Code : 041605

B.Tech 6th Semester Exam., 2016

OPTICAL FIBER COMMUNICATION

Time : 3 hours **Full Marks : 70**

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer (any *seven*) : **2×7=14**

(a) A step-index fiber has a core with a refractive index of 1·5 and cladding refractive index of 1·46. Its numerical aperture is

(i) 0·156

(ii) 0·244

(iii) 0·344

(iv) 0·486

(b) Inside the ideal dielectric medium

(i) free charge density ρ is zero but conductivity σ is non-zero

(ii) ρ is non-zero but σ is zero

(iii) both ρ and σ are zero

(iv) both ρ and σ are non-zero

(c) A step-index fiber has a core refractive index 1·5 and a cladding refractive index 1·49. The core diameter is 100 μm. How many guided modes are supported by the fiber if the wavelength of light is 0·85 μm?

(i) 180

(ii) 500

(iii) 1060

(iv) 2040

(d) A GI fiber with a parabolic profile has an axial refractive index of 1·46 and Δ of 0·5% . What is the pulse broadening per unit length due to intermodal dispersion?

(i) 30·4 nm/km

(ii) 60·8 nm/km

(iii) 60·8 ps/km

(iv) Zero

(e) Which of the following refractive index profiles is suitable for achieving the dispersion-flattened design of a single-mode fiber?

(i) Matched cladding

(ii) Triangular profile

(iii) W-profile

(iv) Depressed cladding

(f) In a multimode fiber, the strength member

(i) must be placed along the central axis of the cable

(ii) must be placed in a coaxial cylindrical configuration

(iii) can be placed anywhere within the cable

(iv) is not required at all

(g) With an OTDR, it is possible to know

(i) the location dependence of attenuation

(ii) the overall link length

(iii) splice and connector loss

(iv) All of the above

(h) In an LED, which of the following factors affects most severely the efficiency of the diode and cannot be eliminated even in principle?

(i) Fresnel reflection

(ii) Back emission

(iii) Total internal reflection

(iv) Absorption

(i) A photoconducting detector can be constructed from

(i) an intrinsic semiconductor

(ii) an extrinsic semiconductor

(iii) polycrystalline material

(iv) All of the above

(j) Gain in EDFA depends on which of the following factors?

(i) Doping concentration

(ii) Length of the doped fiber

(iii) Pump power

(iv) All of the above

(a) Explain the advantages of optical fibers compared to copper wires. 7

(b) A typical relative refractive index difference for an optical fiber designed for long distance transmission is 1%. Estimate the NA and the solid acceptance angle in air for the fiber when the core index is 1·46. Further, calculate the critical angle at the core-cladding interface within the fiber. It may be assumed that the concepts of geometric optics hold for the fiber. 7

(Continued)

3. *(a)* Explain linearly polarized (LP) modes. Draw the intensity patterns/visual patterns for the following LP modes: 7

(i) LP_{01}

(ii) LP_{11}

(iii) LP_{02}

(iv) LP_{31}

(v) LP_{12}

(vi) LP_{21}

(b) Derive the expression for numerical aperture for a parabolic profile-based graded index fiber. 7

4. With the help of suitable diagrams, explain the following : 3½×4=14

(a) Goos-Haenchen shift

(b) V-number

(c) Mode-field diameter

(d) Difference between single-mode and multi-mode step index fibers

5. *(a)* Explain different types of distortions in an optical fiber. 7

(b) A multimode step-index fiber has an N.A of 0·3 and a core refractive index of 1·45. The material dispersion parameter

for the fiber is 250 ps nm^{-1} km^{-1} which makes material dispersion the totally dominating chromatic dispersion mechanism. Estimate the total r.m.s. pulse broadening per kilometer when the fiber is used with an LED source of r.m.s. spectral width 50 nm. 7

(a) Discuss the major requirements for an optical detector. 7

(b) With the help of suitable diagram(s) and examples, explain the direct and indirect band gap semiconducting materials. 7

(a) The refractive index of the *InGaAsP* active region of an injection laser at a wavelength of 1·5 μm is 3·5 and the device has an active cavity length of 400 μm. For laser operation at a wavelength of 1·5 μm, determine *(i)* the laser emission mode index, *(ii)* the frequency separation of the modes in the active cavity in order to produce constructive interference. 7

(b) A photodiode has a quantum efficiency of 65% when photons of energy 1.5×10^{-19} J are incident upon it.

(i) At what wavelength is the photodiode operating?

(ii) Calculate the incident optical power required to obtain a photocurrent of 2.5 μA when the photodiode is operating as described above.

8. (a) With the help of neat diagram(s), describe the working of PIN photodiode.

(b) Explain the following : 3½×2

(i) Optical circulators

(ii) Fiber bragg grating

9. (a) Describe the passive optical couplers with neat diagram(s).

(b) Explain rise time budget.

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