11/04/19

Reg. No. :

Question Paper Code : 30961

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Seventh Semester

Electronics and Communication Engineering

EC 2402 — 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

Missing data may be suitably assumed.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Show the correspondence between the lower order in linearly polarized (LP) modes and the traditional exact modes from which they are formed along with the schematic diagram of the electric field configurations for the three lowest LP modes in the cylindrical fiber.

2. Define Goos-Haenchen shift.

3. What is fiber birefringence?

4. When the mean optical power launched into a 8 km fiber is 120 μW. The mean optical power at the fiber output is 3 μW. Calculate the overall attenuation in dB assuming there are no splices.

5. Differentiate between LED and laser diode.

6. What do you mean by thermal noise?

7. Define quantum limit.

8. List out the various error sources in the receiver section.

9. Mention the drawbacks of broadcast and select networks for wide area network applications.

10. List the three common topologies used for fiber optical network.

PART B — (5 × 16 = 80 marks)

11. (a) (i) 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. Calculate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1 μm. (8)

(ii) Define and derive the expression for numerical aperture of the fiber. (8)

Or

(b) (i) An optical fiber in air has a numerical aperture of 0.4. Compare the acceptance angle for meridional rays with that for skew rays which change direction by 100° at each reflection and also comment on the result. (8)

(ii) With a neat sketch, illustrate the modes in a planar guide. (8)

12. (a) (i) Discuss the various fiber alignment losses and joint losses with a neat sketch. (8)

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

(1) the maximum possible bandwidth on the link assuming no intersymbol interference;

(2) the pulse dispersion per unit length;

(3) The bandwidth-length product for the fiber.

Or

(b) (i) A long single-mode optical fiber has an attenuation of 0.5 dB km^{-1} when operating at a wavelength of 1.3 μm. The fiber core diameter is 6 μm and the laser source bandwidth is 600 MHz. Compare the threshold optical powers for stimulated Brillouin and Raman scattering within the fiber at the wavelength specified. (8)

(ii) What is meant by fiber splicing? Brief in detail the technique and methods of fiber splicing. (8)

13. (a) (i) The radiative and nonradiative recombination lifetimes of the minority carriers in the active region of a double-heterojunction LED are 60 ns and 100 ns respectively. Determine the total carrier recombination lifetime and the power internally generated within the device when the peak emission wavelength is 0.87 μm at a drive current of 40 mA. (8)

(ii) Demonstrate the structure and working of silicon avalanche photo diode. (8)

Or

(b) (i) Discuss the basic principle and operation of gain guided laser and index-guided laser diodes along with the schematic diagram. (8)

(ii) When $3*10^{11}$ photons each with a wavelength of 0.85 μm are incident on a photodiode, on avenge $1.2*10^{11}$ electrons are collected at the terminals of the device. Determine the quantum efficiency and the responsivity of the photodiode at 0.85 μm. (8)

14. (a) (i) A photodiode has a capacitance of 6 pF. Calculate the maximum load resistance which allows an 8 MHz post-detection bandwidth. Determine the bandwidth penalty with the same load resistance when the following amplifier also has an input capacitance of 6 pF. (8)

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

Or

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

(ii) Pulse dispersion measurements are taken over a 1.2 km length of partially graded multimode fiber. The 3 dB widths of the optical input pulses are 300 ps, and the corresponding 3 dB widths for the output pulses are found to be 12.6 ns. Assuming the pulse shapes and fiber impulse response are Gaussian, calculate:

(1) the 3 dB pulse broadening for the fiber in ns km^{-1}.

(2) the fiber bandwidth-length product. (8)

15. (a) (i) Describe the SONET frame structures with neat diagrams. (8)

(ii) Write a note on the concept of solitons. (8)

Or

(b) Describe in detail the non-linear effects on the performance of the network. (16)

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