Question Paper Code : Q 2769

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Seventh Semester

(Regulation 2004)

Electronics and Communication Engineering

EC 1402 — OPTICAL COMMUNICATION

(Common to B.E. (Part–Time) Sixth Semester Regulation 2005)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is tunnel effect in Optical fiber?

2. What is Skew Ray?

3. What are micro bends? How they are formed?

4. A Multimode GI fiber exhibits a total pulse broadening of 0.1 μ sec over a distance of 15 km. Estimate maximum possible Bandwidth on the line.

5. Define the three modes of the cavity of Laser.

6. What is a DFB Laser? What is its main difference from the other Lasers?

7. List out the values of Operating Wavelengths and Responsivities of Si, Ge and InGaAs photodiodes.

8. What is meant by (1/f) noise corner frequency?

9. What is chirping?

10. What are the techniques used for minimizing reflection noise?

PART B — (5 × 16 = 80 marks)

11. (a) (i) With the help of suitable diagrams, explain the following concepts in Optical fiber transmission. (12)

(1) Evanescent field (2) Goos–Haenchen shift and (3) mode coupling.

(ii) A Multimode GI fiber has an acceptance angle in air of 8°. Estimate the relative refractive index difference between the core axis and the cladding when the refractive index at the core axis is 1.52. (4)

Or

(b) (i) Explain with simple ray diagrams (1) the multimode SI fiber and (2) the single mode SI fiber. Compare the advantages and disadvantages of these two types. (10)

(ii) A single mode step index fiber has core and cladding refractive indices of 1.498 and 1.495 respectively. Determine the core diameter required for the fiber to permit its operation over the wavelength range 1.48 and 1.60 μm. Calculate the new fiber core diameter to enable single mode transmission at the wavelength of 1.3 μm. (6)

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

(ii) Silica has an estimated fictive temperature of 1400 K with an isothermal compressibility of 7×10^{-11} m^{2}N^{-1}. The refractive index and the photo–elastic coefficient for Silica are 1.46 and 0.286 respectively. Determine the theoretical attenuation in dB/km due to the fundamental Rayleigh scattering in Silica at optical wavelengths 850 nm, 1310 nm and 1550 nm. (Boltzmann's constant = 1.381×10^{-23} JK^{-1}) (8)

Or

(b) (i) Describe the intermodal pulse broadening in Multimode SI and GI fibers and derive the expressions for their delay difference between the extreme meridional ray and the axial ray and the rms pulse broadening at the fiber output. (8)

(ii) The beat length in a single mode optical fiber is 9 cm when light from an injection laser with a spectral line width of 1 nm and a peak wavelength of 1550 nm is launched into it. Determine the modal birefringence and estimate the coherence length in this situation. Also, calculate the difference between the propagation constants for the two orthogonal modes and check the result. (8)

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13. (a) (i) Explain the theory of Stimulated emission and lasing with the help of Energy band diagrams. Also explain its temperature dependence characteristics. (12)

(ii) A GaAs injection Laser has an optical cavity of length 250 μ m and width 100 μ m. At normal operating temperature the gain factor β is 21 $\times$ 10^{-3} A cm^{-3} and the loss coefficient α per cm is 10. Determine the threshold current density and hence the threshold current for the device. It may be assumed that the cleaved mirrors are uncoated and the current is restricted to the optical cavity. The refractive index of GaAs may be taken as 3.6. (4)

Or

(b) (i) With the aid if diagrams explain the permanent joining schemes of optical fiber. (10)

(ii) Compare the threshold current densities at 32°C and 100°C for a AlGaAs injection Laser with $T_0 = 160$ K and the similar ratio for an InGaAlP device with $T_0 = 55$ K. (6)

14. (a) (i) Describe the characteristic of Responsivity against wavelength for an ideal silicon photodiode with the help of its expression. Explain the Direct and Indirect absorption in Si and Ge. (10)

(ii) A photodiode has a quantum efficiency of 73% when photons of energy 1.5 $\times$ 10^{-19} J are incident upon it. Estimate the wavelength at which the photodiode operates and calculate the incident optical power required to obtain a photocurrent of 2.2 μA when the photodiode is operating as above. (6)

Or

(b) (i) Describe the various sources of noise that affect the performance of Optical receivers. Derive expressions for the S/N of APD receiver.(8)

(ii) A good Si APD (x = 0.3) has a capacitance of 5 pF, negligible dark current and is operating with a post detection Bandwidth of 50 MHz. When the photocurrent before gain is 10^{-7} A and a temperature is 18°C; determine the maximum S/N improvement between M = 1 and M = M_{op} assuming all operating conditions are maintained. (8)

15. (a) (i) Draw the Soliton pulse and its envelop and describe its fundamentals and its propagation in optical fibers. (8)

    (ii) Explain the Layers of SONET with neat sketches. (8)

Or

   (b) (i) Describe the operations of Unidirectional and Bidirectional WDM. (8)

    (ii) Draw and explain the principle of operation of an EDFA. Describe the approaches to achieve flatness in its gain. (8)