-Loss method' used for attenuation measurement. (8)

(ii) Explain the technique used in 'Frequency – Domain Intermodal Dispersion measurement'. (8)

15. (a) (i) What is a 'four-fiber BLSR' ring in a SONET? Explain the reconfiguration of the same during node or fiber failure. (8)

(ii) What is 'broadcast-and-select multihop network'? Explain. (8)

Or

(b) (i) Explain the following requirements for the design of an optically amplified WDM link :

(1) Link Band width

(2) Optical power requirements for a specific BER. (8)

(ii) Write a note on solitons. (8)

Reg. No. : | | | | | | | | | | | |

Question Paper Code : 55349

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2011.

Seventh Semester

Electronics and Communication Engineering

EC 2402 — OPTICAL COMMUNICATION AND NETWORKING

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Missing data could be suitably assumed.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the energy of a single photon of the light whose λ = 1550 nm, in eV?

2. Assume that there is a glass rod of refractive index 1.5, surrounded by air. Find the critical incident angle.

3. Define the attenuation coefficient of a fiber.

4. Calculate the cut-off wavelength of an optical signal through a fiber with its core refractive index of 1.50 and that of cladding = 1.46. The core radius of 25 μm. The normalised frequency is 2.405.

5. Why silicon is not used to fabricate LED or Laser diode?

6. Calculate the external differential quantum efficiency of a laser diode operating at 1.33 μm. The slope of the straight line portion of the curve for the emitted optical power P versus drive current I is given by 15 mW/mA.

7. Define 'quantum efficiency' of a photo detector and write the expression.

8. Mention the error sources in fiber optic receiver.

9. What are the three common topologies used for fiber optical network? Give the schematic of any one network?

10. Calculate the number of independent signals that can be sent on a single fiber in the 1525-1565 nm band. Take the spectral spacing as per ITU-T recommendation G.692.

PART B — (5 × 16 = 80 marks)

11. (a) (i) What is numerical aperture of an optical fiber? Deduce an expression for the same. (12)

(ii) Calculate NA of silica fiber with its core refractive index (n_1) of 1.48 and cladding refractive index of 1.46. What should be the new value of 'n_1' in order to change the NA to 0.23. (4)

Or

(b) (i) Explain the phenomenon of total internal reflection using Snell's law with figures and calculations. (12)

(ii) Distinguish step-index from graded index fibers. (4)

12. (a) (i) What do you mean by pulse broadening? Explain its effect on information carrying capacity of a fiber. (12)

(ii) An LED operating at 850 nm has a spectral width of 45 nm. What is the pulse spreading in ns/km due to material dispersion? What is the pulse spreading when a laser diode having a 2 nm spectral width is used? The material dispersion is 90 ps/nm km. (4)

Or

(b) (i) What is meant by 'fiber splicing'? Explain fusion splicing of optical fibers. (8)

(ii) Explain expanded beam fiber connector with a neat schematic. (8)

13. (a) (i) Compare LED with a laser diode. (4)

(ii) With the help of a neat diagram explain the construction and working of a surface emitting LED. (12)

Or

(b) (i) Explain the structure and working of a silicon APD. (12)

(ii) Define S/N ratio of a photodetector. What conditions should be met to achieve a high SNR? (4)

14. (a) (i) Explain the fiber optic receiver operation using a simple model and its equivalent circuit. (8)

(ii) Explain the operation of a pre-amplifier built using a FET. (8)

Or

(b) Explain the measurement technique used in the case of

(i) Numerical aperture

(ii) Refractive index profile

(iii) Fiber cut-off wave length

(iv) Fiber diameter. (16)

15. (a) Explain the architecture of SONET and discuss nonlinear effects on Network performance. (16)

Or

(b) Write short notes on

(i) Wavelength routed networks. (8)

(ii) Optical CDMA. (8)

Reg. No. :

Question Paper Code : 11347

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Seventh Semester

Electronics and Communication Engineering

EC 2402/EC 72/10144 EC 702 — OPTICAL COMMUNICATION AND NETWORKING

(Regulation 2008)

(Common to PTEC 2402 – Optical Communication and Networking for B.E. (Part-Time) Sixth Semester Electronics and Communication Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Calculate the cutoff wavelength of a single mode fibre with core radius of 4 μm and $\Delta = 0.003$.

2. For a fibre with core refractive index of 1.54 and fractional refractive index difference of 0.01, calculate its numerical aperture.

3. What are the two reasons for chromatic dispersion?

4. What are the most important non-linear effects of optical fibre communication?

5. Compare and contrast between surface and edge emitting LEDs.

6. What is the significance of intrinsic layer in PIN diodes?

7. What is dark current?

8. List out the various error sources.

9. What were the problems associated with PDH networks?

10. Enumerate the various SONET/SDH layers.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Starting from the Maxwell's equation, derive the expression for wave equation of an electromagnetic wave propagating through optical fibre. (8)

(ii) Describe the ray theory behind the optical fibre communication by total internal reflection. State the application of Snell's law in it. (8)

Or

(b) (i) A SI fibre with silica-core refractive index of 1.458, V = 75 and NA = 0.3 is to be operated at 820 nm. What should be its core size and cladding refractive index? Calculate the total number of modes entering this fibre. (8)

(ii) Derive expression for the linearly polarized modes in optical fibres and obtain the equation for V number. (8)

12. (a) (i) Describe the linear and non-linear scattering losses in optical fibres. (8)

(ii) An LED operating at 850 nm has a spectral width of 45 mm. What is the pulse spreading in ns/km due to material dispersion? What is the pulse spreading when a laser diode having a 2 nm spectral width is used? (8)

Or

(b) (i) Draw and explain the various fibre alignment and joint losses. (8)

(ii) Write notes on fibre splices and connectors. (8)

13. (a) Draw and explain the structure of Fabry-Perot resonator cavity for a Laser Diode. Derive Laser diode rate equations. (16)

Or

(b) (i) Draw the structure and electric fields in the APD and explain its working. (8)

(ii) What are the three factors that decides the response time of photodiodes? Explain them in detail with necessary sketches. (8)

14. (a) (i) Draw the front end optical amplifiers and explain. (8)

(ii) Considering the probability distributions for received logic 0 and 1 signal pulses, derive the expressions for BER and error function. (8)

Or

(b) Write notes on the following :

(i) Fibre refractive index profile measurement. (8)

(ii) Fibre cut-off wavelength measurement. (8)

15. (a) Discuss the concepts of Media Access Control protocols in Broadcast and select networks. (16)

Or

(b) (i) Describe the non-linear effects on network performance in detail. (8)

(ii) Explain the basics of optical CDMA systems. (8)

$NA = n_1 (2\Delta)^{1/2} \Rightarrow \Delta =$

$V = \frac{2\pi}{\lambda} a n_1 (2\Delta)^{1/2} \Rightarrow a$ (radius).

$\Delta = \frac{n_1 - n_2}{n_1}$ → refractive index

$M = \frac{V^2}{2}$