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# Question Paper Code : 40972

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018

Seventh Semester

Electronics and Communication Engineering

EC 6702 – OPTICAL COMMUNICATION AND NETWORKS

(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Sketch the cross sectional view of the transverse electric field vectors for the four lowest order modes in a step index fiber.

2. State the reasons to opt for optical fiber communication.

3. What is elastic and inelastic scattering ? Give examples.

4. Define polarization mode dispersion and write the expression for it.

5. Illustrate the factors that determine the response time of the photodiode.

6. An LED has radiative and non-radiative recombination times of 30 ns and 100 ns respectively. Determine the internal quantum efficiency.

7. List the error sources associated with fiber optic receiver section.

8. Define quantum limit.

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

10. Write a short note on soliton.

PART – B (5×16=80 Marks)

11. a) i) A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and a cladding refractive index of 1.47. Determine : (8)

a) The critical angle at the core-cladding interface.

b) The numerical aperture for the fiber.

c) The acceptance angle in air for the fiber.

ii) Discuss briefly about the structure of graded index fiber. (8)

(OR)

b) i) A graded index fiber with a parabolic refractive index profile core has a refractive index at the core axis of 1.5 and a relative index difference of 1%. Estimate the maximum possible core diameter which allows single-mode operation at a wavelength of 1.3 μm. (8)

ii) With the neat block diagram, explain the fundamental blocks of optical fiber communication. (8)

12. a) i) Explain in detail about the scattering and the bending losses that occur in an optical fiber with relevant diagrams and expressions. (8)

ii) When the mean optical power launched into an 8 km length of fiber is 120 μW, The mean optical power at the fiber output is 3 μW. Determine : (8)

a) The overall signal attenuation or loss in decibels through the fiber assuming there are no connectors or splices ;

b) The signal attenuation per kilometer for the fiber

c) The overall signal attenuation for a 10 km optical link using the same fiber with splices at 1 km intervals, each giving an attenuation of 1 dB ;

d) The numerical input/output power ratio in (c).

(OR)

b) i) Discuss material and waveguide dispersion mechanisms with necessary mathematical expressions. (8)

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

a) The maximum possible bandwidth on the link assuming no inter-symbol interference ;

b) The pulse dispersion per unit length

c) The bandwidth-length product for the fiber.

13. a) i) A planar LED is fabricated from gallium arsenide which has a refractive index of 3.6. (8)

a) Calculate the optical power emitted into air as a percentage of the internal optical power for the device when the transmission factor at the crystal-air interface is 0.68.

b) When the optical power generated internally is 50% of the electric power supplied, determine the external power efficiency.

ii) Illustrate the different lensing schemes available to improve the power coupling efficiency. (8)

(OR)

b) i) Give a brief account on the resonant frequencies of laser diodes. (8)

ii) Explain about the various fiber splicing techniques with necessary diagrams. (8)

14. a) i) Measurements are made using a calorimeter and thermocouple experimental arrangement. Initially a high absorption fiber is utilized to obtain a plot of $(T_\infty - T_t)$ on a logarithmic scale against t. It is found from the plot that the readings of $(T_\infty - T_t)$ after 10 and 100 seconds are 0.525 and 0.021 μV respectively. The test fiber is then inserted in the calorimeter and gives a maximum temperature rise of $4.3 * 10^{-4}$ °C with a constant measured optical power of 98 mW at a wavelength of 0.75 μm, The thermal capacity per kilometer of the silica capillary and fluid is calculated to be $1.64 * 10^4$ J $°C^{-1}$. Determine the absorption loss in dB $km^{-1}$, at a wavelength of 0.75 μm, for the fiber under test. **(8)**

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

(OR)

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

ii) A He-Ne laser operating at a wavelength of 0.63 μm was used with a solar cell cube to measure the scattering loss in a multimode fiber sample. With a constant optical output power the reading from the solar cell cube was 6.14 nV. The optical power measurement at the cube without scattering was 153.38 μV. The length of the fiber in the cube was 2.92 cm. Determine the loss due to scattering in dB $km^{-1}$ for the fiber at a wavelength of 0.63 μm. **(4)**

iii) A trigonometrical measurement is performed in order to determine the numerical of a step index fiber. The screen is positioned 10.0 cm from the fiber end face. When illuminated from a wide-angled visible source the measured output pattern size is 6.2 cm. Calculate the approximate numerical aperture of the fiber. **(4)**

15. a) i) What is optical power budgeting ? Determine the optical power budget for the below system and hence determine its viability.
Components are chosen for a digital optical fiber link of overall length 7 km and operating at 20 Mbit $s^{-1}$ using an RZ code. It is decided that an LED emitting at 0.85 μm with graded index fiber to a p-i-n photodiode is a suitable choice for the system components, giving no dispersion-equalization penalty. An LED which is capable of launching an average of 100 μW of optical power (including the connector loss) into a graded index fiber of 50 μm core diameter is chosen. The proposed fiber cable has an attenuation of 2.6 dB $km^{-1}$ and requires splicing every kilometer with a loss of 0.5 dB per splice. There is also a connector loss at the receiver of 1.5 dB. The receiver mean incident optical power of –41 dBm in order to give the necessary BER of $10^{-10}$, and it is predicted that a safety margin of 6 dB will be required. **(8)**

ii) Discuss about the concept of routing and wavelength assignment in the wavelength routed networks. **(8)**

(OR)

b) i) Briefly explain the layers of the SONET. **(6)**

ii) Describe in detail the non-linear effects on the performance of the network. **(10)**

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