EC-703B

Optical Communication and Networking

Time Allotted: 3 Hours Full Marks:

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP A
(Multiple Choice Type Questions)

1. Answer any *ten* questions. 10×1 =

(i) In purely single mode operation pulse broadening is due to

(A) intermodal dispersion (B) intramodal dispersion
(C) large bandwidth (D) none of these

(ii) Optical bandwidth is always

(A) greater than the electrical BW (B) less than the electrical BW
(C) equal to the electrical BW (D) square of the electrical BW

(iii) The responsivity of a given PIN diode is 0.5 AW^{-1} for a wavelength of 1 micrometer. What is the output photocurrent when optical power of 0.2 μm at this wavelength is incident on it?

(A) 1 μm (B) 0.1 μm (C) 10 μm (D) 1 Å

(iv) What is the maximum limit of BER allowed in optical communication system for faithful digital transmission?

(A) 10^{-19} (B) 10^{-9} (C) 10^{9} (D) 10^{19}

(v) Erbium doped fiber amplifiers operate at which of the following window(s)?

(A) low dispersion window (around 1300 nm)
(B) low dispersion window (1550 nm)
(C) both of the windows
(D) none of these

(vi) Which of the following is an inherent property of an optical signal and cannot be determined even in principle?

(A) thermal noise (B) shot noise
(C) background noise (D) environmental noise

(vii) Photodetectors used in optical fiber is

(A) p-i-n, APD (B) p-i-n, Gunn diode
(C) APD, Gunn diode (D) none of these

(viii) Which of the following is true for LASER

(A) spatial coherence (B) temporal coherence
(C) both (A) and (B) (D) none of these

(ix) Which of the following pairs are suitable for making a heterojunction?

(A) Si and Ge (B) Si and GaAs
(C) GaAs and AlAs (D) GaAs and GaAlAs

(x) Attenuation in optical fiber is measured in

(A) dB/km (B) dB/hr
(C) k dB/m (D) dBm/m

(xi) Pulse broadening in multimode fiber is due to

(A) Intermodal dispersion (B) intramodal
(C) both (A) and (B) (D) none of these

(xii) The v number for an optical fiber is 50. The number of modes in that fiber is approximately

(A) 50 (B) 1050
(C) 1250 (D) 1650

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. (a) What do you mean by population inversion? 2
   (b) With the help of suitable diagram, show how population inversion is obtained during the operation of laser diode. 3

3. (a) What are the differences between meridional rays and skew rays? 2
   (b) Compare between step index fiber and graded index fiber? 3

4. What are the desired requirements of the optical source suitable for optical communication? 5

5. What is optical power budgeting? Why is system margin provided? 3+2

6. Discuss the different modulation drive circuits for LEDs and explain their operation. 5

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) What do you mean by luminescence process? 3
   (b) How does an LED work? 5
   (c) Show the construction of ELED. 5
   (d) What are the applications of LED? 2

8. (a) What are shot noise and Johnson noise? 3
   (b) Draw the characteristic curves for I vs V_R, P_{OPT} vs I_{PH}, λ vs R, λ vs absorption coefficient for photodiodes. 6

   (c) A photo detector has a load resistor of 50 Ω and the optical power absorbed by the detector is 1 μW. The detector has a quantum efficiency of 10% at the operating wavelength of 800 nm. Calculate the voltage across the load.

9. (a) A glass optical fiber has a core refractive index of 1.5 and the cladding refracting index of 1.45, calculate:
   (i) the critical angle for core–cladding interface; (ii) the acceptance angle in air for the fiber; (iii) NA of the fiber.
   (b) What do you mean by intermodal and intramodal dispersions?
   (c) A multimode graded index fiber exhibits total pulse broadening of 0.1 μs over distance of 15 km. Estimate:
      (i) The maximum possible bandwidth on the link assuming low inter symbol interference.
      (ii) The pulse dispersion per unit length.
      (iii) The bandwidth length product for the fiber.

10. (a) What are the advantages of LASER diode over LED?
   (b) Why direct bandgap material is used for LED?
   (c) The radiative and non-radiative recombination lifetime of the minority carriers in the active region of a double hetero-junction LED are 60 ns and 100 ns respectively. Determine:
      (i) the total carrier recombination lifetime and
      (ii) the power internally generated within the device when peak emission wavelength is 0.87 μm at a drive current of 40 mA.

11. Draw the structure of semiconductor laser diode. A GaAs ILD has an optical cavity of length 250 μm and width 100 μm. At normal operating temperature the gain factor is 21×10^{-3} Acm^{-3} and the loss coefficient per cm is 10. Determine the threshold current density and hence the threshold current for the device. Given the reflectivity of the mirrors $r_1 = r_2 = 0.32$.

12. Write short notes on any *three* of the following:
   (a) OEIC
   (b) Avalanche photodiode
   (c) Topology
   (d) WDM
   (e) ISDN