Total No. of Questions : 12] **SEAT No. :**

P3620 **[Total No. of Pages : 4**

[5154]-123

B.E. (E & TC)

OPTICAL FIBER COMMUNICATION

(2008 Pattern)

Time : 3 Hours] ***[Max. Marks : 100***

Instructions to the candidates:

1) ***Answer Q1 or Q2, Q3 or Q4, Q5 or Q6 from Section - I and Q7 or Q8, Q9 or Q10, Q11 or Q12 from Section - II.***
2) ***Answers to the two sections should be written in separate answer-books.***
3) ***Figures to the right indicate full marks.***
4) ***Your answer will be valued as a whole.***
5) ***Neat diagrams must be drawn wherever necessary.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Explain the terms: mode field diameter, spot size and cut off wavelength for single mode fibers. **[6]**

b) A multimode step index fiber with a core diameter of 80 μm and a relative index difference of 1.5% is operating at a wavelength of 0.85 μm. If the core refractive index is 1.48 estimate the normalized frequency for the fiber and number of guided modes. **[6]**

c) State advantages and disadvantages of vapour phase decomposition in the preparation of glass for optical fiber. **[6]**

OR

Q2) a) Compare and Contrast Multimode and Single mode fiber. **[6]**

b) A multimode step index fiber has a relative refractive index difference of 1% and a core refractive index of 1.5. the number of modes propagating at a wavelength of 1.3 μm is 1100 **[6]**

Estimate the diameter of the fiber core.

c) With the help of neat diagram explain the principle of total internal reflection. **[6]**

P.T.O.

Q3) a) Explain the various attenuation mechanisms in optical fiber. Sketch attenuation characteristics w.r.t. wavelength for a fiber. Hence indicate the three windows of transmission for the optical fiber communication. **[8]**

b) What are the major requirements of an optical source to be used as a light source in optical fiber communication. **[8]**

OR

Q4) a) What are advantages of LED over ILD as optical source? Why LED is preferred as light source for analog link rather than ILD? Support your answer with a suitable diagram. **[8]**

b) Explain various types of Dispersion mechanisms observed in optical fiber. **[8]**

Q5) a) Explain Dispersion shifted fibers and dispersion flattened fibers. **[8]**

b) Radiative and non-radiative recombination lifetimes for minority carriers in the active region of a double-heterojunction LED are 60ns and l00ns 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]**

OR

Q6) a) Sketch and explain: **[8]**

i) Insertion loss characteristics for jointed fibers with various types of misalignments.

ii) Various mismatch losses at the fiber joints.

b) Explain fiber optic splices. What are different types of splices? Draw diagram and explain any one type of splice. How splice differs from a connector? **[8]**

SECTION - II

Q7) a) Explain the following factors limiting the speed of response of a photo diode: **[10]**

i) Drift time of carriers

ii) Diffusion time

iii) Time constant

A silicon p-i-n photodiode has 25 μm depletion layer width and carrier velocity 3×l04 m/s. Determine the maximum bandwidth and the corresponding response time for the device.

b) Explain the terms quantum efficiency and responsivity of a photo detector. How are these terms related to each other? **[8]**

OR

Q8) a) Explain the working of PIN photo detector with relevant diagrams. Compare and contrast performance of PIN and APD as photo detector in optical fiber communication. **[10]**

b) A photodiode has a quantum efficiency of 65% when photons of energy 1.5×10^{-19} J are incident upon it. **[8]**

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 above.

Q9) a) Draw the block diagram of an analog optical fiber link and state the major noise contributors. Explain carrier to noise ratio and relative intensity noise with reference to analog link. **[8]**

b) The following parameters are established for a long-haul single-mode optical fiber system operating at a wavelength of 1.3 μm: **[8]**

Mean power launched from the laser transmitter: – 3 dBm

Cabled fiber loss: 0.4 dB km^{-1}

Splice loss: 0.1 dB km^{-1}

Connector losses at the transmitter and receiver: 1 dB each

Mean power required at the APD receiver:

when operating at 35 Mbit s^{-1} (BER $l0^{-9}$): – 55 dBm

when operating at 400 Mbit s^{-1} (BER 10^{-9}): – 44 dBm

Required safety margin: 7 dB

Estimate:

i) The maximum possible link length without repeaters when operating at 35 Mbit s^{-1} (BER 10^{-9}). It may be assumed that there is no dispersion– equalization penalty at this bit rate.

ii) The maximum possible link length without repeaters when operating at 400 Mbit s^{-1} (BER 10^{-9}) and assuming no dispersion– equalization penalty.

OR

Q10)a) Describe digital link budget. Explain link power budget analysis and system rise time budget. **[8]**

b) An optical fiber system is to be designed to operate over an 8km length without repeaters. **[8]**

The rise times of the chosen components are:

Source (LED):	8 ns
Fiber: Intermodal:	5 ns km^{-1}
(Pulse broadening) intramodal:	1 ns km^{-1}
Detector (p-i-n photodiode):	6 ns

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

Q11)a) Explain in detail the architecture and working of EDFA. What are noises observed in EDFA **[8]**

b) Draw block schematic of WDM and explain its working. Specify range of wavelengths commonly used for WDM. **[8]**

OR

Q12)a) Explain various applications of optical amplifiers. Support your answer with suitable diagram. **[8]**

b) Explain usage of optical couplers. How they differ from connectors? **[8]**

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