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Code : 041605

B.Tech 6th Semester Exam., 2015

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 option (any *seven*) : 2×7=14

   (a) If any substance emits light of a wavelength larger than that of incident light, then this is known as

   (i) scattering

   (ii) diffraction

   (iii) luminescence

   (iv) None of the above

   (b) The process of separating light into each of its component frequencies is known as

   (i) refraction

   (ii) dispersion

   (iii) scattering

   (iv) total internal reflection

(c) The critical angle of incidence between two substances with different refractive indices, where $n_1 = 1 \cdot 5$ and $n_2 = 1 \cdot 46$ is

(i) 66·3°

(ii) 66·9°

(iii) 67·9°

(iv) 76·7°

(d) In the formation of optical fiber through MCVD method the diameters of core and clad are taken respectively as

(i) 8, 117

(ii) 5, 120

(iii) 11, 114

(iv) 9, 116

(e) The term 'power budgeting' refers to

(i) the cost of cable, connectors, equipments and installation

(ii) the loss of power due to defective components

(iii) the total power available minus the attenuation loss

(iv) the comparative cost of fiber and copper installations

(f) Which of the following fibers has the highest modal dispersion?

(i) Step-index multimode

(ii) Graded index multimode

(iii) Step-index single mode

(iv) Graded index mode

(g) Which of the following is used as an optical receiver in fiber-optic communications?

(i) APD

(ii) Tunnel diode

(iii) Laser diode

(iv) LED

(h) A fiber-optic cable has a loss of 15 dB/km. The attenuation in a cable 1000 ft long is

(i) 4·57 dB

(ii) 9·30 dB

(iii) 24 dB

(iv) 49·20 dB

(ii) How many modes are possible with a multimode step index with a core diameter of 50 μm, a core refractive index of 1·6, a cladding refractive index of 1·584 and wavelength of 1300 nm?

(i) 456

(ii) 213

(iii) 145

(iv) 372

(j) When connector losses, splice losses and coupler losses are added, what is the limiting factor?

(i) Source power

(ii) Fiber attenuation

(iii) Connector and splice losses

(iv) Detector sensitivity

2. (a) Describe, with the help of a block diagram, the working of an optical fiber communication. Also discuss its advantages over general communication system. 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 constants of geometric optics hold for the fiber. 7

3. (a) What do you mean by modes of fiber? Illustrate the modes for cylindrical fiber. 7

(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—

(i) normalized frequency for the fiber; 7

(ii) number of guided modes.

4. (a) Discuss the all non-linear scattering losses associated in optical fiber communication. 7

(b) Silica has an effective 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 decibels per beam due to the fundamental Rayleigh scattering in silica at optical wavelength. 7

5. *(a)* What do you mean by fiber connector? Describe the multiple fiber connectors with neat diagram. 7

(b) A four-port multimode fiber FBT coupler has 60 μW optical power launched into port 1. The measured output power at ports 2, 3 and 4 are 0·004 μW, 26·0 μW and 27·5 μW respectively. Determine the excess loss, insertion losses between the input and output ports, the crosstalk and the split ratio of the device. 7

6. *(a)* Discuss the major requirements for an optical fiber emitter. 7

(b) A DH surface emitter which has an emission area diameter of 50 μm is butt jointed to an 80 μm core step-index fiber with an NA of 0·15. The device has a radiance of 30 W $Sr^{-1} cm^{-2}$ at a constant operating drive current. Estimate the optical power coupled into the fiber. It is assumed that the reflection coefficient at the index matched fiber surface is 0·01. 7

(Continued)

7. *(a)* Describe the working of PIN photodiode with neat diagram. 7

(b) The quantum efficiency of a particular silicon APD is 80% for the detection of radiation at a wavelength of 0·9 μm. When the incident optical power is 0·5 μW, the output current from the device (after avalanche gain) is 11 μA. Determine the multiplication factor of photodiode under these conditions. 7

8. *(a)* Write short notes on the following : 7

(i) Dark current noise

(ii) Quantum noise

(b) What do you mean by splicing? Illustrate the differences between mechanical and fusion splicings. 7

9. *(a)* Discuss the need of power budget in fiber optical communication. 7

(b) What do you mean by solitons? What are their applications and specifications? 7

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